MIDDLE POMERANIAN SCIENTIFIC SOCIETY OF THE ENVIRONMENT PROTECTION

Rocznik Ochrona Środowiska

Volume 22. Year 2020 ISSN 1506-218X 24-39

Safety Assessment of a Mineworking in Order to Use Its Cultural and Educational Potential and Ensure Environmental Sustainability

Oľga Végsöová, Martin Straka[*]*, Kamil Kyšeľa*

Technical University of Kosice, Slovakia

[*]*corresponding author's e-mail: martin.straka@tuke.sk*

1. Introduction

This paper presents a proposal for the revitalization of a mining operation and the surrounding environment, which may have a significant socio-economic impact on this micro-region of the Spiš region. The paper concerns the mining operation in Novoveská Huta, where its closure and a proposal for revitalization are being considered in the foreseeable future. Our proposal shows one of the possibilities of dealing with the mineworking in such a way that, in our opinion, contributes to the sustainable development of this micro-region, which has been associated with mining activities for decades so that it remains on today's mining map of Slovakia.

Alexandrowicz and Miskiewicz (2016) addressed the issue of revitalization of mining areas from the point of view of geoheritage, working with the idea of revitalization in the form of geoparks, designing them from the conceptual phase through implementation, with an emphasis on the Republic of Poland.

As reported by Novas et al. (2017), underground space can be remodelled for uses such as underground museums, car parks, an entertainment centre or new communities.

Szente et al. (2019) point out that information and spreading knowledge of environmental burdens in connection with mineworkings that are no longer in operation is of great importance to the local population.

Geological records are the result of processes lasting millions of years. They are considered valuable and require special care. Our main responsibility is to take care of this heritage so that it is not lost forever, according to Lopes et al. (2015), who also emphasized the need to pass on knowledge and geoheritage to

future generations. Also, Manyuk et al. (2020) focus on the protection of geological heritage. Similarly, Tlhapiso and Stephens (2020) share the view that geoheritage sites can be an excellent source of sustainable development. Gray and Gordon (2020) add to the view and argue that geodiversity as a concept has real value because it is the backbone of international and national geoheritage strategies and they present a document that explains e.g. the relationship between geology, geodiversity, geoheritage geoconservation.

Closed mines are becoming a suitable place for teaching.

Molokac et al. (2017) stated the reasons why education is a powerful tool not only for obtaining information and knowledge, but also for creating opinions and decision making. Education is capable of changing views and stereotypes associated with various industrial sectors. The aim of Alvarez (2020) was to highlight the educational activities that resulted from the UNESCO Villuercas global geopark, which provides resources to address the process of teaching cultural and natural values, including geology, while having a positive impact on environmental awareness and respect for the environment and cultural resources.

Meléndez et al. (2007) confirmed that museum mines, when properly selected and maintained, offer students good opportunities to teach geology. As Stefano and Paolo (2017) describe, abandoned mines often serve as valuable resources for education or as exhibits for museum purposes. At present, museums also offer digitized content, or virtual reality, which significantly increases the understanding of technology by visitors. Torres-Ruiz et al. (2020) address this area of visitor perception, which develops the technology of the Internet of Things and semantic analysis. More on this technology can be found in Glova et al. (2014), Tilabi et al. 2019, Grabara et al. (2020), which includes the creation of business models for various types of solutions, also applicable in the context of revitalization.

As expressed by Filocamo et al. 2020 Geotourism is a powerful and new form of sustainable tourism that has spread rapidly around the world in recent decades. Chrobak et al. (2020) define Geotourism as a type of qualified tourism promoting geosites related to geological backgrounds and relief elements.

Bento et al. (2020) present a study in which they attempted to understand the segmentation of tourism; reflect Geotourism in its historical context, relate the concepts of Geodiversity and Geotourism, understand and differentiate the approaches directed to the concepts of Ecotourism and Geotourism, evaluate issues related to geotourism products and types of geotourists.

Ruiz (2020) investigates the material and non-material remains of mining activities that have undergone a growing process of heritage enhancement that enables relevant cultural initiatives to be sustained, among them mining museums and mining parks. This paper examines mining heritage in the context of the

UNESCO Geoparks. The objective is to heighten the visibility of the mining heritage by taking advantage of the Geoparks "brand" when integrating mining tourism activities into geotourism.

Strba et al. (2016) and Klos, Trebuna (2017) pointed out that not only do geotourism and geoparks create a sustainable form of environmental protection, but the reopening of a mineworking also requires comprehensive safety for the entire operation and has a significant impact on the environment. Environmental awareness assessment for geotourism is also addressed by Mokhtari et al. (2019). Vukoicic et al. (2020) explain why abandoned mines can pose a major risk to the environment. At the beginning of the 21st century, significant steps were taken around the world to protect these historically valuable complexes, and mining heritage began to be seen as having potential for the development of alternative tourism. The main requirement for safely reconciling decommissioned mineworkings with the environment is, if necessary, their subsequent decontamination and reclamation (Kumar et al. 2013, Božek 2019).

Jeong et al. (2020) also considered the fact that if geologically and geomorphologically valuable resources are used for geotourism, then it can also be expected that there will be a positive impulse for the revitalization of the regional economy through diversification of attractive factors and job creation for local people. A perspective on the use of geological and geomorphological valuable resources in geotourism is also offered by Jeong et al. (2020), who emphasize that the revitalization of the regional economy through diversification is an attractive factor for job creation for local people. Shekhar et al. (2019) also argue that investing in the renewal of disused mining operations will help strengthen the local economy by developing infrastructure, health care and educational activities. Komoo (2010) also states that another advantage of a geopark so created lies in the creation of new job opportunities for local young people. Stemberk et al. (2018) present results that show that an increase in economic benefits in the field of geotourism results from the development of key areas.

Kravtcova (2014) states that in the process of implementing the main social functions, museums become centres for representing mining associations, forming professional culture, promoting patriotic education and increasing the prestige of the occupation of mining. Moradipour et al. (2020) emphasize the need to pay attention to the state of conservation of geomorphosites in order to preserve their scientific, educational and geotouristic values. Casale et al. (2008) state that examples of the use of unused mining space, such as mining museums, are essential for the revitalization of the mine.

Franco et al. (2020) point to the importance of projects related to the geomorphological and geological characteristics of land use for tourism. A sustainable development project was published by Meech et al. (2006), in which they

examine a specific project aimed at the transformation of an abandoned mineworking.

The aim of the presented paper is to provide information on the design for a comprehensive underground mining museum, the purpose of which is to increase the attractiveness of the entire region.

2. Theoretical base

The anhydrite and gypsum deposit in Novoveská Huta is located on the southeastern slopes of Tolstein. It is one of the most important mining deposits in Slovakia. The deposit stretches approximately 5 km, which ranks it among the largest deposits in Slovakia. The shape of the deposit is very varied. This mining deposit is located in the immediate vicinity of the protected area The National Park Slovak Paradise. The location of the Novoveská Huta deposit can be seen in Fig. 1.

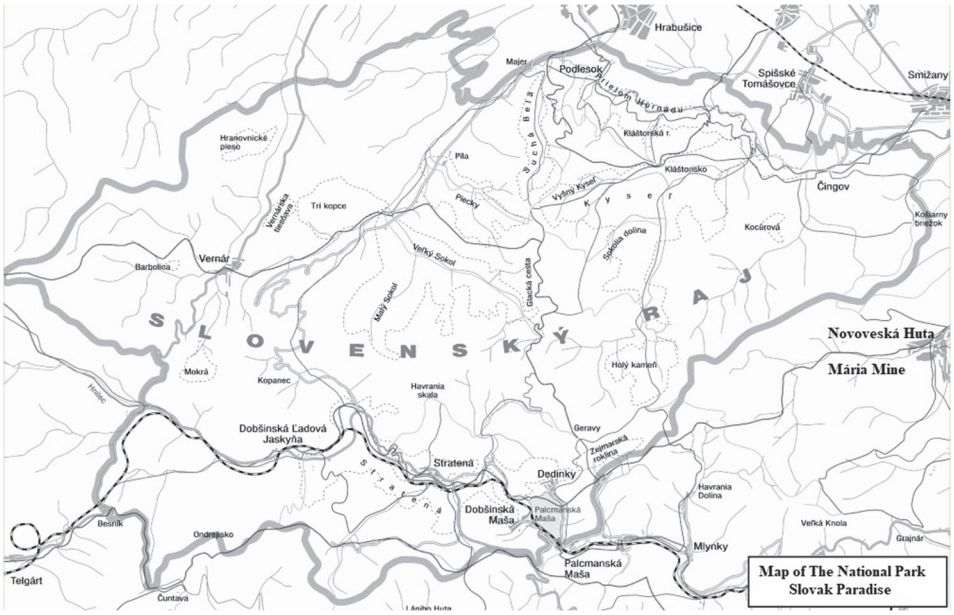

Fig. 1. Novoveská Huta deposit (Mária Mine)

Water infiltrates into the deposit along tectonic structures, causing serious complications of the body of the deposit. The thickness of the deposit ranges from 1 to 15 m. It reaches its maximum thickness at the surface. The current spatial limitations of the deposit give a fairly accurate picture of the original shape

and thickness of the sedimentation basin. More information on the chemical composition of the mined raw material is located in Table 1 and 2.

Table 1. Content of useful components in gypsum and anhydrite

Mineral	Sulfate content	SO_3 content
Gypsum	69.97%	30.03%
Anhydrite	65.04%	34.96%

Table 2. Chemical and physical-mechanical properties

Property	Gypsum	Anhydrite
Chemical composition	$CaSO_4 \cdot 2H_2O$	$CaSO_4$
Hardness	1.5-2.0	3.0-3.5
Bulk density	2.2-2.4 g/m^3	2.7-2.9 g cm^3
Density	2.3-2.4 g/cm^3	2.8-3.0 g/cm^3
Transparency	transparent to opaque	transparent to translucent
Lustre	glass, pearlescent	pearlescent, glassy
Cleavage	perfect	good
Solubility	soluble in acids; very slightly soluble in water	slightly soluble in acids and in water

Due to the fact that the deposit in Novoveská Huta has an important place among mining activities in Slovakia, it is necessary to make it accessible to the professional and general public. The current state of the deposit is that mining activity is still in progress. The condition of the mine meets the technical and safety regulations according to Slovak legislation. In the foreseeable future, the termination of mining activities here is being considered, and that poses the question of its subsequent use for the needs of society.

This represents a proposal for a way to revitalize a mineworking, which can have a positive effect on the socioeconomic impacts in the Spiš region. In the future, after the completion of mining, the Novoveská Huta mine would be environmentally sustainable and at the same time remain to serve the public as a mining exhibition and therefore keep its important place on the mining map of Slovakia.

3. Sustainability of the mining environment for the needs of the safety of the mining exhibition / Proposal of a mining exhibition, Novoveská Huta Case Study

The Novoveská Huta deposit includes the Mária mineworking, which has great potential for creating an extremely interesting mining exhibition. The mining exhibition at the Mária mine cannot be designed without examining the technical condition of the deposit, which is closely related to safety.

The Mária Mine consists of 4 levels. The underground exhibition proposed by us includes only part of the 0^{th} level (elevation 540 m above sea level) of the Mária mine. In the plan, all mining technology and equipment, lighting, rails, pumps and other mining materials are to be removed (or taken to the surface) from the first (elevation 520 m above sea level), the second (elevation 480 m above sea level) and the third (elevation (420 m above sea level) levels, and all three levels will be flooded. The main pumping station (level 2) will also be destroyed. Before opening the museum, it is necessary to perform safety work that would guarantee the construction of the open-air museum under our valid legislation.

Only part of the 0th horizon will remain available to the open-air museum. Drainage is solved by gravity. Excess, unnecessary water from the mine falls by gravity to the surface then comes out through the existing channel, into the nearest stream. An auxiliary CVE pump is placed on the surface (max. flow 4500 l / min). The auxiliary pump is only used in the event of an emergency in the mine.

We propose an artificial ventilation method, using the vacuum from a main APA 1120 fan. The ventilation system would therefore be diagonal. The ventilation network would consist of one ventilation area with one inlet and one vent for the mineworking.

The main inlet for the mineworking is the entrance adit, 950 metres long, which connects the 0th horizon with the surface. The up-cast shaft, which is located on the 0th horizon at a distance of 1700 metres from the entrance to the mine, will serve as the ventilation outlet for the mineworking. The main fan located in the ventilation chimney has an air output of 24.6 kW and the power of the electric motor of the fan is 30 kW. As mining will end in the mine, the air consumption will not be so high. Therefore, the new fan could have a power output of a few kW less than the current fan.

The mine is currently illuminated by rechargeable electric lamps along the entire length of the underground space. Initially, for economic reasons, the lights must be removed from the places that will not be accessible to the public. Subsequently, defective lights must be replaced with new, functional lights. The operation would be connected from a 22 kW overhead line, which is connected

to a surface transformer station. This transformer station would supply energy for the surface, but also for the underground. The lighting would be partly provided by the fact that the visitors and the guide are provided with their own lamps.

The total length of the underground exhibition is estimated at approximately 1700 metres, and therefore it is necessary from a safety point of view to determine where to place safety equipment.

We would suggest placing 5 fire extinguishers in the underground area, which will be marked with lights. Fire extinguishers will be placed every 500 metres, from the mine entrance to the ventilation chimney. The exception will be the 2 fire extinguishers, which will be located by the demonstration of wooden reinforcements and in the presentation hall. The reason for placing these fire extinguishers in this place is due to the risk of fire. These would be powder fire extinguishers.

In our technical-safety proposal we present 2 escape routes. One is designed with the intention of leading through the entrance adit and the other is located near the main ventilation chimney. Escape routes will also be lighted. First-aid kits can be found with every fire extinguisher, except for the one that is by the example of the wooden reinforcement. It is assumed that the guide will also carry a first aid kit. Before entering the mine, it is necessary for an authorized and responsible person to provide safety training.

From a safety point of view, it would be advisable to install sensors at the entrance to the mine. These sensors would sense the chips that would be placed on the mine lights that every visitor must have when entering the mine. In the lamp room, a lamp is given to a specific visitor, who is entered in the computer records. The sensors would automatically transfer this information from the chip to a computer, which would be able to use the given algorithm to immediately find out who entered and left the mine and when (duplicate system). Using these sensors and chips, the exact number of people underground would be determined.

This modern method would avoid any complications. Figure 2 is a graphical representation of the location of the sensors (sensor 1-4) at the entrance to the mine (4 units).

Subsequently, we would propose building a wooden platform with a railing from the entrance towards the mine. This wooden platform should serve as a place to board the mine train with a BND 30 type locomotive. This then transports visitors to the underground exhibition of the open-air museum. The dimensions of the platform would be 10 metres long and 1 metre wide, the railing would be 80 cm high.

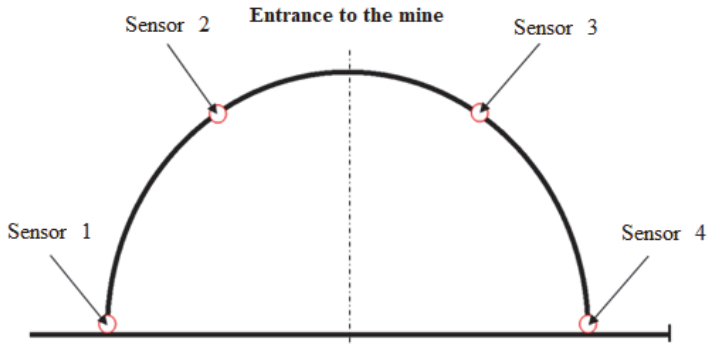

Fig. 2. Sensor placement diagram

The next step would be to renovate the rails. Locomotives and mining trucks intended for the transport of visitors would also have to be inspected.

Another important task would be to build a passing loop for locomotives. A locomotive with rolling stock could move with visitors in only one direction. Therefore, a passing loop would have to be built at a distance of about 800 metres from the entrance to the mine. This would be used to turn locomotives and rolling stock.

It is necessary to eliminate the mining areas where the mining pressures are so high that there could be a flood during the presence of visitors. These areas would either be flooded or made completely inaccessible (walled off). Conversely, mining areas where the pressures would not be so great would be reinforced with mesh and shotcrete (or wooden reinforcement) and would serve as underground areas for the guide's explanations and for storage of various pieces of mining equipment.

Fig. 3 shows the locations of the safety devices, the passing loop and the presentation room.

The Novoveská Huta mineworking, after the cessation of mining, would fulfil an environmental protection purpose. Several modifications and improvements need to be made in the area of the deposit. As can be seen in Fig. 3, a sample of wooden reinforcement will be located at a distance of 300 metres from the entrance to the mine. It would only be a 1 metre section so that people can imagine what it looks like and how wooden reinforcement is used.

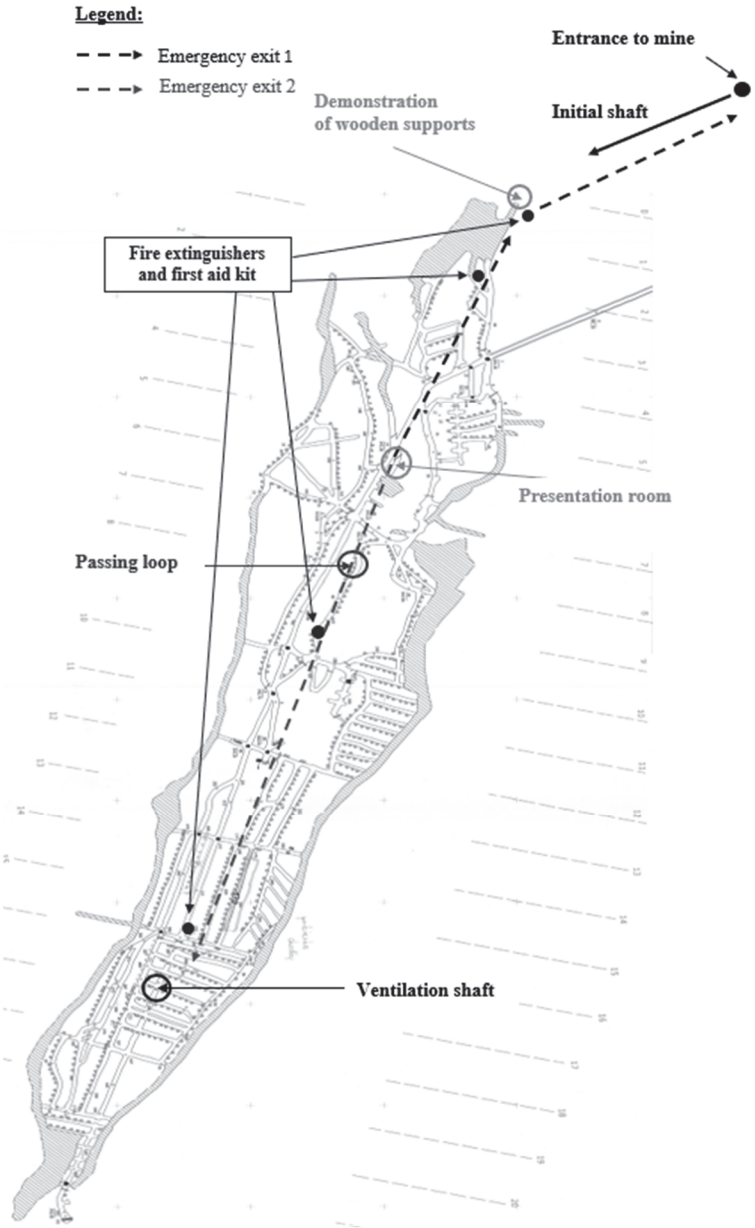

Fig. 3. Location of safety devices on the 0th level

An explosives warehouse is located 500 metres from the mine entrance. In the explosives warehouse, visitors could view dummies of rock and plastic explosives, various electric detonators (modern, old), old detonation equipment, etc. In the explosives warehouse, steel reinforcement would be built across the whole space. This is because the ceiling is in poor condition there. At present, this area is already excavated at a distance of 750 metres from the entrance to the mine. The dimensions are height: 4-5 metres, width: 8-9 metres and length: 20 metres. This room would function as a meeting room. A projector powered with electricity from the surface would be installed and wooden benches would be placed here. This space would be reinforced with mesh and shotcrete.

From a safety point of view, this would be very important. This space would be the only one in the mine where the floor would be modified. Gravel would be transported here, which would be compacted and levelled. There would always be the largest number of people there. This space would also include a mining telephone.

In the underground exhibition, 3 spaces would be set out together, in which there would be various items of mining equipment, tools, helmets, lamps, drilling rods, hammer drills, etc. The spaces would be created in a circular profile measuring 2x3 m and reinforced with circular steel reinforcement. In one of the rooms there would be a pulling machine – a Karlik's wheel with a loop of rope. A smaller part of a gallery would be dug out, to enable the visitors to see the method used. It would consist of a pair of vertical access shafts (entry and exit to the shaft) and discharge funnels. Visitors will have the opportunity to see the handling space for the mining method currently used on the deposit. They would use the first vertical access shaft to get to the handling area. At this point there would be a wooden bridge with a railing, as shown in Fig. 4, above the discharge system, along which visitors could safely access the other side of the handling area and then take the second vertical access shaft to return to the mining gallery.

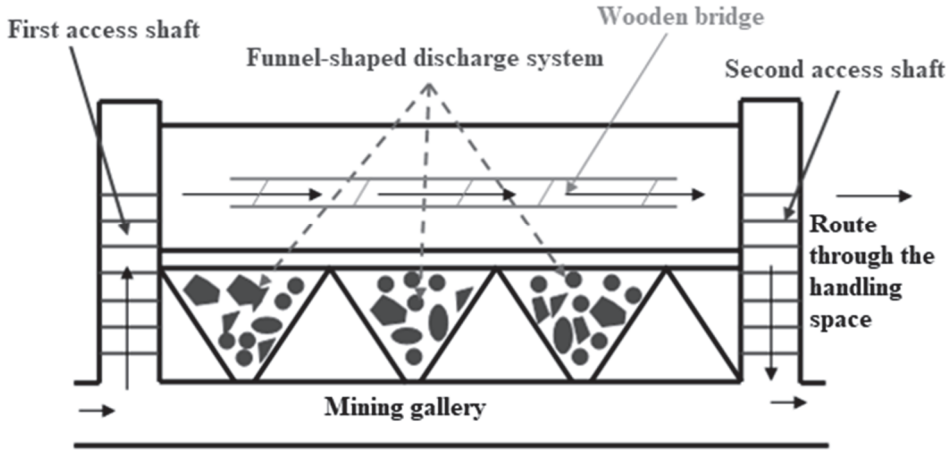

Fig. 4. Schematic drawing of the funnel-shaped discharge system and the route through the handling space

4. Conclusion

The construction of a museum would be very beneficial for the surrounding environment. Building it would increase awareness of mining as well as highlight the need for permanent care for the environment. The main vision of this proposal is not only the visit to the museum itself, but also the need for the visitor to realize that the place they have visited is a unique part of the environment and that making such an old mineworking accessible can have a great effect on environmental sustainability and safety. A visit to the museum forces the visitor to think about the seriousness of the environmental situation in mining operations. The creation of a mining museum in places that have been known for mining is the result of an ideal combination of environmental protection and the overall sustainability of the operation of the deposit even after mining has reduced.

All the safety, liquidation, renovation and other necessary work for the construction of the open-air museum represents a significant investment, which would ensure the maintenance of the mining tradition and history around the village of Novoveská Huta, and also of the Spiš region. The resulting investment could be covered by non-repayable grants from European Union funds. With the help of the investments made, the entire region of Eastern Slovakia would gain attractiveness and its economic potential would increase.

As it was already mentioned, this mining deposit is located in the immediate vicinity of the protected area The National Park Slovak Paradise. The daily attendance of the Slovak Paradise in the summer is in the number of approx. 4500 people a day. As the preliminary economic calculation of the sustainability of

a given geopark shows, it would be profitable and sustainable at least during the summer season. In addition, such a geopark could be one of the important attractions of the Slovak Paradise National Park, which would significantly increase the attractiveness of the area, which can also benefit from the vicinity of the High Tatras.

Another benefit of the proposed project is also the presentation and determination of the direction of development of the Spiš region, where after the end of mining operations the socio-economic level is likely to decrease, as happened in upper Nitra region in the mining area of the Nováky mine.

The mining museum is a unique project for this kind of local tourism within the whole region. It also brings a large number of economic benefits for the inhabitants of the Novoveská Huta mining area. The biggest economic positive can be considered to be the creation of new jobs, both direct and indirect. The opening of the mining museum would result in an increase in the number of domestic as well as foreign visitors, and with them, the needed economic revitalization of the entire region.

In our opinion, the proposed museum will significantly increase the positive awareness of mining, while still ensuring the continuous use of the deposit, taking into account its sustainability.

The layout of the individual parts of the underground exhibition during a visit to the mining museum are shown in Figure 5. The figure shows that the underground exhibition would start with entering the mine and subsequent boarding of transport trucks, mostly they would move about underground using mining transport. After entering the underground area, there would be samples of wooden and steel reinforcement. Subsequently, visitors will be able to view the explosives store. Then they will walk to the presentation room. At this point, the guide will show them a short film about the deposit and then they will move to the mining area. After viewing the mining (handling area), visitors will move on foot to another area with mining equipment. Next, they move to a third room, where there is a demonstration of a towing machine – a Karlik's wheel with a rope loop. The excursion would end at the place where the ventilation shaft is located. Subsequently, visitors would return to the passing loop, where they would board a locomotive and it would take them back to the wooden platform. The total duration of the tour would be 60 minutes, in which they would walk 1700 metres with the participation of a qualified guide giving expert explanations.

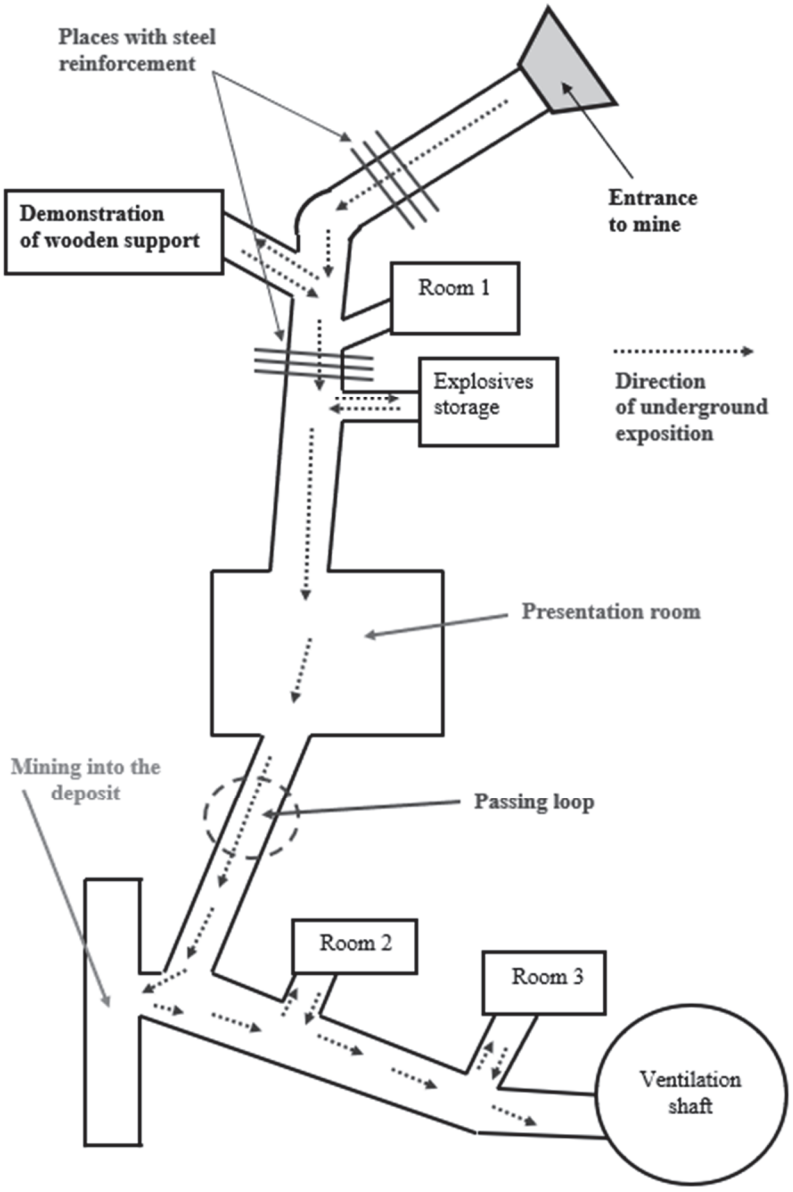

Fig. 5. Diagram of the underground exhibition

The submitted paper is a part of the projects "Projects of applied research as a means for development of new models of education in the study program of industrial logistics" KEGA 016TUKE-4/2020 and the project "Research and development of new smart solutions based on the principles of Industry 4.0, logistics, 3D modelling and simulation for streamlining production in the mining and building industry" VEGA 1/0317/19.

References

Alexandrowicz, Z., Miskiewicz, K. (2016). Geopark – from the concept to implementation, with special reference to Poland. *Chronmy Przyrode Ojczysta,* 72(4), *Instytut Ochrony Przyrody PAN,* 243-253.

Alvarez, R.F. (2020). Geoparks and Education: UNESCO Global Geopark Villuercas-Ibores-Jara as a Case Study in Spain. *Geosciences*, 10 (1), Article number 27.

Bento, L.C.M., de Farias, M.F., do Nascimento, M.A.L. (2020). Geotourism: A Tourism Segment? *Turismo-Estudos e Praticas (UERN)*, 9(1), 1-23.

Božek, P. (2019). Virtual production technology vs. environment. *Acta Tecnología, 5(4),* 109-114.

Casale, M., Oggeri, C., Peila, D. (2008). Imporovemnts of safety conditions of unstable rock slopes through the use of explosives. *Natural Hazards and Earth System Sciences, 8*, 473-481.

Filocamo, F., Di Paola, G., Mastrobuono, L., Rosskopf, C.M. (2020). MoGeo, a Mobile Application to Promote Geotourism in Molise Region (Southern Italy). *Resources-Basel, 9*(3), Article number 31.

Franco, L.J.N., Rojas, B.H.S., Cruz, C.S.S. (2020). Geotourism: Tourist Use of the Geological Potential in the San Benito and San Eugenio Streets in the Municipality of Sibate. *Anuario Turismo Y Sociedad, 27*, 187-215.

Glova, J., Sabol, T., Vajda, V. (2014). *Business models for the internet of things environment*. In: Procedia Economics and Finance: Emerging Markets Queries in Finance and Business: 24-27 October 2013, Tîrgu Mureş, Romania, 15, 1122-1129.

Grabara, J., Dabylova, M., Alibekova, G. (2020). Impact of legal standards on logistics management in the context of sustainable development. *Acta logistica, 7*(1), 31-37.

Gray, M., Gordon, J.E. (2020). Geodiversity and the '8Gs': a response to Brocx & Semeniuk (2019). *Australian Journal of Earth Sciences, 67*(3), 437-444.

Chrobak, A., Witkowski, K., Szmanda, J. (2020). Assessment of the Educational Values of Geomorphosites Based on the Expert Method, Case Study: the Bialka and Skawa Rivers, the Polish Carpathians. *Quaestiones Geographicae, 39*(1), 45-57.

Jeong, S.H., Gwon, O., Kim, T., Naik, S.P., Lee, J., Son, H., Kim, Y.S. (2020). Value of Geologic.Geomorphic Resources of Danyang-gun and Its Application from Geotourism Perspective. *Economic and Environmental Geology, 53*(1), 45-69.

Klos, S., Trebuna, P. (2017). The impact of the availability of resources, the allocation of buffers and number of workers on the effectiveness of an assembly manufacturing system. *Management and Production Engineering Review, 8*(3), 40-49.

Komoo, I. (2010). Geopark sebagai Peraga Pembangunan Lestari Wilayah (Geopark as a Model for Regional Sustainable Development). *Akademika, 80*(1), 9-18.

Kumar, S., Bansal, V.K. (2013). Construction Safety Knowledge for Practitioners in the Construction Industry. *Journal of Frontiers in Construction Engineering, 2*(2), 34-42.

Lopes, L., Martins, R. (2015). *Global Heritage Stone: Estremoz Marbles, Portugal*. In: Global Heritage stone: Towards International Recognition of Building and Ornamental Stones, Geological Society, London, Special Publications, 407(1), 57-74.

Manyuk, V.V., Bondar, O.V., Yaholnyk, O.V. (2020). Ukraine in the history of the movement for the conservation of geological heritage in Europe. *Journal of Geology Geography and Geoecology*, *29*(1), 111-134.

Meech, J.A., Mcphie, M., Clausen, K., Simpson, Y., Lang, B., Campbell, E., Johnstone, S., Condon, P. (2006). Transformation of a derelict mine site into a sustainable community: the Britannia project. *Journal of Cleaner Production*, *14*(3-4), 349-365.

Meléndez, G., Fermeli, G., Koutsouveli, A. (2007). *Analyzing Geology Textbooks for Secondary School Curricula in Greece and Spain: Educational use of Geological Heritage*. Conference: 11th International Conference of the Geological Society of Greece, Geoenvironment: Past-Present-Future At: Athens, Greece, 40(4), 1-14.

Mokhtari, D., Roostaei, S., Khodadadi, M., Ahmadi, M., Ebrahimi, O., Shahabi, H. (2019). Evaluation of the Role of Environmental Education in Manesht and Ghelarang Geotourism Destination, Iran. *Journal of Quality Assurance in Hospitality & Tourism, 20*(6), 681-708.

Molokac, M., Alexandrova, G., Kobylanska, M., Hlavnova, B., Hroncek, P., Tometzova, D. (2017). *Virtual Mine – educational model for Wider Society*. 15TH IEEE International Conference on Emerging Elearning Technologies and Applications (ICETA 2017), IEEE, 307-311.

Novas, N., Gazquez, J.A., MacLennan, J., García, R.M., Fernandez-Ros, M., Manzano-Agugliaro, F. (2017). A real-time underground environment monitoring system for sustainable tourism of caves. *Journal of Cleaner Production, 142*, 2707-2721.

Ruiz, M.D.C. (2020). Visibility and promotion of mining heritage in some Spanish geoparks. *Documents D Analisi Geografica*, *66*(1), 109-131.

Shekhar, S., Kumar, P., Chauhan, G., Thakkar, M.G. (2019). Conservation and Sustainable Development of Geoheritage, Geopark, and Geotourism: a Case Study of Cenozoic Successions of Western Kutch, India. *Geoheritage*, *11*(4),1475-1488.

Stefano, M., Paolo, S. (2017). Abandoned Quarries and Geotourism: An Opportunity for the Salento Quarry District (Apulia, Southern Italy). *Geoheritage*, *9*(4), 463-477.

Stemberk, J., Dolejs, J., Maresova, P., Kuca, K. (2018). Factors affecting the number of visitors in National Parks in the Czech Republic, Germany and Austria. *ISPRS International Journal of Geo-Information*, *7*(3), 1-10.

Strba, L., Krsak, B., Molokac, M., Adamkovic, J. (2016). *Geotourism and geoparks-a sustainable form of environmental protection*. Production management and Engineering Sciences, International Conference on Engineering Science and Production Management (ESPM), April, 279-284.

Szente, I., Takacs, B., Harman-Toth, E., Weiszburg, T.G. (2019). Managing and Surveying the Geological Garden at Tata (Northern Transdanubia, Hungary). *Geoheritage*, *11*(4), 1353-1365.

Tilabi, S., Tasmin, R., Takala, J., Palaniappan, R., Abd Hamid, N. A., Ngadiman, Y. (2019). Technology development process and managing uncertainties with sustainable competitive advantage approach. *Acta logistica, 6*(4), 131-140.

Tlhapiso, M., Stephens, M. (2020). Application of the Karst Disturbance Index (KDI) to Kobokwe Cave and Gorge, SE Botswana: Implications for the Management of a Nationally Important Geoheritage Site. *Geoheritage*, *12*(2), Article number 39, 1-13.

Torres-Ruiz, M., Mata, F., Zagal, R., Guzman, G., Quintero, R., Moreno-Ibarra, M. (2020). A recommender system to generate museum itineraries applying augmented reality and social-sensor mining techniques. *Virtual Reality*, *24*(1), 175-189.

Vukoicic, D., Ivanovic, R., Radovanovic, D., Dragojlovic, J., Martic-Bursac, N., Ivanovic, M., Ristic, D. (2020). Assessment of Geotourism Values and Ecological Status of Mines in Kopaonik Mountain (Serbia). *Minerals, 10*(3), Article number 269, 1-24.

Abstract

This paper addresses the protection of the environment and provides a design for the use of the deposit after the cessation of mining in the Novoveská Huta region. The area of interest of this case study describes the practical transformation of a functioning mining operation into a mining museum in order to reduce the pressures on the environment after mining. The resulting model of the functioning of the mining museum also deals in detail with the safety of a mining operation which is no longer used for mining, taking into account its further use. The article describes the proposed 1700-metre route which visitors will pass along, and also gives a detailed description of the proposed measures necessary for safety and long-term sustainable operation.

The aim was to design a use of the mining space, that would offer visitors the opportunity to see the handling space and mining methods of the deposit. An interesting element will also be the possibility of inspecting the explosives store, wall linings, steel and wooden reinforcements. The tour will also include a demonstration of storage facilities as well as a Karlik's wheel mining equipment with a rope loop. The open-air museum also offers the opportunity to get acquainted with transport around the entire deposit under strict safety conditions. It is assumed that devices such as a mining telephone or a siren placed on the walls of the tunnel will also arouse interest. An important element of the entire tour would also be a constant reminder of the safety rules during the tour.

The impacts of this solution on the environment are very acceptable and incomparably more beneficial than in the case of the termination of mining and subsequent non-use of the Novoveská Huta deposit.

Keywords:
mining, safety, environment, cultural heritage, safety