The geotouristic potential of the scenic underground routes in the "Wieliczka" and "Bochnia" Salt Mines (Carpathian Foredeep)

Potencjał geoturystyczny tras podziemnych kopalń soli w Wieliczce i Bochni dostępnych do zwiedzania (zapadlisko przedkarpackie)

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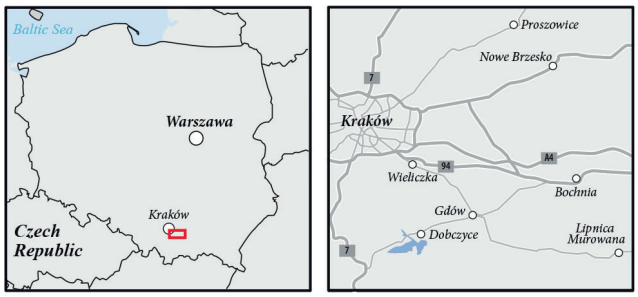

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Abstract: *In this article, five scenic underground routes of historical salt mines in Wieliczka and Bochnia towns were the subject of comparative research, considered as very essential examples of geotouristic potential. In the "Wieliczka" Salt Mine, there are Touristic and Miners' Routes, and in the "Bochnia" mine, there is a Multimedia Touristic route, as well as two Miners': Natural and Historical ones. The routes lead through the parts of old mines. These salt deposits are a part of the Miocene evaporitic formations, as a fragment of the Carpathian Foredeep. A comparative geotouristic potential evaluation of all these routes was made to meet tourists', educators' and investors' expectations and needs to raise their geotouristic development level. The statistical data of the annual number of visitors for the last few years at the described routes were also discussed. In general, interest in these routes has been growing, as the popularity of the industrial heritage in the "Wieliczka" and "Bochnia" Salt Mines has been regularly developing. They have become very widely known in Poland and around the world.*

Keywords: *Carpathian Foredeep, evaporates, underground routes, salt mine, geotourism*

Treść: *Artykuł poświęcony jest analizie porównawczej potencjału geoturystycznego pięciu tras podziemnych zabytkowych kopalń soli w Wieliczce i Bochni. Dwie z nich (turystyczna i górnicza) znajdują się w Wieliczce, a trzy pozostałe (multimedialna turystyczna i dwie górnicze: historyczna i przyrodnicza) w Bochni. Prowadzą one fragmentami dawnych wyrobisk kopalnianych. Opisywane złoża solne mają postać ewaporatowej formacji powstałej w miocenie, wchodzącej w skład zapadliska przedkarpackiego.*
Ocena porównawcza potencjału geoturystycznego poszczególnych tras została dokonana z uwzględnieniem potrzeb turystów, nauczycieli i inwestorów. Wzięto pod uwagę także dane statystyczne dotyczące frekwencji turystów w omawianych obiektach dla kilku ostatnich lat. Ogólnie rzecz biorąc, zainteresowanie opisywanymi trasami podziemnymi systematycznie wzrasta do chwili obecnej, co jest skutkiem zwiększającej się z biegiem czasu popularności dziedzictwa przemysłowego w Wieliczce i Bochni, zarówno w Polsce, jak i na całym świecie.

Słowa kluczowe: *zapadlisko przedkarpackie, ewaporaty, trasy podziemne, kopalnia soli, geoturystyka*

Introduction

The role of the abiotic elements of the natural environment in tourism has been growing very fast (Słomka & Kicińska-Świderska, 2004; Osadczuk & Osadczuk, 2008; Krzeczyńska & Woźniak, 2011; Wójcik *et al.*, 2014). "Geotourism", a new knowledge field, is defined as "a natural tourism form aimed at recognizing inanimate nature objects"

(Mika, 2011) or "a tourism form between its natural and cultural one" (Migoń, 2012). For this purpose, single objects are designated, for example the Głęboka Cave at Podlesice, "Guido" historical coal mine in Zabrze. In this group several routes can be included. Such as the three didactic ones at the Racławka River Valley around Dubie, located in the vicinity of Krakow, or the archaeo-geological path around the Holly Cross Voivodeship. Information tables or QR codes recreate the knowledge of them in an interesting fashion (Migoń, 2012). These objects should be characterized by their high substantive and didactic values, touristic attractiveness and accessibility (Krzeczyńska & Woźniak, 2011).

Researched scenic underground routes of the historical salt mines in Wieliczka and Bochnia towns, include numerous old workings showing various ways of salt extraction. There are also exhibitions displaying the geological setting of the salt deposits, which is a unique natural value of these mines. Therefore, these routes are very commonly visited by tourists.

The article aims to compare the geotouristic potential of five scenic underground routes of the above salt mines in terms of their use in tourism and education and determine the investment demand for raising their touristic development level.

Methodology

The research was done by direct field observations and photographic documentation made personally at the described sites. Apart from that, some papers were reviewed for choosing the geotouristic valorisation evaluation made for them. The statistical data of the tourist visits at these sites were obtained from their management. The research was made to examine the adequacy of these data in geotourism evaluation.

The evaluation of the geotouristic potential of the scenic underground routes was made by the compilation of the methods of the geotouristic valorisation of the inanimate nature object proposed by Dmytrowski & Kicińska (2011) and Doktor *et al*. (2015). It was directed to tourists, educators and investors being assessed by the point rating of four principal categories of criteria: visual, cognitive, functional and investment potential. The route values were assessed in the following way (Tabs. 1–3):

- the visual one by its substantive value (SV);
- the cognitive one by its cultural value (CV);
- the functional one by its location value (LV);
- the investment one by its geotouristic development level (V) and the availability of information on the route (AIR).

The results of the geotourism evaluation consists of didactic values (DV = SV + CV + LV + AIR) and geotouristic attractiveness (AG = DV + V) (Dmytrowski & Kicińska, 2011). This model was used as it is very significant in the possibility of creating a geopark of these historical mines development and/or in promoting very geologically attractive routes (Dmytrowski & Kicińska, 2011; Doktor *et al.*, 2015).

Tab. 1. Criteria and evaluation range in the geotouristic potential of the underground routes (after Sołowiej, 1992; Dmytrowski & Kicińska, 2011; Dryglas & Miśkiewicz, 2014; Doktor *et al.*, 2015)

Symbol	Criterion	Evaluated qualities	Points
Route's substantive value (SV)			
A	route's relevance in regional geological setting	irrelevant for regional geological setting	0
		partly showing regional geological setting	1
		clearly showing regional geological setting	2
B	route's particular geological structures (e.g. erosional) number	small number of geological structures	0
		average number of geological structures	1
		large number of geological structures	2
C	presence of rocks with mineralogical features on the route	simple rock mineral composition	0
		average complex rock mineral composition	1
		very complex rock mineral composition	2
D	route's rocks scope	hardly visible geological setting and processes	0
		little complex geological setting and few processes	1
		complex geological setting and numerous processes	2
E	route's length	short/average/long	0/1/2

Tab. 1 cont.

F	route's concentration degree in the region	large (one of many routes in the region)	0
		average (one of few routes in the region)	1
		small (the only example of the route in the region)	2
Route's cultural value (CV) ("yes" = 2 pt; "no" = 0 pt)			
G	G_1	route's connection with regional history	0/2
	G_2	route's connection with regional mining	0/2
	G_3	route's connection with regional legend	0/2
Route's location value (LV)			
H	location from roadways	>3 km from a roadway	0
		1–3 km from a roadway	1
		<1 km from a roadway	2
I	location from touristic routes	>200 m from a touristic route	0
		10–200 m from a touristic route	1
		<10 m from a touristic route	2
J	location from touristic resorts (cities, spas)	>5 km from a touristic resort	0
		<5 km from a touristic resort	1
		in a touristic resort	2
K	degree of difficulty in visiting	great (very difficult for visiting)	0
		average (some difficulty for visiting)	1
		small (easy for visiting)	2
The availability of the information on the route (AIR)			
L	the availability of the general information on the route	hardly available guidebooks, no description on webpages	0
		few guidebooks, short information on webpages	1
		many guidebooks, detailed description on webpages	2
M	the availability of the geological information on the route	hardly available guidebooks, no description on webpages	0
		few guidebooks, short information on webpages	1
		many guidebooks, detailed description on webpages	2
Route's geotouristic development level (V)			
N	Route's visiting character	individual, with no guide / in groups, with a guide	0/2
O	general information panel / QR code around the route	no information panel / QR code	0
		information panel / QR code describes the route superficially	1
		information panel / QR code describes the route in detail	2
P	geological information panel / QR code on the route	No information panel / QR code	0
		information panel / QR code describes the route superficially	1
		information panel / QR code describes the route in detail	2
R	exhibitions/lapidaries around the route	no exhibition/lapidary	0
		small exhibition/lapidary	1
		big exhibition/lapidary	2
S	infrastructure vicinity of the route	no infrastructure	0
		partial and incomplete infrastructure	1
		technical, sanitation infrastructure, gastronomic facilities and accommodation (within 1 km distance) developed very well	2

Tab. 2. Marks and range points for different values of the geotouristic attractiveness and its components for researched underground routes (after Sołowiej, 1992; Dmytrowski & Kicińska, 2011; Dryglas & Miśkiewicz, 2014; Doktor *et al.*, 2015)

Values	Grade		
	high (>70%)	average (70–40%)	low (<40%)
Substantive value (SV = A + B + C + D + E + F)	>8	8–5	<5
Cultural value (CV = G = G_1 + G_2 + G_3)	>4	4–2	<2
Locational value (LV = H + I + J + K)	>6	6–3	<3
The availability of the information on the route (AIR = L + M)	>3	3–2	<2
Didactic value (DV = SV + CV + LV + AIR)	>21	21–12	<12
Geotouristic development level (V = N + O + P + R + S)	>7	7–4	<4
Geotouristic attractiveness (GA = SV + CV + LV + AIR + V)	>28	28–16	<16

Tab. 3. Results of scenic underground routes geotourism evaluation (Tabs. 1–2)

Criterion & value	"Wieliczka" Salt Mine		"Bochnia" Salt Mine		
	Touristic Route	Miners' Route	Multimedia Touristic Route	Miners' Natural Route	Miners' Historical Route
A	2	2	2	2	2
B	2	2	2	2	2
C	2	2	2	2	2
D	2	2	2	2	2
E	2	2	2	2	2
F	1	1	1	1	1
SV	11	11	11	11	11
G_1	2	2	2	2	2
G_2	2	2	2	2	2
G_3	2	2	2	2	2
CV	6	6	6	6	6
H	2	2	2	2	2
I	2	2	2	2	2
J	2	2	2	2	2
K	2	1	2	2	1

Tab. 3 cont.

LV		8	7	8	8	7
L		2	1	2	1	1
M		2	2	2	2	2
AIR		4	3	4	3	3
DV	[1]	29/30	27/30	29/30	28/30	27/30
	[%]	97	90	97	93	90
N		2	2	2	2	2
O		1	1	1	0	0
P		2	1	0	1	1
R		2	1	2	2	2
S		2	2	2	2	2
V		9	7	7	7	7
GA	[1]	38/40	34/40	36/40	35/40	34/40
	[%]	95	85	90	88	85

Wieliczka and Bochnia salt deposits geological setting

Wieliczka and Bochnia towns are situated in southern Poland (Fig. 1A) and on the southern margin of the Carpathian Foredeep close to the Carpathian margin (Fig. 1B). The area around them is built of Neogene (Miocene, Badenian) allochthonous sediments, hosting evaporates belonging to the Wieliczka Beds (Figs. 1B, 2–3).

The salt deposit in the vicinity of Wieliczka stretches West–East in a belt around 10 km long and 300–1000 m wide (Figs. 1B, 2A). It is in the form of an evaporate series, consisting of the rock salt together with the siliciclastic ones: clays, sandstones and sulphate sediments: gypsum and anhydrite. It comprises two sections: the stratiform one, built of ordered layers, and the boulder one, built of mixed rock material, containing salt boulders of various sizes (Figs. 1B, 2).

The stratiform salt deposit lies on the Skawina Beds and is divided into five salt cyclothems. Its lower part consists of rock salts, the Oldest Salt, Green Stratified Salt and Shaft Salt complexes, and the upper part of Spiza Salt. Rock salt complexes have claystone, mudstone, anhydrite/gypsum sandstone and clay-anhydrite shale intercalations (Fig. 2B). In the stratiform salt deposit, some carbonized plant fragments also occur, in the form of brown coal, particularly in the complex of sub-salt sandstone, as xylitic and detritic debris, and in the upper Spiza Salt, as coal layers and pockets (Fig. 2B). The brown coal in that deposit comes from peat deposits evolved around marine salt bays (Wagner *et al.*, 2008). In the stratiform salt deposit, tuff intercalations $^{40}Ar/^{39}Ar$ dated 13.81 ±0.08 – 13.60 ±0.07 Ma are also present. They were formed due to volcanic activity during the Neogene (Bukowski, 1999, 2011; Fig. 2B).

The boulder salt deposit (Breccia Salt) was formed in multiple stages, as a result of both the tectonic overthrust of the Outer Carpathians and the lack of stability of the sedimentary basin bottom. In the southern part of the basin, submarine debris flows brought about the salt deposit of a mighty olistostrome, consisting of the Green Boulder Salt olistoliths and clays of the Skawina Beds, detached from the basement, all stuck in a matrix of the salt zuber (Fig. 2). The olistostrome of the boulder deposit was later overthrust onto the top of the stratiform deposit. As a result, the deposit was formed due to a successive overthrust phase, in which both parts were pushed further to the north and folded into three major scale folds of the stratiform deposit, surrounded by the boulder deposit (Fig. 2A; Kolasa & Ślączka, 1985a, 1985b; Rowan *et al.*, 2020).

The boulder salt deposit consists of salt blocks of various dimensions, intermingled with marly clays and zuber (Fig. 2B). The zuber consists of marly clays with dispersed monocrystalline halite and nodular concentrations of blue anhydrite (Garlicki, 1979; Wiewiórka, 1988). Some brown coal intercalations occur in the barren rocks of the boulder deposit. They are in the form of coal layers and pockets (Fig. 2B; Wagner *et al.*, 2008).

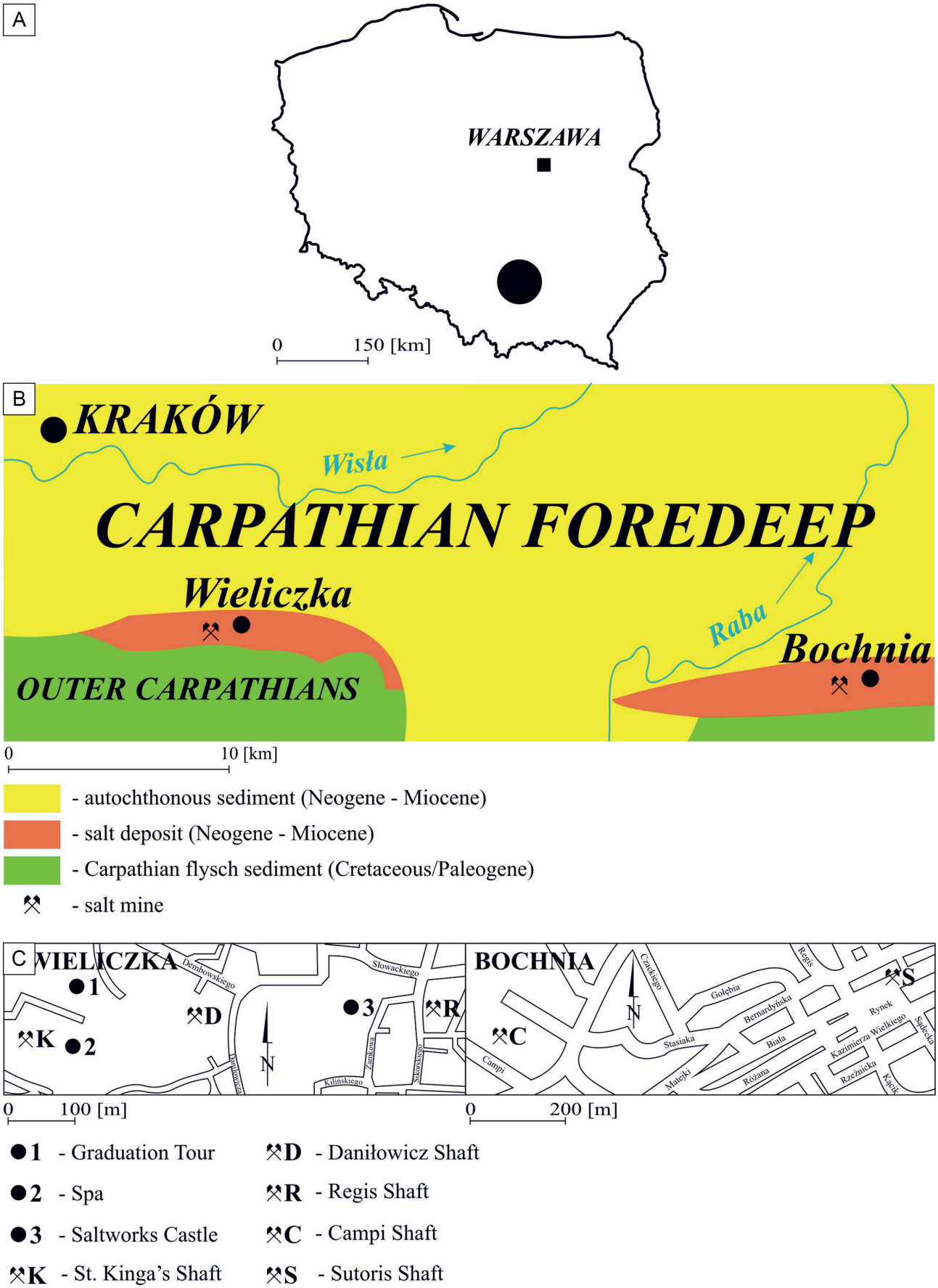


Fig. 1. Location of Wieliczka and Bochnia towns within Poland area (A), Carpathian Foredeep (B) (after Książkiewicz, 1972) and the objects related to the "Wieliczka" and "Bochnia" Salt Mine (C) (after www13; www22)

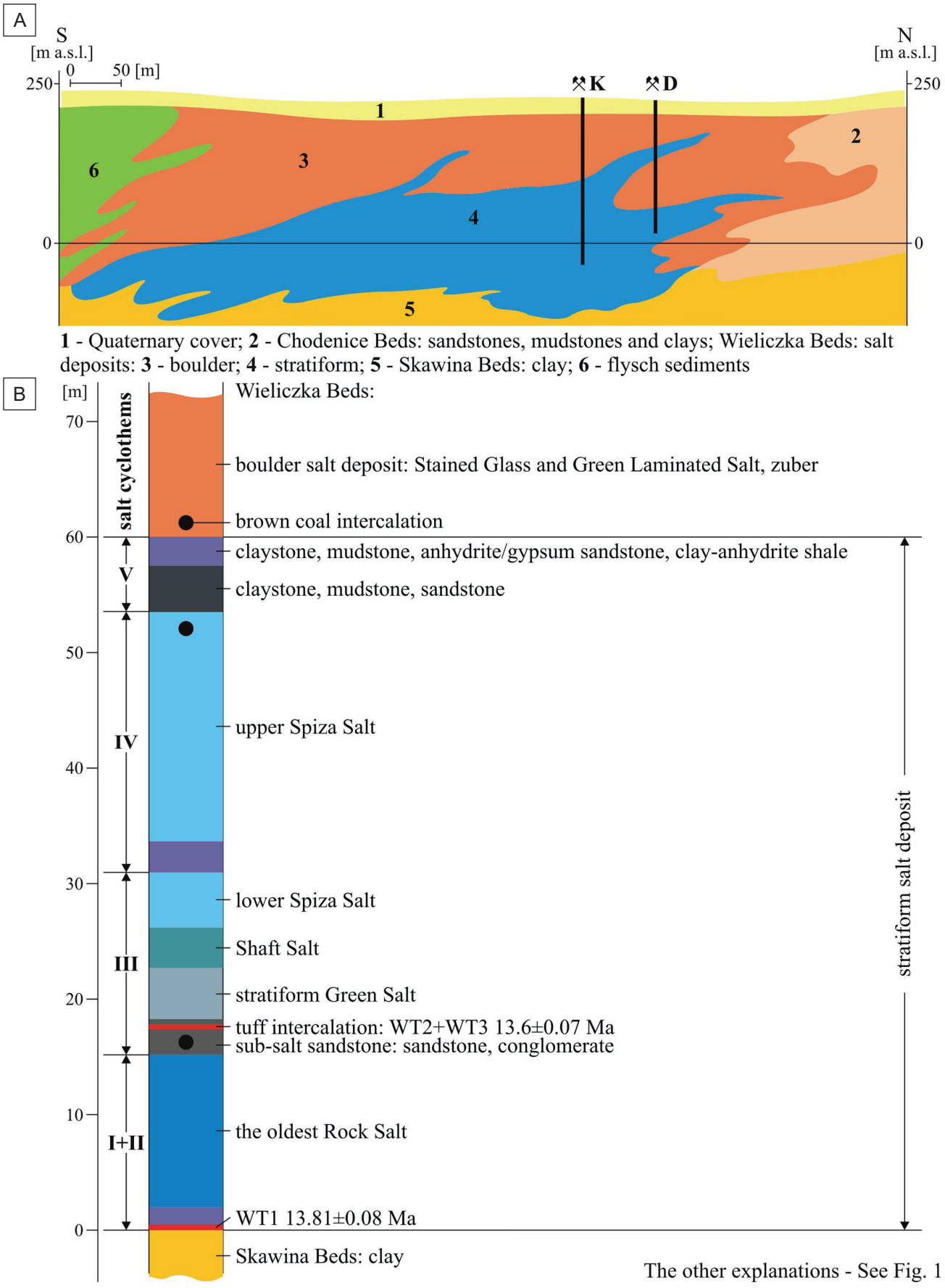


Fig. 2. Simplified cross-section through: the area around Wieliczka town (A) (after Poborski & Skoczylas-Ciszewska, 1963; Garlicki, 1968) and stratigraphic profile of the Wieliczka Beds around the "Wieliczka" Salt Mine (B) (after Garlicki, 1979; Bukowski, 1999, 2011)

For the first few hundred years, the boulder deposit was of great economic importance in its over-700-year mining history. The oldest and most beautiful old workings of the "Wieliczka" Salt Mine were cut in that part of the deposit (Fig. 4; Brudnik *et al.*, 2001; Dzięgiel, 2010; Wolańska, 2010, 2017; Dębkowski *et al.*, 2012; Bukowski *et al.*, 2019). Owing mostly to the variety of the boulder salt deposit, the "Wieliczka" Salt Mine has immense underground uniqueness. Later in time, very pure types of stratified rock salt: Shaft and Spiza salt, were also exploited.

In the vicinity of Bochnia town, sediment layers hosting the salt deposit are deeply folded. The axis of their two anticlines: Uzbornia on the south and Bochnia on the north (Fig. 3A), are parallel to the Carpathian margin. Their cores are built of flysch sediments, lifted from a deeper substratum and are surrounded by the sediments underlying evaporates (Fig. 3A). The Bochnia salt deposit is situated in the northern limb of the Bochnia Anticline (Figs. 3A, B). The rock salt deposit stretches W-E in a belt around 4.5 km long and from a dozen to 200 m wide. It is almost vertical in its upper part and characterized by a steep dip to the south. However, in its lower part, it gradually widens, and the dip value decreases (Figs. 3A, B). At the top, where the salt was eroded, a clay-gypsum crust was formed and covered with Quaternary sediments (Fig. 3B).

The Bochnia salt deposit is the thickest one, at a depth of 200–400 m, where it reaches 200 m in thickness (Fig. 3A). That zone is a result of particular tectonic enrichment of the rock salt layers, which were internally folded within larger-scale overthrust folds. Unlike plastic salt, some more rigid layers of marly clays and anhydrite are frequently fractured, torn and displaced, and the fissures are filled with secondary anhydrite and fibrous halite (Poborski, 1952).

The Bochnia salt deposit also lies on the Skawina Beds and consists of marly clays and sandstones, marls, gypsum and anhydrite, as well as concentrations of rock salt. The evaporates are also divided into five cyclothems of around 70 m total thickness and the following lithostratigraphic elements: basal anhydrite, lower zuber, the Southern Salts complex, marly clays, clays with anhydrite, upper zuber with rock salt blocks, clays with anhydrite and crystal salt intercalations, the Middle Salts complex, clays with anhydrite, the Northern Salts complex, clays, and top anhydrite (Figs. 3B, C). The Southern Salts complex consists of grey rock salt with claystone intercalations. The Middle Salts complex consists of laminated and striped rock salt with anhydrite claystone or clay and anhydrite shale intercalations. These intercalations are in the form of alternating laminae: white and grey. The Northern Salts complex consists of rock salt with numerous clay-anhydrite and pollution intercalations (Wagner *et al.*, 2010). All three salt complexes are intercalated by the carbonized plant fragments in the form of brown coal: xylite and gelitic ones (Fig. 3C; Wagner *et al.*, 2010). In the Bochnia salt deposit, tuff intercalations $^{40}Ar/^{39}Ar$ dated 13.81 ±0.08 – 13.6 ±0.07 Ma are also present (Fig. 3C; Bukowski, 1999, 2011).

The history of salt mining in southern Poland (Fig. 1A), in front of the Carpathians (Fig. 1B), is very long. It started in Wieliczka and Bochnia towns (Fig. 1B) in the 13th century. It ceased in the 1990s, mainly because of the need to protect the old historical workings of both mines, the dangerous water supply into the Mina Transverse in Wieliczka town, and the deposit resources exhaustion in the vicinity of Bochnia town (Garlicki, 2008; Włodarska, 2018; Charkot *et al.*, 2015; Flasza & Manecki, 2016).

Some parts of two historical salt mines in Wieliczka and Bochnia towns have been transformed into museum complexes, named the "Wieliczka" and "Bochnia" Salt Mines. Both of them, together with Saltworks Castle in Wieliczka (Fig. 1C) historically formed the "Krakow Saltworks" royal enterprise, one of the oldest industrial plants in Europe. They were cut in the same salt deposit and managed from the Saltworks Castle. In 1368, King Casimir III the Great issued the Saltworks Statute, ordering the old mining laws and traditions, which guaranteed these two mines' stable development for decades to come. As they were royal facilities, they generated a huge income. Hence, the Krakow Saltworks and the towns with salt mines were under the special care of monarchs (Jodłowski, 1988, 2015).

Currently, both mines have become famous not only for their valuable salt, but also for their very interesting old workings, tradition and art, as well as their unique geological features. Many sculptures carved in salt by miners in their old workings have survived. Particularly the unique underground chapels, with their rich decor and equipment (Włodarska, 2018; Flasza & Manecki, 2016).

Apart from two touristic routes of the Wieliczka and Bochnia Salt Mines, three new specialist old miners' routes have been open for tourism, since the 2010s. These are the Miners' Route leading around the Regis Shaft of the Wieliczka Salt Mine (Dębkowski *et al.*, 2012; Kopalnia Soli „Wieliczka", 2012; Włodarska, 2014; Wolańska, 2017) and two of the Bochnia one: the Natural Route, and the Historical ones, called "The Old Mountains Expedition" (Kopalnia Soli „Wieliczka", 2012; Mróz, 2015; Flasza & Manecki, 2016; www5; www20). The Miners' Route in Wieliczka and the Historical one in Bochnia towns traverse through the oldest workings of these mines. An expedition along them is proposed as complementary addition to their touristic routes. Going along these routes allows one to experience the mine's values in a modern way by actively involving tourists in exploring the miners' life and work. The routes require great physical effort, and in each of them, the visitors are equipped with protective suits, carbon monoxide absorbers, helmets and miner's lamps, because they lead through the narrow galleries and ladder sections. The expedition to these specialist miners' routes combines education with a wonderful underground adventure (Dębkowski *et al.*, 2012; Kopalnia Soli „Wieliczka", 2012; Mróz, 2015; Flasza & Manecki, 2016; Wolańska, 2017; Włodarska, 2018).

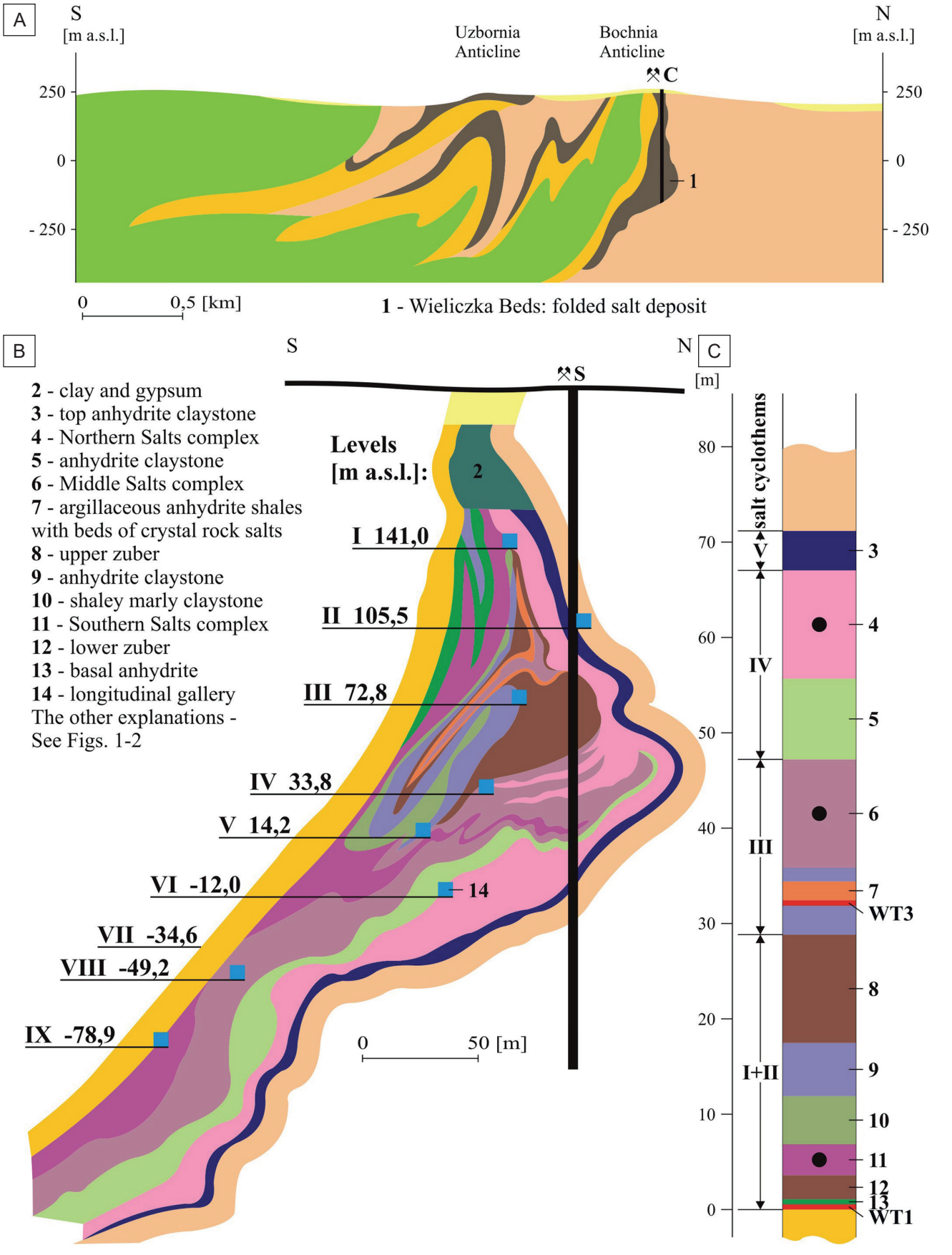


Fig. 3. Simplified cross-section through: the area around Bochnia town (A) (after Poborski, 1952; Garlicki, 1968), the salt deposit around the Sutoris Shaft of the "Bochnia" SaltMine (B) (after Poborski, 1952; Cyran & Toboła, 2008) and its lithostratigraphic profile (C) (after Poborski, 1952; Bukowski, 1999, 2011)

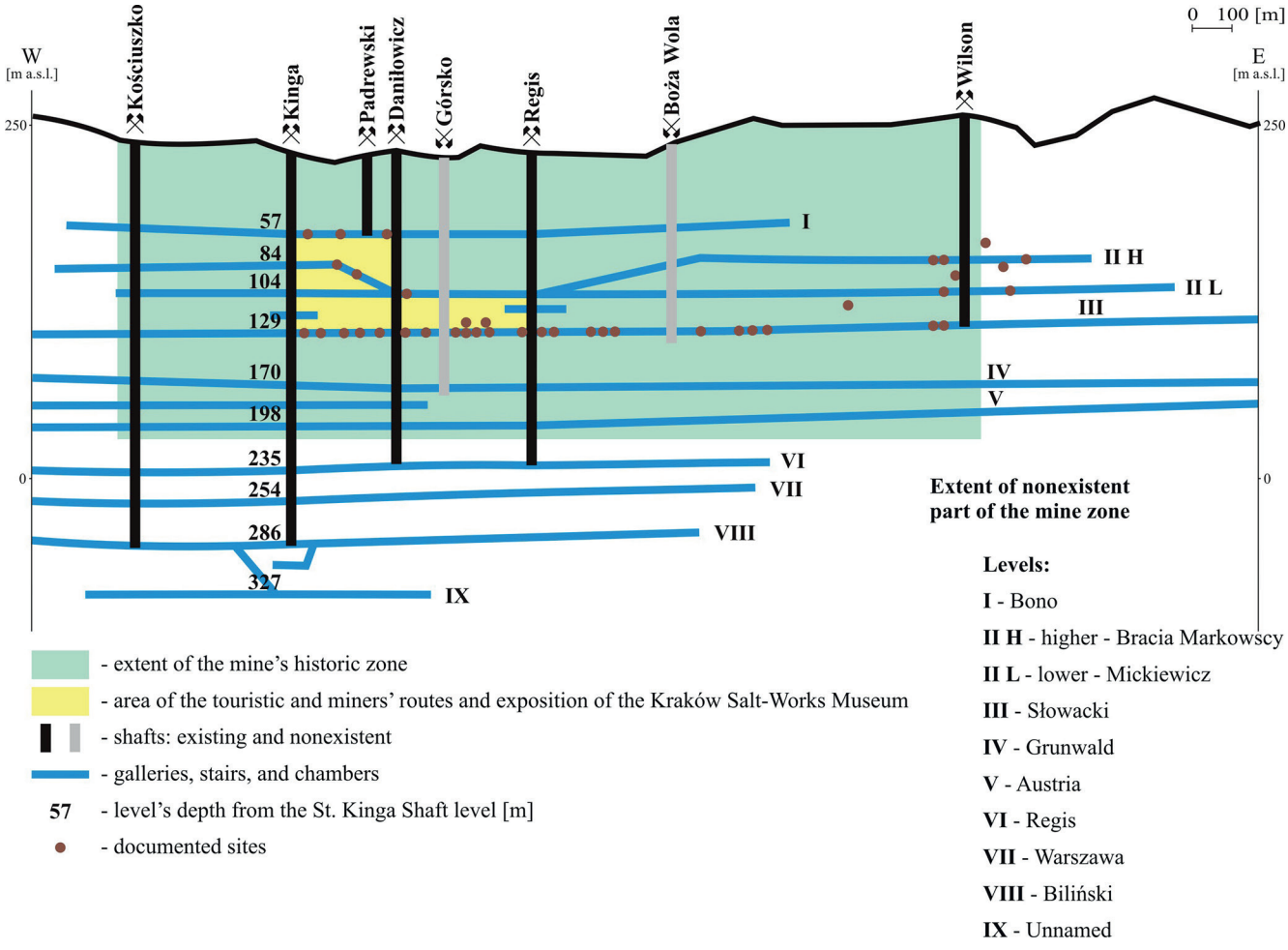


Fig. 4. Simplified vertical sketch-map of the "Wieliczka" Salt Mine with the documentated sites (after Wiewiórka *et al.*, 2008)

Historical salt mining in Wieliczka

The history of salt mining near Wieliczka town dates back to the Neolithic times, around 3,000 years BC. Salt was acquired by evaporating water from brine drawn from springs. Brine wells gave way to excavating salt with the use of mining methods (Wiewiórka *et al.*, 2008; Jodłowski, 1988, 2015). In the 13th century, in Wieliczka town, while one of the saline wells was being dug. The first boulders of rock salt were accidentally found as well. The discovery of valuable raw materials was revolutionary, making it possible to obtain salt by mining. Therefore, explorative works for some rich salt deposits were done, and the first shaft cut in Wieliczka town was the Goryszowski one (Jodłowski, 1988, 2015). A saline well was probably transformed into the mining shaft. Until the end of the 15th century, four more mining shafts: Świątkowski, Świętosławski, Wodny, Regis, and one underground level were cut in the "Wieliczka" Salt Mine (Piotrowicz, 1988). However, the mine had already become famous enough that it had started to be visited. Nicolaus Copernicus was its first visitor, probably in 1493 (Kurowski, 1990). In the 16th century, the search for salt continued, and in the middle of the 17th century, the mine reached its third level (Keckowa, 1988). The number of tourists grew steadily (Kurowski, 1990).

After 1772, the first partition of Poland, the "Wieliczka" Salt Mine, started to be managed by the Austrians. Their administration modernised the mine working system, improved the exploitation methods and gained considerable profits from mining. Using gunpowder for salt mining began. An underground railway line was built, and a steam hoisting machine and a power plant were commissioned in the mine (Dziwik, 1988).

Since that time, tourism has become an important source of income for the company as well. Many investments were made in order to increase tourism, and hence, various services were offered. The first touristic route in the mine was established at the turn of the 18th and 19th centuries. However, it was occasionally visited only by some travellers or naturalists. Since 1868, it could be partly toured by

a horse-drawn railway. Breath-taking attractions were prepared for the guests, such as the miners' descent into the mine using a rope. Boat rides on the saline lake were organised as well. During the tour, the route was illuminated with torches, the mining orchestra played for the visitors, and there were firework shows (Pitera, 2017).

While at the end of the 18th century, the visitors' number in the mine reached several dozen a month, at the beginning of the 20th century, it was as high as a hundred people a week. Among the visitors at that time were burghers: wealthy merchants and high-ranking officials, secular and clerical magnates, and members of aristocratic and royal families (Kurowski, 1990).

After the First World War and Poland's regaining of independence, the mine became the property of the Polish State Treasury and was retaken under the Polish administration again. As a result, the mine started to be significantly developed not only as a salt production plant, but also for its tourist and therapeutic functions. Since then, some events, particularly rallies, conventions, and anniversaries also started to be organised in the mine. Continuing the tradition of the First Republic, many distinguished guests from abroad were invited underground: rulers, high-ranking politicians and diplomats, to boast about the size of the company (Kurowski, 1990).

After the Second World War, the mine was developed dynamically in two ways. Salt production increased steadily and reached its maximum level in the 1970s. The mine working system has been arranged on nine levels, with a maximum depth of 327 m beneath the surface (Fig. 5A). It became a real labyrinth of underground galleries built over more than seven centuries. Their total length overtook 300 km, linking around three thousand chambers (www2; www11). As many dangers lurked in the dark, waiting for the miners, underground crosses and chapels devoted to saints were erected, guardians and patrons of the mining profession. Over the past five centuries, more than forty sacral objects have been built in the mine. The chapels devoted to St. Anthony and St. Kinga have gained particular importance and significance. The Touristic Route around the Daniłowicz Shaft (Fig. 5) continued to be open to the public (Dzięgiel, 2010; Wolańska, 2010; www2; www11).

In 1951, the Krakow Saltworks Museum was established. Its management has been seated in the Saltworks Castle (Fig. 1C). Its underground exhibitions have been placed at the third level of the Touristic Route (Fig. 5) and on the surface in the Saltworks Castle since 1973 (Fig. 1C; www23, www24). Tourist traffic was becoming more and more important, and the awareness of the site's cultural significance was growing (Charkot *et al.*, 2015; www2, www3; www11).

Since 1976, the "Wieliczka" Salt Mine has often been listed in registers of monuments. In 1978, it was inscribed into the UNESCO World Cultural and Natural Heritage List (www2; www11). It has been demonstrated that the historical salt mine is a monument requiring special care and protection (Alexandrowicz *et al.*, 2009). In 1994, it was declared a National Historic Monument by the President of the Republic of Poland (www2; www11).

In 1996, the "Wieliczka" Salt Mine stopped its operation mainly because of the need to protect its old historical workings and dangerous water supply into its Mina Transverse (Charkot *et al.*, 2015; Flasza & Manecki, 2016; Włodarska, 2018). Since 1997, it has been transformed into a world-famous geotouristic attraction, an object of culture, a museum, and a balneotherapeutic facility. It has become a place of birth of the so-called "subterraneotherapy", i.e., an innovative method of curing that utilizes a specific microclimate in underground chambers of inoperative salt workings. The method was originally developed by Professor Mieczysław Skulimowski, who revived the efforts of a 19th-century mine physician Feliks Boczkowski. Hence, the salt mine has obtained a spa status, and its mineral waters (brines) from some outflows have been recognized as therapeutic. The Spa of the "Wieliczka" Salt Mine (Fig. 1C) offers balneotherapeutic treatment in four chambers: the Jezioro Wessel, Stajnia Gór Wschodnich, Smok, and Feliks Boczkowski situated on the third, Słowacki level, at a depth of 135 m beneath the surface. The most commonly treated patients are those with non-infectious problems of the upper and lower respiratory tracts (d'Obyrn & Rajchel, 2014; Bralewska *et al.*, 2022; www2; www11). Moreover, the Spa offers a recreation zone with multimedia stations and arcade games. The patients can also have a meal at the Karczma Górnicza in the underground (www9). The surface building of the health resort is situated around the St. Kinga's Shaft (Fig. 1C). Since 2014, the Spa of the "Wieliczka" Salt Mine has also had a Graduation Tower situated in the Kinga park (Fig. 1C; d'Obyrn & Rajchel, 2014). Its visitors experience a sense of well-being and increased energy. The visit is recommended for allergy sufferers with skin and inhalation problems and people with reduced immunity (d'Obyrn & Rajchel, 2014; www14).

In 1996, the Regis Shaft (Fig. 1C), cut in 1334, started to be renovated for touristic purposes as well (Dębkowski *et al.*, 2012). Since 2012, it has been used to transport tourists and patients underground, when a new scenic underground route, the Miners' Route around it, was established as a result of the project: "New Adventure Routes in the Historical 'Wieliczka' Salt Mine", carried out by the workers of the Krakow Saltworks Museum (Wolańska, 2017; www15).

Approximately 2350 chambers and 240 km of galleries dug in the Wieliczka salt deposit (Fig. 5A) remain well preserved. They constitute the "Wieliczka" Salt Mine, written into the first UNESCO List of the World Natural and Cultural Heritage in 1978 and recognised as a National Monument of History in 1994. Due to the initiative of the Department of the Environmental Protection of the voivode office in Krakow, the sites important for the geology of the salt deposit were chosen and documented with detailed descriptions, sketches, photographs, and information tables.

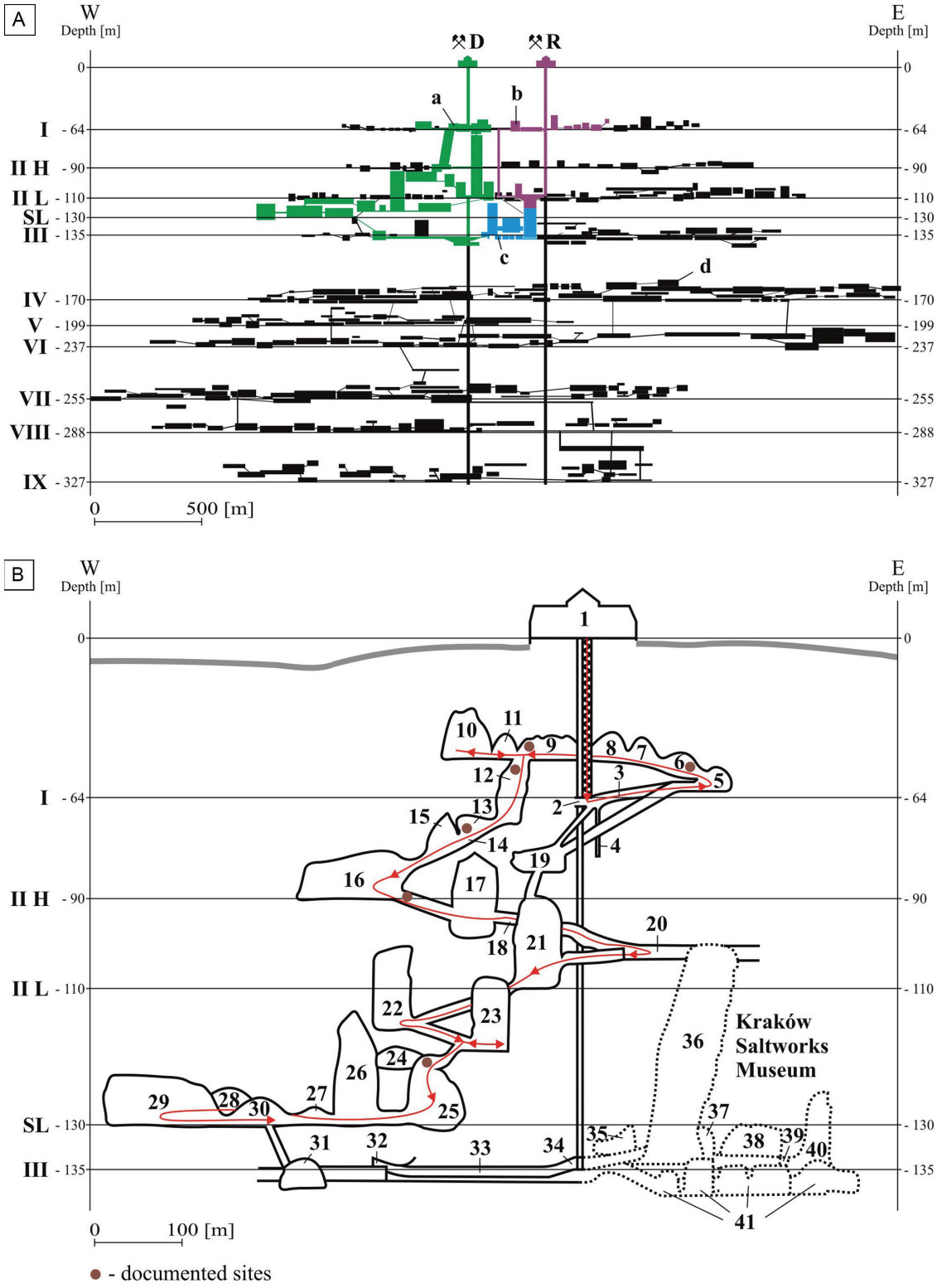
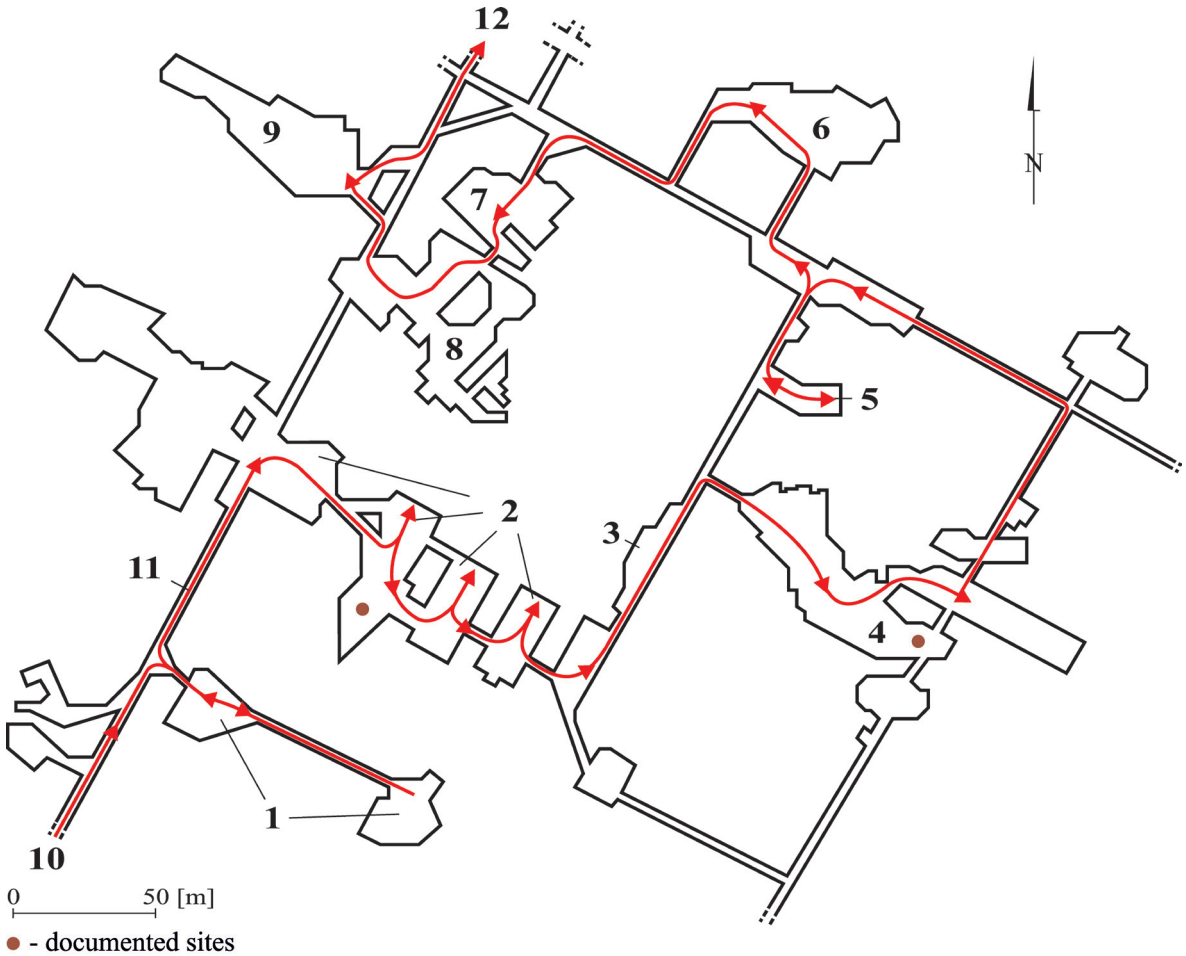


Fig. 5. Simplified vertical sketch-map of the "Wieliczka" Salt Mine (A) (after www10): Routes: a – Touristic; b – Miners'; c – Krakow Saltworks Museum; d – part unavailable for tourism; SL – Kazanów Split-Level; the other explanations – see Fig. 4; and the Touristic Route (B) (after www7): Daniłowicz Shaft: 1 – headframe; 2 – Bottom no. I; 3 – Touristic Route; 4 – Antonia Fore-Shaft; Chambers: 5 – Nicolaus Copernicus; 6 – Janowice; 7 – St. Anthony's Chapel; Chambers: 8 – Spalone; 9 – Sielec; 10 – Casimir the Great; 11 – Neolithic Saline Works; 12 – Pieskowa Skała; 13 – Foreman's Excavation; 14 – Kunegunda Gallery; Chapels: 15 – Holy Cross; 16 – St. Kinga's; 17 – Erazm Barącz Chamber; 18 – Erazm Barącz Incline; Chambers: 19 – Ursula; 20 – Michałowice; 21 – Rarańcza Incline; Chambers: 22 – Drozdowice; 23 – Weimar; 24 – Pistek; 25 – Józef Piłsudski; 26 – Stanisław Staszic; 27 – Treasurer; 28 – Prof. Witold Budryk; 29 – Warszawa; 30 – Wisła; 31 – St. John's Chapel; 32 – Haluszki Chamber; 33 – Antonia Gallery; 34 – Bottom no. II of Daniłowicz Shaft; Kraków Saltworks Museum: Chambers: 35 – Alfons Długosz; 36 – Saurau; 37 – Kraj; 38 – Modena; 39 – Miejska; 40 – Maria Teresa; 41 – Russegger

Since 1992, 40 documented sites were included. They are situated within the Tourist Route, including the underground exhibition of the Krakow Saltworks Museum (Figs. 4, 5B, 6), as well as the galleries leading to and surrounding the Crystal Caves: Upper and Lower. They are situated around 80–130 m beneath the surface, and their height is from 1.5 m to 5.8 m. In 2000, the underground Natural Reserve "Crystal Caves" within the "Wieliczka" Salt Mine was approved by the Małopolska voivode. Visiting the documented sites outside the Tourist Route and the Museum's exhibition is possible after previous notification in the Tourist Office of the Wieliczka Salt Mine (Alexandrowicz, 2000; Wiewiórka *et al.*, 2008). Entering the Crystal Caves requires the consent of the Regional Nature Conservator.

Among 40 documented sites in the "Wieliczka" Salt Mine, six are situated within its Touristic Route, and two are in the Krakow Saltworks Museum (Figs. 4, 5B). Three are situated at the first Bono level, two at the second higher Bracia Markowscy level and one at the second Mickiewicz lower level (Figs. 4, 5B). Among the first three, two comprise the boulder salt deposit and one the stratiform deposit belonging to its Middle Fold (Figs. 2, 4, 5B). The following two documented sites are situated at the second Bracia Markowscy higher level, between the Pieskowa Skała and Erazm Barącz Chambers. The first one comprises stratiform salt deposite, also belonging to its Middle Fold, and the second boulder comprises salt deposite (Figs. 4, 5B).

The last documented site within the Tourist Route is situated at the second Mickiewicz lower level. It consists of the contact zone of the boulder and stratiform salt deposits (Figs. 4, 5B; Dz.Urz. z 1997 r. nr 21, poz. 119).



● - documented sites

Chambers (Fig. 5B):
1 - Aleksandrowice
2 - Russegger
3 - Szerzyzna
4 - Maria Teresa
5 - Miejska
6 - Modena
7 - Kraj
8 - Alfons Długosz
9 - Saurau
10 - entrance from the Wisła Chamber (Fig. 5B)
11 - Touristic Route
12 - exit to the Regis Shaft (Figs. 5A)

Fig. 6. Map of Krakow Saltworks Museum in the "Wieliczka" Salt Mine

In the Krakow Saltworks Museum, situated at the third Słowacki level, the first documented site is situated in the Russeger Chamber Complex, and the second one in one of the Maria Teresa Chamber Complex (Fig. 5B, 6). The first one consists of stratiform salt deposits belonging to their Northern Fold (Fig. 2), and the second one, consists of the boulder salt deposits (Figs. 4, 5B; Dz.Urz. z 1997 r. nr 21, poz. 119).

Among 32 other documented sites situated outside the Tourist Route, twelve are in the eastern part of the "Wieliczka" Salt Mine around the Wilson Shaft, at three levels: the second Bracia Markowscy and Mickiewicz ones, and the third Słowacki one, and at the level between them (Fig. 4). They comprise boulder and stratiform salt deposits. The latter one forms very complex tectonic structures of the unit, named "Crystal Caves Dome". The remaining twenty documented sites are situated at the third Słowacki level between the St. Kinga and Wilson Shafts (Fig. 4). They also comprise the boulder and stratiform salt deposits. The latter ones comprise mainly Spiza Salt, which is micro tectonically disturbed (Dz. Urz. z 1997 r. nr 21, poz. 119).

The Touristic Route in Wieliczka

The Touristic Route is the main visiting route in the "Wieliczka" Salt Mine, the most often visited and one of the best-known underground touristic attractions in the world. The route was cut mostly in the boulder salt deposit (Fig. 2A). The unique underground city hides many mysteries: chambers carved in salt, majestic woodwork, underground lakes and unique salt sculpture masterpieces. The route leads through a very small part of the great underground world. Long galleries, over twenty of the most beautiful chambers, three of which are flooded with brine. Additionally, a collection of former devices, machines, and mining equipment and exceptional chapels are situated around the Daniłowicz Shaft (Fig. 5B). The knowledge of the natural phenomena, history and the elements that shaped the miner's work, is also presented owing to multimedia exhibitions along the route. Visitors are brought into virtual space by the only underground 3D cinema in the world, as well as interactive applications and games (Brudnik *et al.*, 2001; Dzięgiel, 2010; Wolańska, 2010; Bukowski *et al.*, 2019; www16; www29).

The Touristic Route is long, around 2.5 km, and begins in the Daniłowicz Shaft. The visitors descent around 135 m beneath the surface to the third level of the mine (Fig. 5). First, they go down the stairs to the first, Bono level, 64,5 m beneath the surface, and walk along the galleries linking a few chambers (Fig. 5B; Dzięgiel, 2010; Wolańska, 2010; www16; www29). The galleries are wood-lined, and there are also plenty of boxed cribs. However, some outcrops of the salt deposits and secondary halite cauliflowers are on the ceiling or sidewall. In the section linking the Daniłowicz Shaft with Pieskowa Skała Chamber, two of them are included in the documented sites: the boulder one, including laminated salt (Figs. 2, 4, 5B, 7A), and the stratiform one, including different kinds of Spiza Salt and belonging to its Middle Fold, with secondary halite cauliflowers (Figs. 2, 4, 5B, 7B; Dz.Urz. z 1997 r. nr 21, poz. 119).

St. Kinga's Chapel (Fig. 5B, 7C) is the heart of the mine. It was fully carved in salt at the end of the 19th century and is the most recognisable chamber on the route and the largest underground place of worship in Europe. The St. Kinga's figure, the saint patron of salt miners, is connected with a legend about the discovery of salt (Brudnik *et al.*, 2001; Dzięgiel, 2010; Wolańska, 2010; Bukowski *et al.*, 2019; www16; www29).

The Michałowice Chamber (Figs. 5B) is one of the largest ones in the "Wieliczka" Salt Mine and was exploited over 100 years ago. A very complex wooden support system was used for its ceiling, as the majestic woodwork example (Fig. 7D).

The Piłsudski Chamber (Fig. 5B) was developed in the 1830s after two neighbouring salt boulders were exploited, and these two smaller chambers were linked by a tunnel named "Piłsudski Grotto" and are flooded with brine. St. John of Nepomuk's figure was established on its bottom (Fig. 7E; Brudnik *et al.*, 2001; Dzięgiel, 2010; Wolańska, 2010; Bukowski *et al.*, 2019; www16; www29).

The Warszawa Chamber is used for conferences and as a 3D cinema (Fig. 5B). From the Wisła Chamber, visitors can go to the bottom of the Daniłowicz Shaft situated on the third Słowacki level (Figs. 4, 5B) to return to the surface by lift, or continue visiting the underground part of the Krakow Saltworks Museum situated entirely at the same level (Fig. 4). This is the additional and final part of the Touristic Route of the "Wieliczka" Salt Mine. It features objects and very nice nature elements that cannot be seen in the earlier sections of the route. Its beautiful monumental chambers also provide unforgettable impressions. The museum route is long, around 1.5 km (Fig. 6; www24; www28).

In the museum, the visitors walk among very picturesque boxed cribs to the Russegger Chambers complex (Fig. 6), where they can admire specimens of crystals, delicate salt hair, Christmas trees, stalactites and stalagmites. Their unusual shapes are due to the secondary halite crystallization occurring where brine appears. Particularly impressive is the exhibition of the large halite crystals from the famous Crystal Caves (Fig. 7F; Alexandrowicz, 2000; www21; www24; www28). Moreover, within the Russegger Chambers complex (Fig. 6) a unique giant horse-powered treadmill is also exhibited along with a prehistorical saline furnace with brine-evaporation vessels and former devices used for miners' descending, mine drainage and salt mining. The visitors can also admire some paintings by famous Polish painter Jan Matejko in these chambers.

The Maria Teresa Chambers complex (Figs. 5B, 6) also comprises some enormous chambers, high over 20 m. They are very impressive, from which salt boulders were once extracted. Numerous traces of torn salt boulders create an unusual texture

of the walls (Fig. 5B, www24; www28). After visiting the exhibitions in the other chambers, the visitors walk to the bottom of the Regis Shaft (Figs. 1C, 6) and return to the surface by lift.

The surface part of the Krakow Saltworks Museum is situated in the Saltworks Castle (Fig. 1C) and exhibits the saltcellars collected since 1973. They are dated from the beginning of the 16th century to modern times (www24; www28). Metal saltcellars were very common then.

The Touristic Route in the "Wieliczka" Salt Mine is very widely known; therefore, its didactic value and geotouristic attractiveness are of high grade, estimated at 97% and 95% (Tabs. 1–3). The interest in it was always very high both in Poland and all over the world. From 2012–2019, the number of visitors in that facility grew regularly and varied from 1,113,222 to 1,824,829. In 2020, it dropped to 437,458 probably due to the COVID-19 pandemic (Tab. 4).

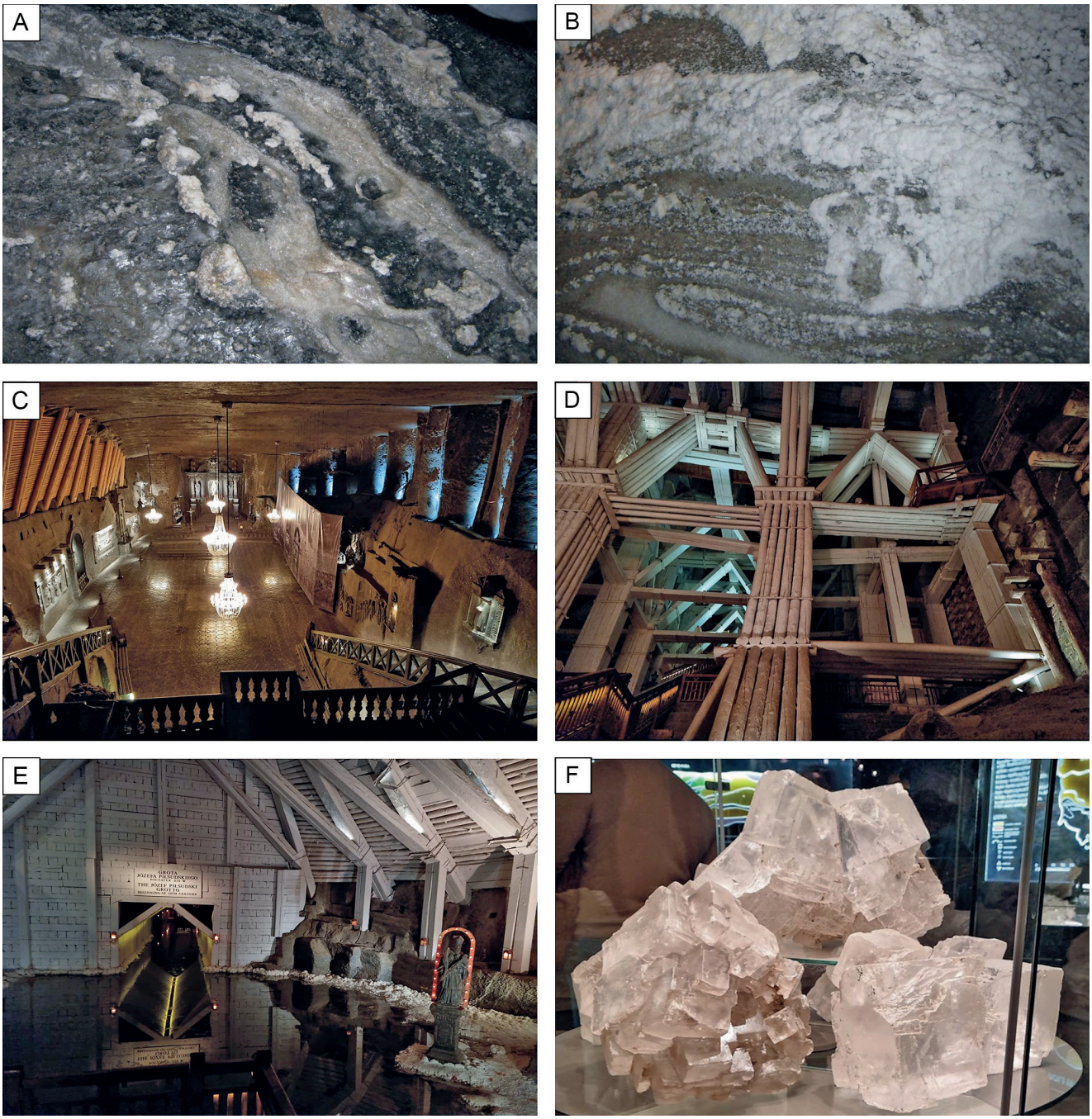


Fig. 7. Photographs of the Touristic Route of the "Wieliczka" Salt Mine (Figs. 1C, 4, 5) and Krakow Saltworks Museum (Fig. 6): A – boulder salt deposit between the Daniłowicz Shaft and Janowice Chamber; B – stratiform salt deposit, with secondary halite cauliflowers between the Spalona and Pieskowa Skała Chambers; C – St. Kinga's Chapel; D – wooden support system for the ceiling, as the majestic woodwork example in the Michałowice Chamber; E – Józef Piłsudski's Chamber and Grotto, and St. John of Nepomuk's figure established on the bottom of the saline lake; F – halite crystals specimens occurring in the Crystal Caves of the mine in the Krakow Saltworks Museum (Fig. 6). Photos M. Dzięgiel unless otherwise noted

Tab. 4. Tourist attendance at geotouristic facilities in Wieliczka, Bochnia, and Kłodawa towns (after Kruczek, 2019; obtained from salt mines' managements)

Year	"Wieliczka" Salt Mine		"Bochnia" Salt Mine			"Kłodawa" Salt Mine
	Touristic Route	Miners' Route	Multimedia Touristic Route	Natural Miners' Route	Historical Miners' Route	
2012	1 113 222	3 936	no data	no data	no data	25 034
2013	1 193 054	16 654	no data	no data	no data	27 696
2014	1 262 331	27 957	71 402	no data	no data	no data
2015	1 360 531	29 459	86 751	no data	444	31 300
2016	1 538 403	29 397	102 125	855	492	no data
2017	1 674 126	34 005	111 725	1 365	517	no data
2018	1 710 693	35 102	113 422	1 031	290	no data
2019	1 824 429	37 414	114 056	1 355	445	no data
2020	437 458	3 602	38 432	203	77	no data

The Miners' Route in Wieliczka town

This new, specialized miners' route leads through the oldest and raw workings of the "Wieliczka" Salt Mine situated around the Regis Shaft (Fig. 1C). Its visitors turn into novice miners, adept of the underground trade, and its darkness must be overcome using a lamp. They are given some tasks, such as searching for salt, testing the air in the mine and finding the correct route underground. To perform practical mining tasks, they will have to learn the work of the old mining professions, such as crushers, methane testers and mining carpenters, earned through 700 years of mine exploitation (Kopalnia Soli „Wieliczka", 2012; Wolańska, 2017; www15; www25). Thus, they experience an extraordinary and unforgettable adventure.

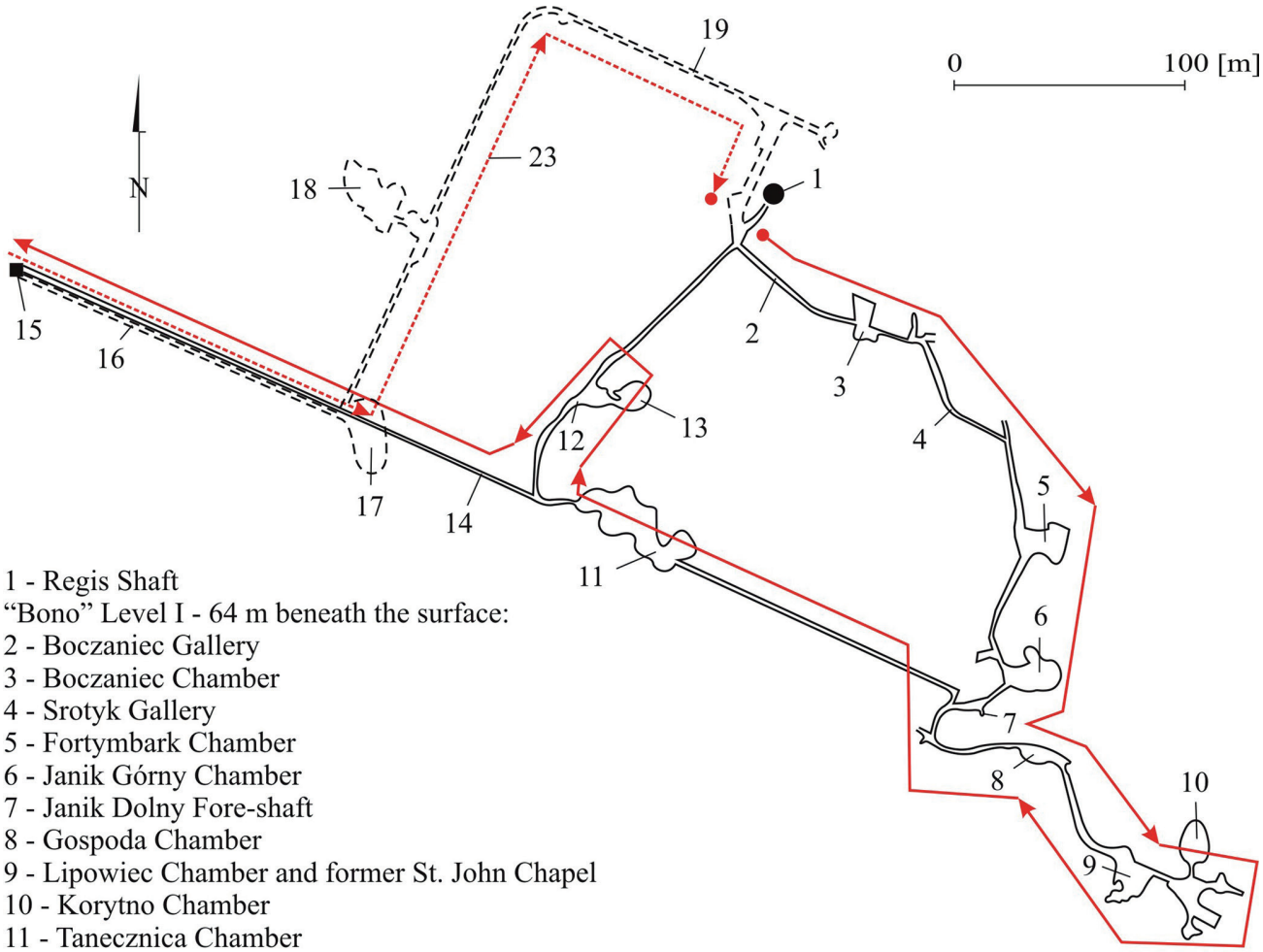
The route comprises over twenty old working sites situated at two levels: the first Bono, 64,5 m, and the second Mickiewicz lower ones, 101 m beneath the surface. Its total length is around 2 km (Fig. 8; Kopalnia Soli „Wieliczka", 2012; www15; www25). It leads mainly through the first "Bono" level and only at its final section, through the second Mickiewicz lower level (Fig. 8).

The Miners' Route is also unique due to its geological value. The dominating feature is a boulder salt deposit in the form of beautifully shaped boulders of green laminated and stained glass salt (Fig. 2; Kopalnia Soli „Wieliczka", 2012; Wolańska, 2017; www15; www25).

In general, the galleries of the route are wood-lined. However, there are also some unprotected sections as very picturesque salt deposit outcrops. Some parts of their chambers' sidewalls are protected with anchors or boxed cribs (Dębkowski *et al.*, 2012; Kopalnia Soli „Wieliczka", 2012; Wolańska, 2017; www15; www25).

The visitors descent by a lift of the Regis Shaft to the first Bono level (Fig. 9). Between the Fortymbark and the Janik Górny Chambers, the visitors can examine the outcrop of the secondary halite cauliflowers on the side wall and boxed crib (Figs. 8–9A). In some places, the gallery's ceiling level is so low that the visitors must bend down (Fig. 9B). It is a typical example of miners' toil. The southern part of the Gospoda Chamber is supported by a salt wall, interspersed with wood and reinforced with stands (Figs. 8, 9C; www12). In the Tanecznica Chamber, the visitors can experience the old miners' work, spinning the hoisting wheel (Figs. 8, 9D) and crumbling the salt brittles using pick-axes (Fig. 9E). Then, they go down the stairs, around the Klemens Nowy Split-Shaft, to the second "Mickiewicz" lower level (Fig. 8). They can examine mining rescue equipment (Fig. 9F) and walk to the ceiling part of one of the Maria Teresa Chambers complex, also open for the visitors of the Krakow Saltworks Museum, but at its bottom (Fig. 6; www24; www28). Then, they walk along the Przykos Gallery to the bottom of the Regis Shaft (Fig. 8) and return to the surface by lift.

Despite the fact that this route has been open for tourism only recently, both its didactic value and geotouristic attractiveness are of high grade, estimated at 90% and 85% (Tabs. 1–3). The interest in this new route was high from the beginning of its opening. In the first years, 2012–2013, the total visitors number in that facility varied from 3,936 to 16,654. In the next period, 2014–2019, it regularly grew, varying from 27,954 to 37,414. In 2020, it decreased to 3,602 probably due to the COVID-19 pandemic (Tab. 4).



1 - Regis Shaft
"Bono" Level I - 64 m beneath the surface:
2 - Boczaniec Gallery
3 - Boczaniec Chamber
4 - Srotyk Gallery
5 - Fortymbark Chamber
6 - Janik Górny Chamber
7 - Janik Dolny Fore-shaft
8 - Gospoda Chamber
9 - Lipowiec Chamber and former St. John Chapel
10 - Korytno Chamber
11 - Tanecznica Chamber
12 - Nadachów Fore-shaft
13 - Rzepki Chamber
14 - Klemens Gallery
15 - Klemens Nowy Fore-shaft; stairs down to the "Mickiewicz" Lower Level II
"Mickiewicz" Lower Level II - 101 m beneath the surface:
16 - Klemens Gallery
17 - Franciszek Karol Chamber
18 - one of the Maria Teresa Chamber Complex
19 - Przykos Gallery: the way to Regis Shaft Bottom

Old workings at the levels (Figs. 4-5):

═══ - "Bono" I

⁝⁝⁝⁝⁝⁝⁝ - "Mickiewicz" Lower (IIL)

Miners' Route at the levels:

→ - "Bono" I

⇢ - "Mickiewicz" Lower (IIL)

Fig. 8. Map of Miners' Route in "Wieliczka" Salt Mine (after Dębkowski *et al.*, 2012)

Fig. 9. Photographs of the Miners' Route in the "Wieliczka" Salt Mine (Figs. 1C, 9): Srotyk Gallery: A – secondary halite cauliflowers on the sidewall and crib; B – the example of low passage leading to the Janik Górny Chamber (the show of former miners' toil); C – salt wall made of salt cubes interleaved with wood in the Gospoda Chamber; Former miners' working demonstration made by visitors in the Tanecznica Chamber: D – moving hoisting wheel; E – crushing salt brittles; F – exhibition of the mining rescue equipment in the Klemens Gallery, at the second "Mickiewicz" lower level.

Historical salt mining in Bochnia

The history of salt mining in the vicinity of Bochnia dates back to the Neolithic times, around 3,500 years B.C. Just as in the vicinity of Wieliczka, the salt was also originally acquired by evaporating water from brine drawn from springs. Brine wells gave way to excavating salt with the use of mining methods (Fischer, 1962; Jodłowski, 1971).

The "Bochnia" Salt Mine is the oldest mine in Poland. It was developed probably in 1248, when salt seams were found there. The Eastern Zone of the salt deposit in the vicinity of Bochnia town was the first to be mined. Therefore,

it is called "Stare Góry" (Fig. 10). The oldest shafts of the mine are Sutoris (Figs. 1C, 10) and Gazaris (Fig. 10; Fischer, 1962). They were first sunk down to the depth of 70 m beneath the surface, to the first, Danielowiec working level (Fig. 10; Wiewiórka *et al.*, 2013a, 2013b; Piotrowicz, 2014).

The mine developed rapidly in the 15th and 16th centuries. The shafts were sunk down much deeper, and further ones were constructed at that time includng Floris, Regis, Bochneris, and Campi (Fig. 10). Until the end of the 16th century, the mine working system was arranged to the depth of around 300 m beneath the surface, and its extent was expanded westwards. Its new part was called the "Nowe Góry" Zone (Fig. 10). However, since then, due to wars and an economic decline, the mine's development was slowed down (Fischer, 1962; Jodłowski, 1988).

After 1772, the first partition of Poland, the "Bochnia" Salt Mine, started to be managed by the Austrian Empire. Their administration began again to develop the mine. Since the turn of the 18th and 19th centuries, the mine working system was expanded again, arranged on sixteen levels, with a maximum depth of 468 m beneath the surface (Fig. 10), which allowed the mine to operate for the next dozen years. In 1908, the Trinitatis Shaft (Fig. 10) was sunk down. It is the most ventilated and youngest of the "Bochnia" Salt Mine. The exploitation methods were improved, and therefore considerable profits from mining were gained. This marked the period of the most significant development of the mine (Fischer, 1962; Charkot, 2005).

At the beginning of the 20th century, salt mining in Bochnia town decreased considerably due to its smaller profitability. In 1981, a decision of the conservation office in Tarnów, after recognising the six oldest levels of the "Bochnia" Salt Mine (Fig. 10) as a historical monument, opened the way for preserving its most precious underground excavations and surface devices. The mine was also listed in the Polish Registry of Cultural Property in the same year. In 1990, they stopped its operation due to the exhaustion of deposit resources (Wiewiórka *et al.*, 2008; Flasza & Manecki, 2016). The galleries below the ninth level (289 m) were closed down and successively backfilled (Fig. 10).

However, in the early 1990s, a new period of activity of the mine commenced, focused on tourism, recreation, and health care. In the selected sites of the higher levels, the adaptation works unveiled illegible geological structures and remains of historical excavations, often backfilled, without disturbing the stability of the rocks masses. Three shafts: Sutoris, Campi and Trinitatis, some fore-shafts and galleries at nine levels were preserved as a relic of the historic salt mine, some part of which was open for tourism (Fig. 10). It has been transformed into a widely known geotouristic attraction, an object of culture and recreation, and a balneotherapeutic facility. A Touristic Route was established there in 1993 (Cyran & Toboła, 2008; Wiewiórka *et al.*, 2008), and since 2008, it has been extended by a boat trip in the Chamber 81, flooded with brine, as a trace of the salt-wet mining method (Dzięgiel, 2010; Wiewiórka *et al.*, 2013a, 2013b; Piotrowicz, 2014). It is the only salt mine with an underground boat crossing in Poland. Since 2011, an underground multimedia exhibition was also activated, currently called the "Multimedia Touristic Route" (www18).

In 1995, the Underground Healing Centre was established. It is a part of the Spa of the "Bochnia" Salt Mine, with its unique microclimate recommended for respiratory diseases. It has offered balneotherapeutic treatment in the Ważyn Chamber at 250 m beneath the surface (Fig. 10; www17). Since 2017, this activity was stopped for economic reasons (www8). However, overnight stays and sports events have been held there until today. These take place in the Ważyn Chamber as well which consists of a sleeping room with around 250 beds, a restaurant, a souvenir shop, and recreational facilities: a sports field, disco/conference room and children's playground (Fig. 10; Cyran & Toboła, 2008; Mróz, 2015; www17).

In 2013, the "Bochnia" Salt Mine was inscribed on the UNESCO World Cultural and Natural Heritage List. Since then, these two objects and the "Wieliczka" Salt Mine have been listed under a common name: "The Royal Salt Mines in Wieliczka and Bochnia town" (Flasza & Manecki, 2016; www6).

Currently, to make the "Bochnia" Salt Mine more attractive, two new miners' routes were established: the Historical one called "The Old Mountains Expedition", in 2014 (www1; www5) and the Natural Route in 2015 (Mróz, 2015; Flasza & Manecki, 2016; Wiewiórka *et al.*, 2016; www1; www20). Since 2017, an additional route was developed: "In the footsteps of the Bochnia miners' chapels", the latest offer of the "Bochnia" Salt Mine (www19). The route leads through mine chapels and niches. According to historical sources, there were over thirty underground chapels in the "Bochnia" Salt Mine. Up until the present, visitors can visit six of them (www19).

Apart from the underground routes, there are some surficial expositions around the Campi Shaft (Fig. 1C). The visitors can examine the lapidary consisting of the rock blocks occurring in the vicinity of Bochnia town and the collection of former mining equipment and machines situated before the building of the Campi Shaft headframe. A former steam hoisting machine and rock salt block are both exposed inside the building at the booking office. The visitors can also examine a small collection of salt specimens in the glass cases.

The position of the mine as a historical object to be protected was strengthened by legal documents: the Decree of the President of the Republic of Poland recognizing the "Bochnia" Salt Mine as a National Monument of History (2000), and the Decree of the Małopolska voivode (2005) approving 27 documented sites (Fig. 10).

Among 27 documented sites in the "Bochnia" Salt Mine, nineteen are within three scenic underground routes. Their largest number, eight, are within the Historical Miners' Route, six within the Multimedia Touristic one, and five within the Natural Miners' one (Fig. 10).

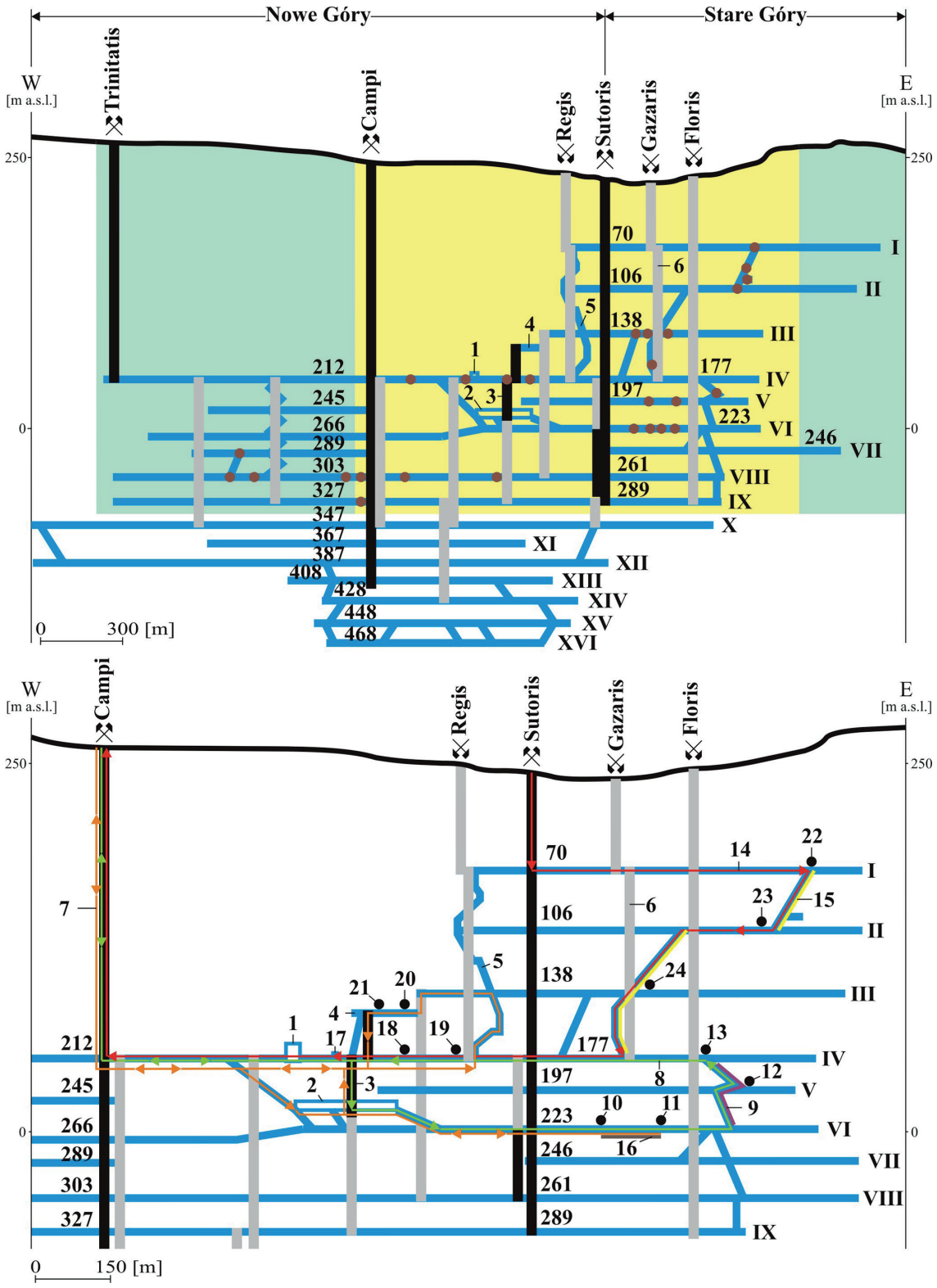


Fig. 10. Simplified vertical sketch-map of the "Bochnia" Salt Mine with the documentated sites (after Charkot, 2016): 1 – St. Kinga's Chapel; 2 – Ważyn Chamber; 3 – Ważyn Fore-Shaft; 4 – Dobosz Split-Level; 5 – Regis Stairs; 6 – non-existent Gazaris II Fore-Shaft; 7 – Touristic Route; 8 – Natural Miners' Route; 9 – Lichtenfels Descent (Horse Route); 10 – Rupprecht V Gallery; 11 – Rupprecht II Gallery; 12 – Chamber 51; 13 – Lichtenlels VII; 14 – Historical Miners' Route; 15 – Kalwaria Descent; 16 – boat trip route in the Chamber 81; 17 – St. Kinga station; 18 – underground multimedia exposition; 19 – Mysiur Stable; 20 – Christian Chamber; 21 – Rabsztyn Chamber; 22 – Stanetti I Chamber; 23 – Stanetti II–V Chambers; 24 – Upper and Lower Śmierdziuchy Chamber; Levels (Fig. 3B): I – Danielowiec; II – Sobieski; III – Wernier; IV – August; V – Lobkowicz; VI – Sienkiewicz; VII – Stanetti; VIII – Podmoście; IX – Gołuchowski; X – Słowacki; XI – Piłsudski; XII – Wilson–Paderewski; XIII – Kościuszko; XIV – Skoczylas; Unnamed: XV; XVI; the other explanations – see Fig. 4

One documented site situated at the first Danielowiec level and two between it and the second Sobieski one (Fig. 10) comprise the Northern Salts complex with rock salt seams, anhydrite claystone intercalations, fibre salt veins, and fibre gypsum (Fig. 3).

At the second Sobieski level (Fig. 10), the next documented site is situated, comprising anhydrite shale with crystal rock salt and the folded Middle Salts complex with the striped, shaft and crystal rock salt, anhydrite shale and claystone intercalations (Fig. 3). Three next documented sites situated at the third "Wernier" level (Fig. 10) comprise a folded Northern and Middle Salts complex with crystal rock salt and anhydrite claystone (Fig. 3). At the fourth August level five documented sites are situated (Fig. 10), comprising mainly the Northern Salts complex with anhydrite claystone intercalations, and crystal rock salt laminates with tuff WT3 intercalation (Fig. 3). They are microtectonically very differentiated. In some places, these sites also comprise marly claystone, anhydrite shale, secondary halite cauliflowers, and the Southern Salts complex (Fig. 3). At the fifth Lobkowicz level, three documented sites are situated, among which one is on the Lichtenfels Descent. Four sites are at the sixth Sienkiewicz level (Fig. 10) and comprise mainly the Middle Salts complex, with vertically dipping layers of the laminates of the folded striped and shaft rock salt, anhydrite claystone, and tuff WT3 intercalation (Fig. 3; Dz.Urz. z 2005 r. nr 712, poz. 5111).

Eight documented sites are situated outside the scenic underground routes. The first one is at the seventh "Stanetti" and the second one at the ninth Gołuchowski level. The remaining six ones are at the eighth Podmoście level (Fig. 10). All of them comprise in general, the Northern and Middle Salt complexes with striped, crystal, white and grey rock salt seams, zuber, and anhydrite claystone (Fig. 3; Dz.Urz. z 2005 r. nr 712, poz. 5111).

The "Bochnia" Salt Mine is the greatest treasure near Bochnia town. Owing to its salt deposits, Bochnia became one of the most important economic centres of Małopolska. Numerous touristic activities have been carried out there.

The Multimedia Touristic Route in the "Bochnia" Salt Mine

The route leads through a network of old workings with unique shapes and geological structures, situated in the middle part of the "Bochnia" Salt Mine system, between the Campi and Sutoris Shaft in the "Nowe Góry" Zone (Fig. 10). Route exposes numerous interesting sedimentary structures, characteristic of the Miocene salt series. The arrangement of the mine's old workings system is extremely differentiated due to the complicated geological structure of the deposit and various technics of exploitation applied over centuries. Typical chambers of the "Bochnia" Salt Mine system are long, high and narrow, related to the extraction of almost vertically dipping and high-purity rock salt layers (Figs. 3A, B). Its old workings are wood-lined, but there are numerous outcrops of very picturesque natural geological forms as well (Cyran & Toboła, 2008). Until today, access to the mine has been available place through two shafts: Campi and Sutoris, linked by several mine levels (Figs. 1C, 10). The Multimedia Touristic Route is long, around 2.5 km and links three levels: Wernier, August, and Sienkiewicz (Fig. 10). It starts from the Campi Shaft (Figs. 1C, 10). The visitors descent around 260 m beneath the surface to the sixth Sienkiewicz level of the mine (Fig. 10). First, they go down by lift to the fourth August level, 212 m beneath the surface and experience the former underground train trip along the August Gallery to the St. Kinga station, on a distance of over 0.5 km. This gallery is long at 4.5 km and links all three existent shafts (Fig. 10). This is the longest one in the "Bochnia" Salt Mine (Mróz, 2015; www1; www18).

From the railway station, the visitors return to the St. Kinga's Chapel (Fig. 10), which was exploited in 1747. It is furnished with two altars. Miners made the main one in 1861. In the chapel, several sculptures carved in wood, along with rock salt and the Bethlehem crèche can be enjoyed. The visitors can observe the Northern Salts complex outcrop on the sidewall, where the main altar is situated. This is in the form of folded salt with anhydrite claystone intercalation (Fig. 11A; Wiewiórka *et al.*, 2013a, 2013b; Cyran & Toboła, 2008; www1; www18).

Then, the visitors walk down along the incline to the Ważyn Chamber, on the sixth Sienkiewicz level (Fig. 10). It was exploited in the 1950s and, up until today, is the largest one in the mine, and therefore, was adapted to numerous functions described above (Fig. 11B; Mróz, 2015; www1; www17; www18). On the chamber walls and ceiling outcrops, there are laminated and striped rock salts, with different forms of barren intercalations, related to tectonic deformation (Figs. 11B, C; Cyran & Toboła, 2006; www27).

From the Ważyn Chamber, the visitors walk along the Sienkiewicz Gallery and Rupprecht V Transverse to Harbour A in Chamber 81, flooded with brine and running parallel to the Sienkiewicz Gallery (Fig. 10). The visitors experience a boat trip in the distance of 120 m along the chamber, to the Harbour B. They can admire the raw beauty of the salt chamber (Figs. 10, 11D; Bielak, 2014; Mróz, 2015; Flasza & Manecki, 2016; www1; www18). It is the biggest attraction of the "Bochnia" Salt Mine.

From Harbour B, the visitors walk along the Rupprecht II Transverse, return along the Sienkiewicz Gallery, and through the Ważyn Chamber to the August Gallery, where they can view the Underground Multimedia Exposition (Fig. 10; www18), a unique attraction of the mine. They learn about the history of salt mining and its hardships narrated by Polish kings, Genoese saltworks, and the spirit of Cistercian monks, whose order is connected with the development of the "Bochnia" Salt Mine (www18).

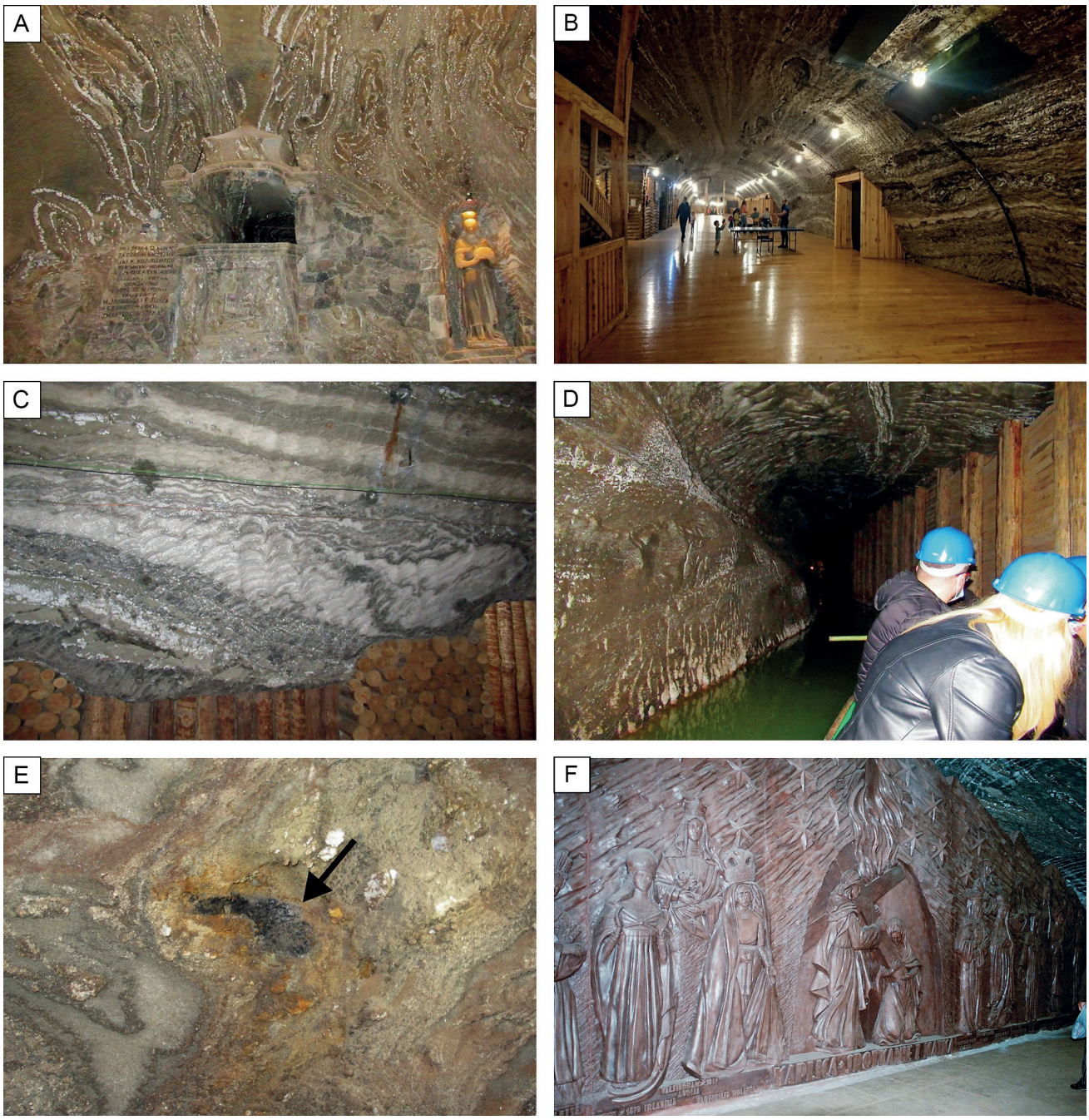


Fig. 11. Photographs of the Touristic Route of the "Bochnia" Salt Mine (Figs. 1C, 10): A – outcrop of the folded rock salt with anhydrite claystone intercalation of the Northern Salts complex in St. Kinga's Chapel at the "August" level; "Sienkiewicz" level: B – sport field part of the Ważyn Chamber; C – outcrop of the tectonic deformation of the laminated and striped rock salt of the Middle Salts complex within the Ważyn Chamber; D – boat trip within the Chamber 81; E – outcrop of folded rock salt and carbonized plant fragments (black arrow) within the folded anhydrite claystone intercalation, at the "Dobosz" split-level; F – bas-relief of the Cross Way at the "August" level

From the August Gallery, the visitors ascend by the Regis Stairs to the third Wernier level and then descend to the Dobosz split-level to the Christian Chamber (Fig. 10).

This is an example of typical chambers for the "Bochnia" Salt Mine, which are very high, long and narrow. Behind the Rabsztyn Chamber, the outcrop of the Northern Salt complex is located, with carbonized plant matter intercalation (Fig. 11E; Wagner *et al.*, 2008).

Then, the visitors return to the August Gallery again. They examine the bas-relief of the Cross Way on its southern sidewall (Fig. 11F), along which they return to the bottom of the Campi Shaft (Fig. 10) and to the surface by lift.

Despite the fact that the Multimedia Touristic Route of the "Bochnia" Salt Mine was opened for tourism much later than in Wieliczka town, it has become widely known. Hence, both its didactic value and geotouristic attractiveness are of

high grade, estimated at 97% and 90% (Tabs. 1–3). Interest in it has also been high, however much less so than in the Touristic Route of the "Wieliczka" Salt Mine. Nevertheless, from 2014–2019, the total visitors number in that facility also grew rapidly, varying from 71,402 to 114,056. In 2020, the number decreased to 38,432 probably due to the COVID-19 pandemic (Tab. 4).

The Natural Miners' Route in the "Bochnia" Salt Mine

This is an amazing route in the "Bochnia" Salt Mine. It is combined with the Multimedia Touristic Route and also begins in the Campi Shaft (Fig. 10). From Chamber 81, it leads through a series of different old workings, dated back to the 18th and 19th centuries, situated between the Sienkiewicz and August Galleries, in the eastern part of the "Bochnia" Salt Mine system, in the lower part of the "Stare Góry" Zone. However, its final section is as the Multimedia Touristic Route again. Its total length is around 2.5 km (Fig. 10; Mróz, 2015; www20).

The visitors descend to the fourth August level, along which, by the former underground train, they arrive at the St. Kinga station. Then, they descend to the Ważyn Chamber by lift and walk to Harbour A in Chamber 81 (Fig. 10), where they also have a boat trip (Fig. 11D).

Then, in the Rupprecht II Transverse, they can watch the outcrop of the vertically dipping folded laminated and striped rock salt of the Middle Salts complex (Fig. 12A; Cyran & Toboła, 2008; Wagner *et al.*, 2008). Then, they return to the Sienkiewicz Gallery. In one of its next transverses, they can examine the collection of halite crystals, displaying their fluorescence phenomenon (Fig. 12B). This involves the crystal turning red under ultraviolet rays (Flasza & Manecki, 2016).

From that place, the visitors walk along the Sienkiewicz Gallery eastwards. Behind the non-existent Floris Shaft, they turn left into the Lichtenfels Descent, linking the gallery with the August one (Fig. 10). In general, the route leads through a very steep and narrow, partly wood-lined incline, where the visitors come up wooden steps, called "trepy" in Polish (Figs. 10, 12C). The former miners carried the salt brittles on the wheelbarrows along that old working. During the descent, the visitors can watch numerous, picturesque outcrops of the folded anhydrite, with claystone and tuff intercalation. Some rock salt outcrops can be observed in the ultraviolet light in the darkness (Mróz, 2015; Flasza & Manecki, 2016; www20).

The visitors pass through Chamber 51, situated on the fifth Lobkowicz level, 197 m beneath the surface (Fig. 10). It was exploited in the first half of the 19th century, and up until today, has been backfilled in its central part (Mróz, 2015). In Chamber 51, there are some boxed cribs and voids, resulting from salt boulder extraction by its manual detachment from the rock body. On its sidewalls, the visitors can also see some traces of the notches of the iron wedges used to break off rectangular salt blocks, called "kłapcie" in Polish (Fig. 12D).

Horses were used for salt output transportation in the past in the section between Chamber 51 and Lichtenfels Chamber (Fig. 10). Therefore, this part of the Lichtenfels Descend is called the "Horse Route". In the Lichtenfels Chamber, at the fourth August level, the visitors can watch a former hand-powered treadmill used for output hoisting (Figs. 10, 12E). Further, they can observe very picturesque outcrops of the rock salt of the Middle Salts complex (Fig. 12F; Flasza & Manecki, 2016). From there, the visitors walk along the August Gallery, returning to the bottom of the Campi Shaft and the surface by lift (Figs. 1C, 10).

This new geotouristic attraction is also very interesting in this region; its didactic value and geotouristic attractiveness are of high grade, estimated at 93% and 88% (Tabs. 1–3). Quite a large number of people have visited it. In the first years, 2016–2019, its total visitors number varied from 855 to 1,365. In 2020, it decreased to 203 probably due to the COVID-19 pandemic (Tab. 4).

The Historical Miners' Route in the "Bochnia" Salt Mine

This is the most amazing miners' route in the "Bochnia" Salt Mine. It also leads through the raw old workings, but is situated on the upper part of the "Stare Góry" Zone (Fig. 10), known from the medieval times and dated in the 14th, 17th, 18th and 19th centuries. Therefore, visiting this route is called "The Old Mountains Expedition" (www1; www5). Its total length is around 3 km, which is the longest of all described underground routes in the paper (Fig. 10). Only some parts of them are wood-lined (Duda & Hydzik, 2009). The visitors find plenty of geological outcrops illustrating the Bochnia salt deposit geological setting. The route links dozens of different old workings situated at three levels: Danielowiec, Sobieski and Wernier. It is also combined with the other two routes of the mine. It descends to the fourth August level, along which it runs further to the Natural Route and later to the Multimedia Touristic one as well (Fig. 10).

The Historical Miners' Route starts at the first Danielowiec level, situated 70 m beneath the surface, from the Sutoris Shaft, where the visitors go down the stairs around it (Fig. 10). In the Danielowiec Gallery (Fig. 10), the shallowest and oldest one in the "Bochnia" Salt Mine system, whose sidewalls and ceiling are wood-lined, the visitors can observe numerous secondary halite cauliflowers on the ceiling (www1; www5). Further on, are numerous outcrops of the folded anhydrite claystone intercalation (Fig. 13A), just before the Stanetti I Chamber (Fig. 10).

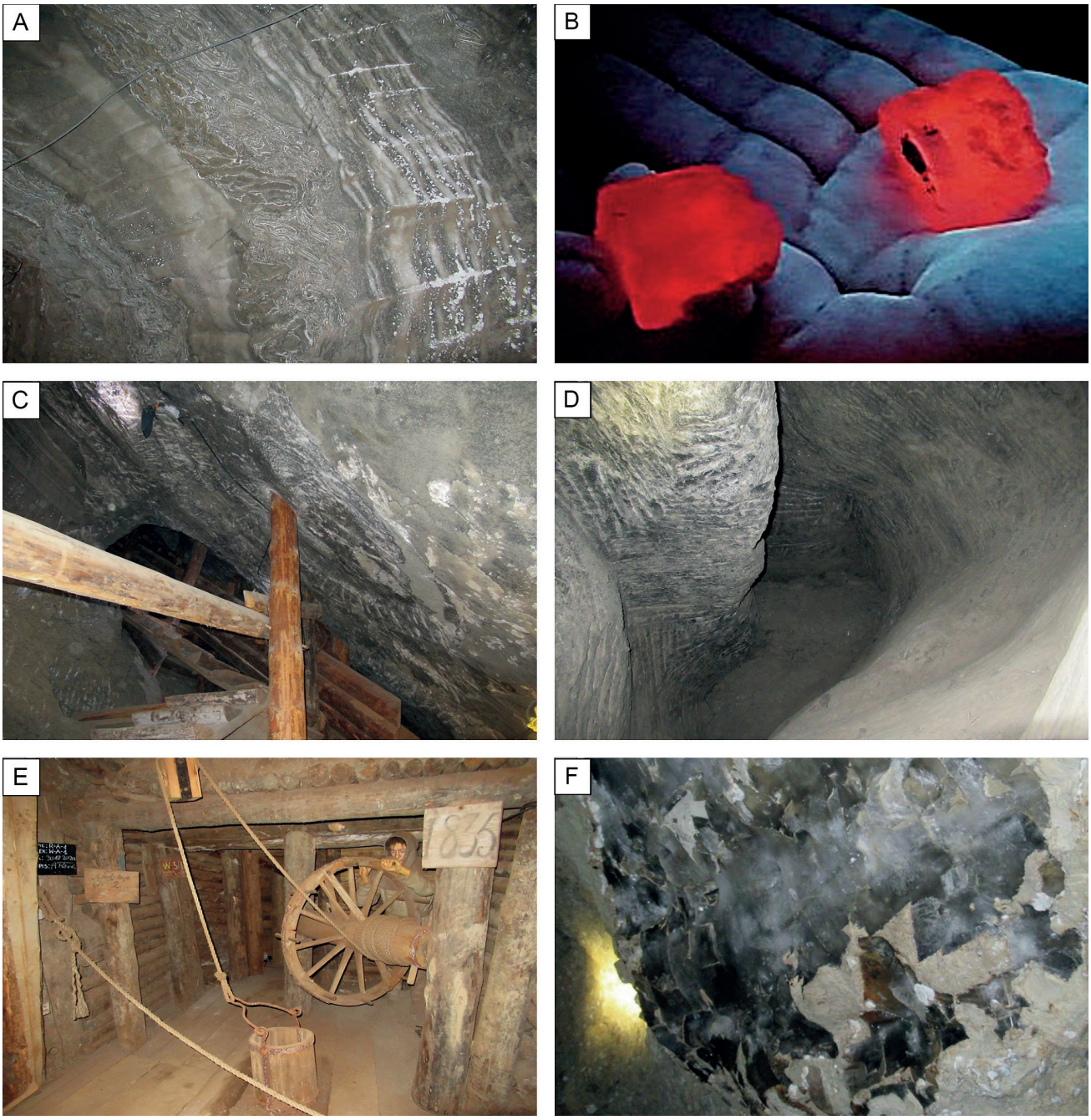


Fig. 12. Photographs of the Natural Miners' Route of the "Bochnia" Salt Mine (Figs. 1C, 10): "Sienkiewicz" level: A – the outcrop of the vertically dipping layers of the laminated and striped rock salt of the Middle Salts complex; B – halite crystals illuminated by ultraviolet rays (halite fluorescence phenomenon); The Lichtenfels Descent: C – wooden steps, called "trepy"; D – void after the extraction of the salt boulder by its manual detachment from the rock body with wedge in the Chamber 51; E – former hand powered treadmill used for output hoisting in the Lichtenfels VII Chamber; F – outcrop of the rock salt of the Middle Salts complex on the wall of the August Gallery

Walking down the wooden steps along the incline linking the Danielowiec and Sobieski levels, the first stage of the Kalwaria Descent (Fig. 10), the visitors can observe very picturesque secondary halite speleothems and stalactites, apart from their cauliflowers as well (Fig. 13B). In the Sobieski Gallery, situated at the second Sobieski level, 106 m beneath the surface, the visitors can see the second very picturesque outcrop of the anhydrite anticlinal fold (Figs. 10, 13C).

At the second Sobieski level, the complexity of the Stanetti II–V Chambers can be found (Fig. 10). The Stanetti II one is long, high and narrow, which is related to the extraction of almost vertically dipping rock salt layers. Some of its sidewalls are covered with secondary halite cauliflowers (Figs. 10, 13D). In the Stanetti III Chamber, there are the fragments of the salt wall, built of salt brittles, and stairs carved in salt (Fig. 13E).

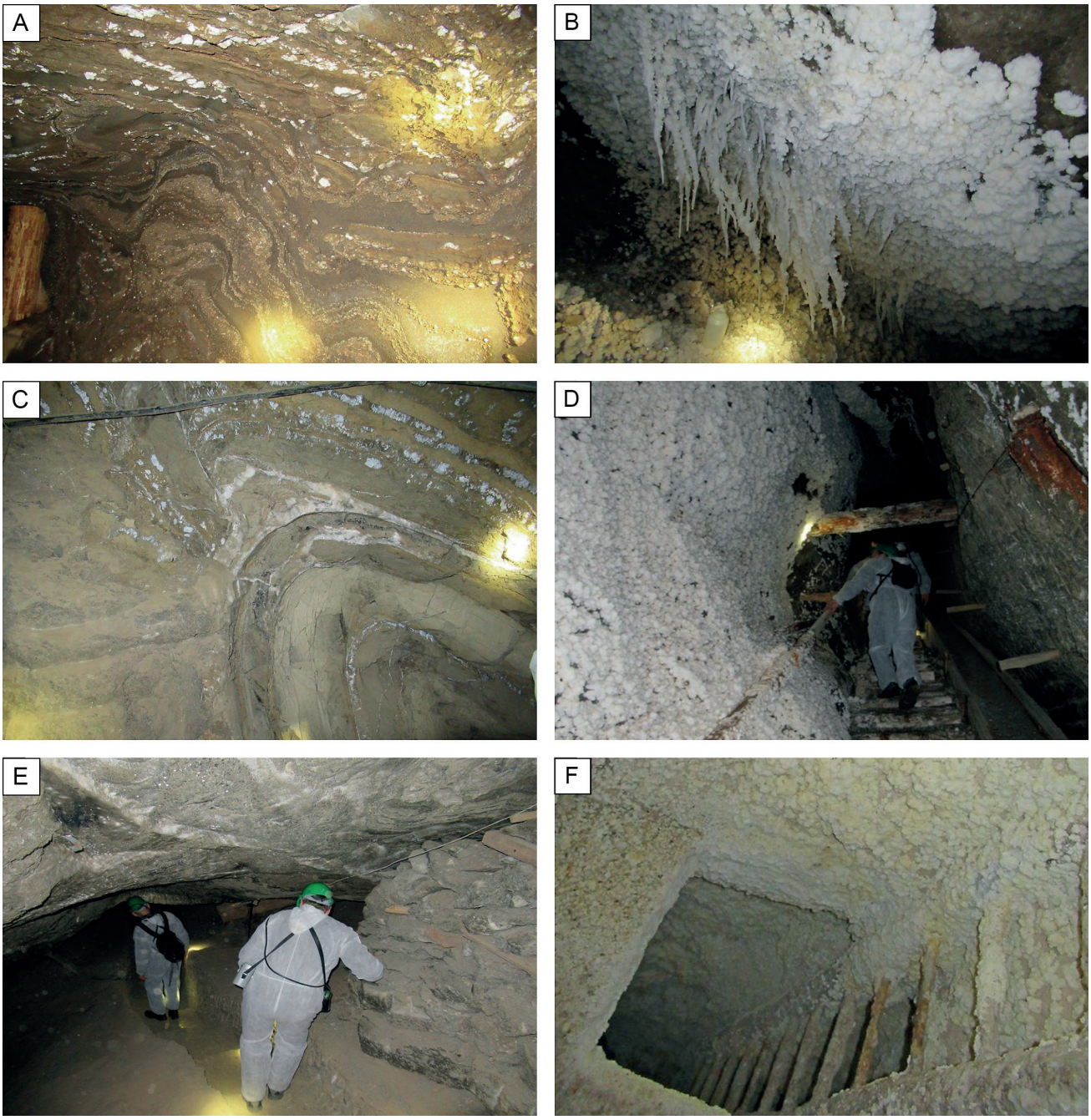


Fig. 13. Photographs of the Historical Miners' Route of the "Bochnia" Salt Mine (Figs. 1C, 10): A – outcrop of the folded anhydrite claystone intercalation in the Danielowiec Gallery; B – secondary halite cauliflowers and stalactites on the sidewall in the incline linking the "Danielowiec" with "Sobieski" level – the first stage of the Kalwaria Descent; C – outcrop of the anhydrite anticlinal fold in the "Sobieski" level; D – high, long and narrow chamber with wooden platforms, the former miners were standing on in the Stanetti II Chamber; the left sidewall covered with secondary halite cauliflowers; E – fragment of the former salt wall, steps carved in salt, and low ceiling in the Stanetti III Chamber; F – ladder section with secondary halite cauliflowers situated between the "Wernier" and "August" levels – the third stage of the Kalwaria Descent

Then, the visitors pass through the Śmierdziuchy Chamber and descend along the next incline, the second stage of the Kalwaria Descent, to the third Wernier level (Fig. 10). The last section of this route, linking the Wernier and August levels, is a unique stage for visitors, as they come down around the Gazaris Fore-Shaft through the ladder section in four stages. The ladders and sidewalls are covered with secondary halite cauliflowers (Figs. 10, 13F). It is the third stage of the Kalwaria Descent. When the visitors descend to the August Gallery, they walk along to the bottom of the Campi Shaft and return to the surface by a lift (Figs. 1C, 10).

This new geotouristic attraction is the most interesting in this region, and both its didactic value and geotouristic attractiveness are of high grade, estimated at 90% and 85% (Tabs. 1–3). However, it has not been visited by many people so far. In the first years, 2015–2019, its total visitors number varied only from 444 to 517. In 2020, it decreased to 77 probably due to the COVID-19 pandemic (Tab. 4).

Discussion of the results

The didactic value assessed for all five described scenic underground routes of the historical salt mines in Wieliczka and Bochnia towns indicates their high grade and potential. The highest marks are represented by 97% for the Touristic Routes of the "Wieliczka" and "Bochnia" Salt Mines (Tabs. 1–3). This grade is related to their uniqueness on a regional and national scale, and the high mark of their assessed values, the components of the didactic value: substantive, cultural, location, and availability of the general and geological information provided by them (Tabs. 1–3). The Miners' Natural Route of the "Bochnia" Salt Mine has a didactic value a little lower, at 93%, due to the lower availability of the general and geological information in it. The Miners' Route of the "Wieliczka" Salt Mine and the Miners' Historical one of the "Bochnia" Salt Mine have the lowest didactic values, at 90%, also due to lower availability of the general and geological information and greater difficulty of visiting them (Tabs. 1–3).

The geotouristic attractiveness values are comprised of the didactic value and geotouristic development level assessed for all five described routes, indicating their high grade. The highest one is 95% for the Touristic Route of the "Wieliczka" Salt Mine. The little lower ones are for the routes of the "Bochnia" Salt Mine: 90% for the Multimedia one, 88% for the Miners' Natural one, and 85% for the remaining Miners' Routes: of the "Wieliczka" Salt Mine and the Historical one of the "Bochnia" one (Tabs. 1–3).

The high grade of the geotouristic development level is only for the Touristic Route of the "Wieliczka" Salt Mine. For the others, average grade (what average?) is proposed. All described routes are visited in groups with a guide, and the infrastructure in their vicinity is well-developed (Tabs. 1–3). However, the general information panels for the Touristic Routes of the "Wieliczka" and "Bochnia" Salt Mines describe them superficially. The Miners' Natural and Historical Routes in Bochnia town have had no panel information/QR code around them until today. Geological information panels on the Miners' Routes of the "Wieliczka" and "Bochnia" Salt Mines are also only superficial, and none are on the Multimedia Touristic Route in Bochnia town. Most of the exhibitions of the rock salt specimens around the described routes are big, except for the Miners' Route of the "Wieliczka" Salt Mine (Tabs. 1–3).

Statistical data analysis of tourist flows in the Touristic Routes of the "Wieliczka" and "Bochnia" Salt Mines reflects their geotouristic attractiveness of high grade and makes them very popular. The "Wieliczka" one is a particularly famous and well-known geosite owing to being known for over 700 years and situated close to the city of Krakow (Fig. 1B), associated with the Royal Castle on the Wawel Hill, known all over the world. This popularity could also be related to "Wieliczka" Salt Mine entering the UNESCO World Heritage List in 1978 (www6). The high interest in the Multimedia Touristic Route of the "Bochnia" Salt Mine could also be related to this mine entering the UNESCO World Heritage List in 2013 (www6). Currently, the number of tourist visits to these routes is higher than those to the also popular "Kłodawa" Salt Mine (Tab. 4), the youngest and largest one in Poland (www30). This perfectly documents the increasing dynamics of the tourist flow in the best-known scenic routes in Poland and the world.

However, although the other three routes: one in the "Wieliczka" and two in Bochnia Salt Mines, also have values of high grade in their geotouristic attractiveness (Tabs. 1–3), they are still much less known as geotouristic attractions than the two ones described above. They were the latest scenic objects in 2012, 2014 and 2015. Hence, they could not be effectively promoted and, thus, are not known as widely.

The proposed methodology of changes in the tourism development of the researched underground routes

High didactic values of the researched routes of the "Wieliczka" and "Bochnia" Salt Mines (Tabs. 1–3) indicate their significant geotouristic potential. They can only be granted their "geotouristic object" status (Słomka & Kicińska-Świederska, 2004; Osadczuk & Osadczuk, 2008) when their geotouristic development level is raised (Tabs. 1–3). In the author's opinion, the scope of general information on the described routes put on the panel/QR code around them should be much more detailed for the Touristic and Miners' Routes of the "Wieliczka" Salt Mine and the Multimedia one of the "Bochnia" one. The Miners' Natural and Historical Routes of the "Bochnia" Salt Mine have had no general information panel/QR code up until today (Tabs. 1–3). The detailed geological information on the salt deposits is only on the Touristic Routes of the "Wieliczka" Salt Mine. At its first Bono level (Figs. 4, 5B), an information panel/QR code should be located on the documented sites situated there, as they comprise salt deposit outcrops in the gallery of the route (Figs. 7A, B). On the three described Miners' Routes in Wieliczka and Bochnia towns, the geological information on the salt deposits is

only superficial, and on the Multimedia, one of the "Bochnia" Salt Mine, no information is yet available (Tabs. 1–3). The exhibition of the rock salt specimens around the Miners' Route of the "Wieliczka" Salt Mine should also be expanded (Tabs. 1–3).

The implementation of the above-proposed enterprises could become much easier when local authorities attempt to create the Geopark of the Royal Salt Mines in Wieliczka and Bochnia towns. Three miners' routes open for tourism since 2012, 2014, and 2015 will gain the potential to be much more popular in Poland and the world. Moreover, owing to that, the Touristic Routes in Wieliczka and Bochnia towns could become even more widely recognised all over the world. As a result of the creation of the Geopark of Royal Salt Mines in Wieliczka and Bochnia, some exchange of experiences and information concerning the restoration and modernization of the geosites among local authorities can be much easier. This could lead to an increase in their global rank and reputation (Alexandrowicz, 2006; Alexandrowicz & Miśkiewicz, 2016; www26). The perspectives of geotourism development in Wieliczka and Bochnia towns, based on their geoheritage attractions, seem to be very optimistic. The idea of the Geopark of Royal Salt Mines in Wieliczka and Bochnia towns was already initiated at the beginning of the 2000s (Alexandrowicz & Alexandrowicz, 2004).

Currently, a new Multimedia Touristic Route in Bochnia town, comprising the Historical Miners' Route is in preparation by carrying out the project: "Introduction of a unique cultural and educational offer on the shared tourist route in the 'Bochnia' Salt Mine – UNESCO World Heritage Site" (www4). When it is ready, this part of the future new route should become more popular.

Conclusions

Based on the conducted research, it can be concluded that all five described scenic underground routes of the "Wieliczka" and "Bochnia" Salt Mines are characterized by high grades of their didactic values. Granting them their "geotouristic object" status requires raising their geotouristic development level, particularly related to general and information panels around and on the routes.

These routes are so well known and popular, that they should be particularly taken care of by their management. First, they should be regularly renovated (Duda & Hydzik, 2009; Charkot, 2016).

When a further scientific investigation of still unknown old workings within the historical salt mines in Wieliczka and Bochnia is developed, some new underground touristic routes in some parts of them could be established in the future, provided that they are spacious enough for smooth tourist movement along them. The above development could be made particularly to the Touristic Routes of the "Wieliczka" Salt Mine, to make it possible for visitors to enjoy its Crystal Caves and stunningly, picturesque salt deposits, the unique in the world (Alexandrowicz, 2000; www21). However, in the Crystal Caves, as an underground Natural Reserve, the tourist flow should be limited due to the thermal and humidity changes inside. Apart from that, entering the Crystal Caves requires the consent of the Regional Nature Conservator.

The "Bochnia" Salt Mine could become much more popular when the activity of its underground health resort is resumed. The presence of salt particles and salty spray in the atmosphere of the salt mine, which may have anti-inflammatory and antiallergic properties, is beneficial to human health (Puławska *et al.*, 2021).

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