https://doi.org/10.7494/miag.2022.1.549.23

KRZYSZTOF SZYDŁOWSKI
MICHAŁ FLASZA

The historic "Bochnia" Salt Mine

The beginnings of the "Bochnia" Salt Mine date back to 1248. Over the centuries, its structure, methods of operation and purpose have all changed, with its miners being pioneers in Poland with regard to the method of extraction and the technologies used. Over hundreds of years, several shafts have been excavated, and a maze of galleries created near Bochnia, creating something like a town outside and underneath the city. Due to the depletion of the deposit and increasing costs, mining was stopped, and the last lump of salt came to the surface in 1990. Since that time the company has been making efforts to protect the natural and historical heritage by securing the workings and making them available for sightseeing by tourists.

Key words: *salt mining, tourism, monument of technology*

1. INTRODUCTION

The beginnings of rock salt mining in Bochnia go back to the mid-thirteenth century, as evidenced by the notes from 1251 regarding the discovery of rock salt: "Sal durum in Bochnia repertum est quod antea nunquam fuerat" – "Rock salt in Bochnia has been found for the first time". This does not mean that salt as such was not known in Bochnia; on the contrary, archaeological research indicates the exploitation of brine springs and the existence of salt works in the vicinity of Bochnia as early as in the middle Neolithic period (around 3500 BC). As the surface sources of brine were depleted, digging of salt water wells began, which contributed to the discovery of rock salt in 1248 [1]. In 1251, exploitation was commenced on an industrial scale. It was the first such discovery on Polish lands. The extraction of rock salt in Bochnia continued for almost 750 years, which makes the mine a unique monument of technology on a global scale, presenting all the historical stages of the development of the mining industry from the 13th to the 20th century [2]. The long-term mining activity, which is estimated to have reached approximately 9 million tons of rock salt output, resulted in the creation of a spatial model including 16 mine levels located at depths from 70 m to 468 m. After the exploitation ended in 1990, the salt mine in Bochnia based its further development on tourist and spa activities, while closing the lowest, non-historic levels. Currently, most of the mining works are aimed at maintaining, securing and conserving the excavations subject to heritage protection [3]. Due to its cultural and natural importance, the mine was inscribed on the UNESCO World Heritage List.

2. HISTORY OF SALT ROCK MINING

The Bochnia rock salt deposit is considered to be very complex in terms of its tectonics [4]. The salt layers are strongly folded and contain interbeddings of clay rocks with anhydrite. In the first periods of the mine's existence, rock salt exploitation involved the mining of pure salt deposits, which from today's point of view should be deemed chaotic. Due to its unusual characteristics, the deposit extraction was carried out in a very spontaneous way, which involved excavating a large number of exploration shafts. The results were not always satisfactory. The first Bochnia shafts – "Gazaris" and "Sutoris" – were built in the 13th century. Due to the very geological structure of the Bochnia

deposit, the miners faced enormous difficulties during its exploitation, as it forced them to look for technological solutions that were pioneering for both Polish and European mining [5]. An example may be the inter-level mine shafts, which enabled them to reach deep deposits. The mining of salt from the beginning until the end of the Old Polish era was based on simple mining tools (pickaxes, hammers, ropes). The period from 14th to the 16th century was marked by the significant organizational and spatial development of the mine. Various mining devices in use, such as treadmills and other smaller ones powered by humans or horses, should be considered advanced for those times [5]. The Bochnia Castellany was a royal property which, together with the nearby salt mine in Wieliczka, generated enormous income to the state treasury. This made the town of Bochnia one of the most important town centres in Poland. It should be noted, however, that due to more difficult geological and mining conditions, the output in the Bochnia mine was lower than that in Wieliczka, and the operating costs were higher. By way of an example, at the beginning of the 16th century, Bochnia provided more than 40% of the total output of Krakow's salt mines, which amounted to approx. 16,000 tons, but at the end of the century, this share dropped to approx. 20% of ca 32,000 tons [6]. In the 17th century, wars and the economic decline of the Republic of Poland stopped the development of the salt mine in Bochnia. The eighteenth century brought the necessary reforms, which improved the situation of the mine. In 1772, the Bochnia mine was included in the territory of Austria as a result of the First Partition of the Republic of Poland, and until 1918 remained the property of the imperial Habsburg family. This period saw general changes to the organizational and legal structure. Systematic works were carried out to organize the irregular mine excavations in a better way. The methods of salt deposit extraction were also gradually modernized. From the second half of the nineteenth century, the deposit was mined with the use of explosives. Gradually, rail transport, steam hoisting machines and steel hoisting ropes appeared in the Bochnia mine. During the Second World War and after 1945, the exploitation of the deposit was very intensive, accompanied by the progressing process of electrification and greater mechanization of work. From 1968, extraction on the lowest, non-historic levels of the mine (from X to XVI) was carried out with the use of fresh water (leaching). Due to the deposit depletion as well as growing problems related to the protection of the historic levels of the Bochnia mine, the extraction was terminated in 1990. Since then, the focus has been on the conservation of historic workings and the closure of the non-historic part of the mine.

3. NATURAL HAZARDS IN THE MINE

The major threat in the mine in Bochnia since ancient times has been the presence of methane [7]. The gas mainly accumulated in poorly ventilated workings on lower levels. Its occurrence was related to the gas-bearing rocks of the Carpathian flysch in the southern parts of the deposit. Another source of methane were organic substances, i.e. charred plant material and bituminous salts containing hydrocarbons. Rarely, methane was found near the northern boundary of the deposit. As the boundaries of the deposit consisted of characteristic, easily recognizable layers, the rule observed in the mine was to not disturb them by mining works. However, accidents caused by methane emissions still happened. In 1906, an explosion of methane released from the rocks occurred when a gallery was being excavated with explosives. In 1949, during the drivage of an exploration gallery near the southern boundary of the deposit, a strong methane explosion occurred, killing several miners. The release of methane was mainly related to the drivage of workings and the extraction of the deposit. Currently, when production is no longer continued and the boundaries of the deposit are not disturbed, methane does not pose any risk [7].

However, the greatest threat to salt mines is the inflow of waters from the rock layers covering the deposit or located in its vicinity. Flowing into the workings, these waters may dissolve the salt and threaten the mine by degrading its structure, The hazard related to the inflow of water to the deposit is not high in the Bochnia mine. The waters getting into the mine mainly come from quaternary aquifers and flow into both active and old shafts, which have been closed by backfilling with rock material. In the mine, they are most often observed as drop leaks.

4. POST-INDUSTRIAL DEVELOPMENT OF THE MINE'S ACTIVITY

In the 1980s, when it was known that the extraction of salt would come to an end in near future, works aimed at transforming and adapting the excavation

voids were undertaken so as to enable tourist traffic and sanatorium activities (Fig. 1). The initiative to protect the mine came from its management and staff, which for centuries had been strongly associated with the largest workplace in the region [5]. Thanks to these efforts, the mine was entered in the register of monuments by virtue of the decision of the voivodship conservator of monuments in 1981.

Fig. 1. Use of the AM-50 roadheader in the galleries of the “Ważyn” Chamber (phot. from the collection of the “Bochnia” Salt Mine)

At the beginning of the 1990s, the first tourists went down the mine with full mining equipment (helmets, lamps, absorbers), and their guides were the members of the mine supervisory staff. At that time, the mine was visited by merely 1,500 tourists a year. In 1995, the tourist traffic was better organised, and owing to further works aimed at adapting the excavations for tourist and sanatorium purposes, the number of visitors to the mine continued to grow [3]. In 2000, it was visited by approximately 90,000 people. In the same year, the President of the Republic of Poland recognized the historic underground of the Bochnia mine as a historical monument.

In order to preserve the geological heritage revealed in the mining excavations for future generations, 27 geologically valuable areas have been legally protected as “documentation sites” since 2005 [3, 8]. In 2013, the Bochnia mine, along with the Saltworks Castle in Wieliczka, was included in the group of the most valuable monuments in the word by being inscribed on the UNESCO World Heritage List (as an extension of the entry of the nearby Wieliczka Salt Mine from 1978). In 2017, the number of tourists visiting the Bochnia mine exceeded 190,000 [3].

5. THE MINE AS A TOURIST SPOT

The present extensive spatial structure of the historic mine consists of nine levels with a total length of excavations reaching several dozen kilometres [6]. This underground space of the salt mine in Bochnia features historic galleries and chambers with works of art, underground chapels, statues, and decorative elements that miners carved out of rock salt. The adaptation of the post-mining chambers and galleries for tourist purposes allowed creating an impressive underground functional space, which houses gastronomic facilities, sports fields, multi-functional halls, attractions such as an underground battery-operated railway and an underground multimedia exhibition [3, 9]. A significant part of these workings has been opened to the public or made available for treatment with the underground atmosphere [10].

At present, the ride down the mine takes place via the “Campi” shaft. This is where the infrastructure for tourists is located and the facility can be visited by groups of people during guided tours. Three completely different tourist trails have been prepared for visitors.

5.1. Trail with an underground multimedia exhibition

It is the main route that runs along the workings of the “August” level (the main ventilation level of the mine is the only one that connects all the shafts preserved to this day), “Sienkiewicz” and inter-level “Dobosz” [7, 10]. The raw chambers and excavations have been enriched with a multimedia presentation of the history of the mine, the development of mining techniques and the history of salt trading. The exhibition consists of stands equipped with holoscreens and MultiNans – multimedia mannequins. Visitors to the mine embark on a journey from the times of Bolesław the Chaste and Princess Kinga through all eras up to the present day, learning about the work of miners as well as the dangers and threats they might have encountered in the mine. Tourists begin their tour of the mine from the “Campi” shaft top, where they can see an unusual monument of technology – an efficient steam engine made in 1909 in the “Laura” steelworks

in Chorzów. It was transported to Bochnia from the closed salt mine in Wapno. It served the longest of all steam engines in the Polish mining industry, until 1996. Tourists cover the route on foot, although there is the opportunity to travel by train (Ldag-05M locomotive with wagons adapted to transport tourists) or by boat along a certain part of the trail. A visit to the mine ends with a stop in the "Ważyn" Chamber (Fig. 2), which houses a restaurant, a souvenir shop, a sports field, and a playground for children.

Fig. 2. "Ważyn" Chamber (phot. by Adam Brzoza)

5.2. Historical route "Expedition to the Old Mountains"

The route, which was made available in 2014, leads tourists through the oldest excavations of the mine in Bochnia, where rock salt was extracted from the Middle Ages to the beginning of the 20th century. Before going underground, the groups undergo specialist training at the Mine Rescue Station, where they are equipped with mining equipment, i.e.: a helmet, a lamp and a carbon monoxide absorber [11]. The expedition starts on the "Danielowiec" level (the first shallowest level of the mine). This is where the tour of the Old Mountains, i.e. the oldest preserved excavations, begins. There are many interesting places along the route, both with regard to the old mining technique and the geological structure of the deposit. One of the excavation complexes is the so-called "Kalwaria" descent, connecting the "Danielowiec" and "August" levels, with a total length of ca 650 m and a height difference of 110 m. This descent includes the "Śmierdziuchy" and "Stanetti" chambers. One of the most interesting is the "Stanetti II" Chamber (Fig. 3), leading to a steep descent, which was made by three techniques: stairs carved in the rock mass, wooden steps and a wooden suspended structure.

Fig. 3. Traces of salt blocks loosening (phot. by Adam Brzoza)

The "Śmierdziuchy" chambers from the first half of the 18th century stretch along the further part of the trail. In the eastern part of the "Śmierdziuchy Środkowa" chamber, tourists can admire the St. Joseph Chapel with the original beams of the altar wall, bearing the inscription "Anno Domini 1722" on a polychrome staining. The route in the Old Mountains also leads through the ladders of the "Gazaris II" shaft and many other unusual places. As the historic trail is characterised by an increased level of difficulty, it is only available to people over 16 years of age [7].

5.3. Nature trail

All the collected natural curiosities are presented to tourists during the nature trip along the nature trail that stretches along the "raw" interiors of the mine [11]. Throughout the trip visitors have the chance to learn about the geological history of the Bochnia deposit while exploring its rocks and minerals. The trip allows them to observe how human activity contributed to the creation of a unique environment in the salt workings. Visitors can understand how the geological processes that formed the salt deposit millions of years ago as well as contemporary phenomena, which are now visible in the excavations, created the natural beauty of the mine's interior. The tourist route leads through historic corridors from the "Sienkiewicz" level through the "Lobkowicz" level to the "August" level.

6. SUMMARY

The "Bochnia" Salt Mine illustrates all stages of the development of rock salt mining technologies

from the 13th to the 20th century. After the centuries-old exploitation came to an end, the mine, which is a masterpiece of material culture, was granted the status of a Historic Monument and entered in the register of monuments. The historic part of the excavations was made available to tourists. The unique character of the mine was marked by its inclusion on the UNESCO World Heritage List.

References

[1] Maślankiewicz K.: *Z dziejów górnictwa solnego w Polsce*. Wydawnictwa Naukowo-Techniczne, Warszawa 1965.

[2] UNESCO World Heritage Convention: *Wieliczka and Bochnia Royal Salt Mines*. https://whc.unesco.org/en/list/32/ [11.07.2022].

[3] Puławska A., Manecki M., Flasza M., Waluś E., Wojtowicz K.: *Rare Occurrence of Mirabilite in the Thirteenth-Century Historic Salt Mine in Bochnia (Poland): Characterisation, Preservation, and Geotourism*. Geoheritage 2021, 13, 2: 36.

[4] Toboła T.: *Badania koncentracji potasu i magnezu w solach kamiennych złoża Bochni*. Przegląd Geologiczny 2000, 48, 12: 1163–1168.

[5] Wojciechowski T.: *Kopalnia soli w Bochni*. Kopalnia Soli Bochnia, Bochnia 2016.

[6] Wiewiórka J., Dudek K., Charkot J., Gonera M.: *Natural and historic heritage of the Bochnia salt mine (South Poland)*, Studia Universitatis Babeş-Bolyai, Geologia 2009, 54, 1: 43–47.

[7] Wiewiórka J., Poborska-Młynarska K., Zięba K., Flasza M.: *W głąb soli i czasu w Kopalni Soli Bochnia*. Wydawnictwa AGH, Kraków 2016.

[8] Wiewiórka J., Charkot J., Dudek K., Gonera M.: *Historic salt mines in Wieliczka and Bochnia*. Geoturystyka/Geotourism 2008, 3, 18: 61–70.

[9] Puławska A., Manecki M., Flasza M.: *Mineralogical and chemical tracing of dust variation in an underground historic salt mine*. Minerals 2021, 11, 7: 686.

[10] Puławska A., Manecki M., Flasza M., Styszko K.: *Origin, distribution, and perspective health benefits of particulate matter in the air of underground salt mine: a case study from Bochnia, Poland*. Environmental Geochemistry and Health 2021, 43, 9: 3533–3556.

[11] Flasza J., Zięba K.: *Kopalnia Soli Bochnia jako obiekt turystyczny*. In: Flasza J., Flasza M., Migdas T., Mróz S., Puławska A., Zięba K.: *Kopalnia Soli Bochnia. Historia wykuta w soli*. Kopalnia Soli Bochnia, Bochnia 2018: 67–72.

KRZYSZTOF SZYDŁOWSKI, M.Sc., Eng.
MICHAŁ FLASZA, M.Sc., Eng.
Bochnia Salt Mine Ltd
ul. Campi 15, 32-700 Bochnia, Poland
{k.szydlowski, m.flasza}@kopalnia-bochnia.pl