

The geotouristic attractiveness of the underground trails in Zabrze, Dąbrowa Górnicza and Tarnowskie Góry towns (Silesian Upland)

Atrakcyjność geoturystyczna tras podziemnych w Zabrzu, Dąbrowie Górniczej i Tarnowskich Górach (Wyżyna Śląska)

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Abstract: In Zabrze, Dąbrowa Górnicza and Tarnowskie Góry towns, seven underground tourist trails are located in historical mines. Four of them were developed in the central part of the Upper Silesian Coal Basin, two of which, at the “Królowska Luiza” (“Queen Louise”) Adit (comprising the former coal mine “Królowska Luiza” and the drainage Main Key Hereditary Adit remnant), and two others at the “Guido” Mine in Zabrze town. The next one was developed in the eastern part of the Upper Silesian Coal Basin, in a part of the “Sztygarka” Training Coal Mine in Dąbrowa Górnicza. Two other trails are located in Tarnowskie Góry town, in the border zone between the Upper Silesian Coal Basin and the Silesian-Kraków Monocline. These are the relics of the historical lead, zinc and silver ore mine, and the “Czarny Pstrąg” (“Black Trout”) drainage adit. The bituminous coal deposits are hosted in the Upper Carboniferous clastic formations, which fills the Upper Silesian Coal Basin. The metal ores are hosted in Middle Triassic dolomites, which belong to the southern margin of the Silesian-Kraków Monocline. The geotourism attractiveness of all these historical mines was demonstrated by selected annual statistical data of tourist attendance. In general, the interest in these facilities has been growing since decades, same as the popularity of industrial heritage in the Upper Silesia. These three towns have become very widely known in Poland and in the world.

Keywords: Upper Silesian Coal Basin, Silesian-Kraków Monocline, underground tourist trails, coal mine, zinc, lead and silver mine

Treść: W Zabrzu, Dąbrowie Górniczej i Tarnowskich Górach utworzono w sumie siedem podziemnych tras turystycznych prowadzonych wyrobiskami górniczymi zabytkowych kopalń. Cztery z nich znajdują się w Zabrzu, w centrum Górnośląskiego Zagłębia Węglowego, a jedna w Dąbrowie Górniczej, na jego wschodnim krańcu. Dwie pozostałe są natomiast zlokalizowane na pograniczu Górnośląskiego Zagłębia Węglowego i Monokliny Śląsko-Krakowskiej, w Tarnowskich Górach. Na terenie Zabrza dwie podziemne trasy turystyczne zostały wytyczone w Sztolni „Królowska Luiza”, zespole łączącym wybrane wyrobiska dawnej kopalni węgla kamiennego „Królowska Luiza” z odwadniającą ją Główną Kluczową Sztolnią Dziedziczną, a pozostałe dwie w zabytkowej kopalni węgla kamiennego „Guido”. W Dąbrowie Górniczej udostępniono do zwiedzania część wyrobisk górniczych dawnej Kopalni Ćwiczebnej „Sztygarka”, natomiast w Tarnowskich Górach podziemne trasy turystyczne wyznaczono w zabytkowej kopalni srebra i sztolni „Czarnego Pstrąga”. Złóża węgla kamiennego występują w klastycznych osadach górnokarbońskich Górnośląskiego Zagłębia Węglowego, natomiast rud metali – w środkowotriasowych dolomitach kruszczońskich południowej części obszaru Monokliny Śląsko-Krakowskiej. Atrakcyjność geoturystyczna poszczególnych tras podziemnych została określona na podstawie porównania wyników analiz statystycznych frekwencji turystów w poszczególnych obiektach. Generalnie obserwowany jest jej wzrost na przestrzeni lat, wraz ze zwiększającą się popularnością dziedzictwa przemysłowego na Górnym Śląsku z biegiem czasu, zarówno w Polsce, jak i na całym świecie.

Słowa kluczowe: Górnośląskie Zagłębie Węglowe, Monoklina Śląsko-Krakowska, trasy podziemne, kopalnia węgla, kopalnia rud metali

Introduction

The history of mining in the central part of the Silesian Upland (www1; Fig. 1) is very long. Two main types of mineral resources were exploited: bituminous (“hard”) coal and zinc, lead and silver ores. The bituminous coal mining has started in Zabrze town (Fig. 1) in 1791 and has lasted until 1998. The “Królowska Luiza” (“Queen Louise”) coal mine located in this town was the oldest one in the Silesian Upland (Dzięgiel, 2007; www1; Fig. 1). Bituminous coal was exploited in numerous locations, but most of these mines had to be closed in the 1990s because of exhaustion of reserves and environmental issues. In Dąbrowa Górnicza town (Fig. 1), coal had been mined in the years 1865–1995 (Ciepiela, 2007; Bielecki, 2008). Metal ores were extracted in Tarnowskie Góry town (Fig. 1), in the 16th century and again, between the 18th and 20th centuries, and their production has ceased in 1922 (Dzięgiel, 2008).

Some parts of three former coal mines in the Silesian Upland have already been transformed into the museums. These are: “Królowska Luiza” Mine, available since 1993 as the “Mining Open-Air Museum” (Dzięgiel, 2007; Frużyński, 2012), the “Guido” Mine, accessible since 2007 (Dzięgiel, 2011; Frużyński, 2012; Piątek, 2013), both located in Zabrze town, and the “Szttygarka” Training Mine in Dąbrowa

Górnicza town, in operation since 2010 (Wójcik & Chmura, 2008; Chmura & Wójcik, 2009; www2). Since 2018, the selected old workings of the former “Królowska Luiza” Mine have been connected to the final section of the old drainage working named the “Main Key Hereditary Adit”, and, therefore, it is currently called the “Królowska Luiza” Adit (Drobniak *et al.*, 2020; Gola, 2020; www3). The “Królowska Luiza” Adit and the “Guido” Mine are also the branches of the Coal Mining Museum in Zabrze, established in 1981 (Gola, 2020).

Two small parts of the old metal ore mine in Tarnowskie Góry were also adapted as geotourism attractions: the Historical Silver Mine (opened in 1976) and the “Czarny Pstrąg” (“Black Trout”) Adit, which has been accessible for public use since 1957 (Szlachcic-Dudzicz, 2006; Dzięgiel, 2008; Wyciszczak, 2008; Czornik *et al.*, 2011; Pawlak & Filak, 2017; www4).

In recent years, all these underground trails were included into the Silesian Industrial Monuments Route and the European Route of Industrial Heritage (Czornik *et al.*, 2011; Drobniak *et al.*, 2020; www5; www6). The Annual Fest of the Silesian Industrial Monuments Route, called “Industriada”, jointly celebrated in all these sites, represents a great part of the Silesian Industrial Monuments promotion (www6). Hence, these trails have become very popular in Poland and in the world.

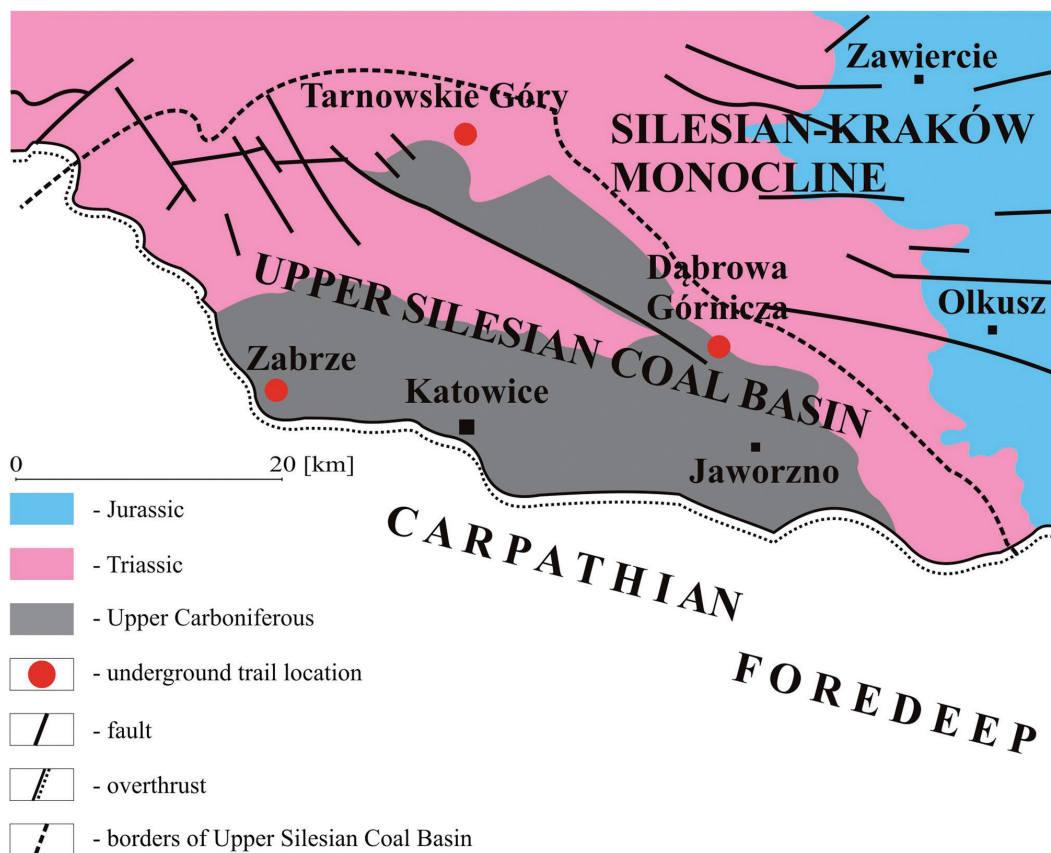


Fig. 1. Location of Zabrze, Dąbrowa Górnicza and Tarnowskie Góry towns in the Silesian Upland (after www1), referred to the Silesian-Kraków Monocline and to the Upper Silesian Coal Basin (after Bukowy *et al.*, 1974)

The aim of this article is to indicate the geotourism attractiveness of these objects. The criterion, chosen for the analysis, is the number of tourists visiting each of described attractions.

Methodology

The research was carried on using the direct field observations and the photographic documentation run personally by the author at the described sites. Apart from that, some papers and statistics from the Polish databank were reviewed for obtaining the statistical data of tourists visits at the described sites.

Geographical and geological settings of the central part of the Silesian Upland

The three towns: Zabrze, Dąbrowa Górnicza and Tarnowskie Góry are located in the central part of the Silesian

Upland (Kondracki, 2011). Moreover, Zabrze is situated in the western part of the Upper Silesian Coal Basin (USCB), Dąbrowa Górnicza – in its eastern part and Tarnowskie Góry – in the border zone between the USCB and the Silesian-Kraków Monocline (Bukowy, 1974; Jureczka *et al.*, 2005; Fig. 1). The USCB area is built of Upper Carboniferous sediments, which crop out in its central part. In the northern margin of the USCB, these strata are covered with Triassic sediments, which belong to the geological unit named the “Silesian-Kraków Monocline”. In that area, some patches of Quaternary sediments occur, as well (Fig. 2).

The Carboniferous (Silesian) sediments outcropped in the vicinity of the “Guido” Mine and the “Królowska Luiza” Adit in Zabrze, and around the “SztYGarka” Training Mine in Dąbrowa Górnicza, comprise three Upper Carboniferous units traditionally named the “series”: the Paralic Series (Namurian A), the Upper Silesian Sandstone Series (Namurian B and C) and, only around Dąbrowa Górnicza, the Mudstone Series (Westphalian B) (Wilanowski *et al.*, 2009; 2015; Wilanowski, 2016; Tab. 1; Figs. 2A–2B).

Table 1. Schematic stratigraphy and lithology of sediments in the central part of the Upper Silesian Coal Basin area (after Żero, 1968; Wilanowski *et al.*, 2009; 2015; Wilanowski, 2016)

Stratigraphy	Series	Beds	Lithology and thickness	Mining tourism objects described in the text
Quaternary	–	–	glacial and alluvial sediments (total thickness: 10–20 m)	–
Middle Triassic	–	Jemielnica, Tarnowice, Rybna, Boruszowice, Miedary beds	limestones, dolomites, claystones, mudstones, shales (total thickness: 190 m)	–
		Błotnica, Gogolin beds	limestones (thickness: 40 m), ore-bearing dolomites (thickness: 60 m)	Historical Silver Mine and “Czarny Pstrąg” Adit in Tarnowskie Góry
Upper Carboniferous – Westphalian B	Mudstone Series	Orzesze Beds	clastic sediments (total thickness: 150 m) with coal seams (average cumulative thickness: 9 m)	“SztYGarka” Training Mine in Dąbrowa Górnicza
Upper Carboniferous – Namurian C	Upper Silesian Sandstone Series	Rudy Beds	mudstones, claystones (total thickness: 530 m) with coal seams (average cumulative thickness: 15–20 m)	
Upper Carboniferous – Namurian B	Upper Silesian Sandstone Series	Anticlinal Beds	conglomerates, sandstones, mudstones, claystones (total thickness: 80–320 m) with coal seams (average cumulative thickness: 28 m)	“Królowska Luiza” Adit in Zabrze
Upper Carboniferous – Namurian A	Paralic Series	Poręba Beds	claystones, mudstones, sandstones (total thickness: 3,800 m) with coal seams (average cumulative thickness: over 150 m)	“Guido” Mine in Zabrze

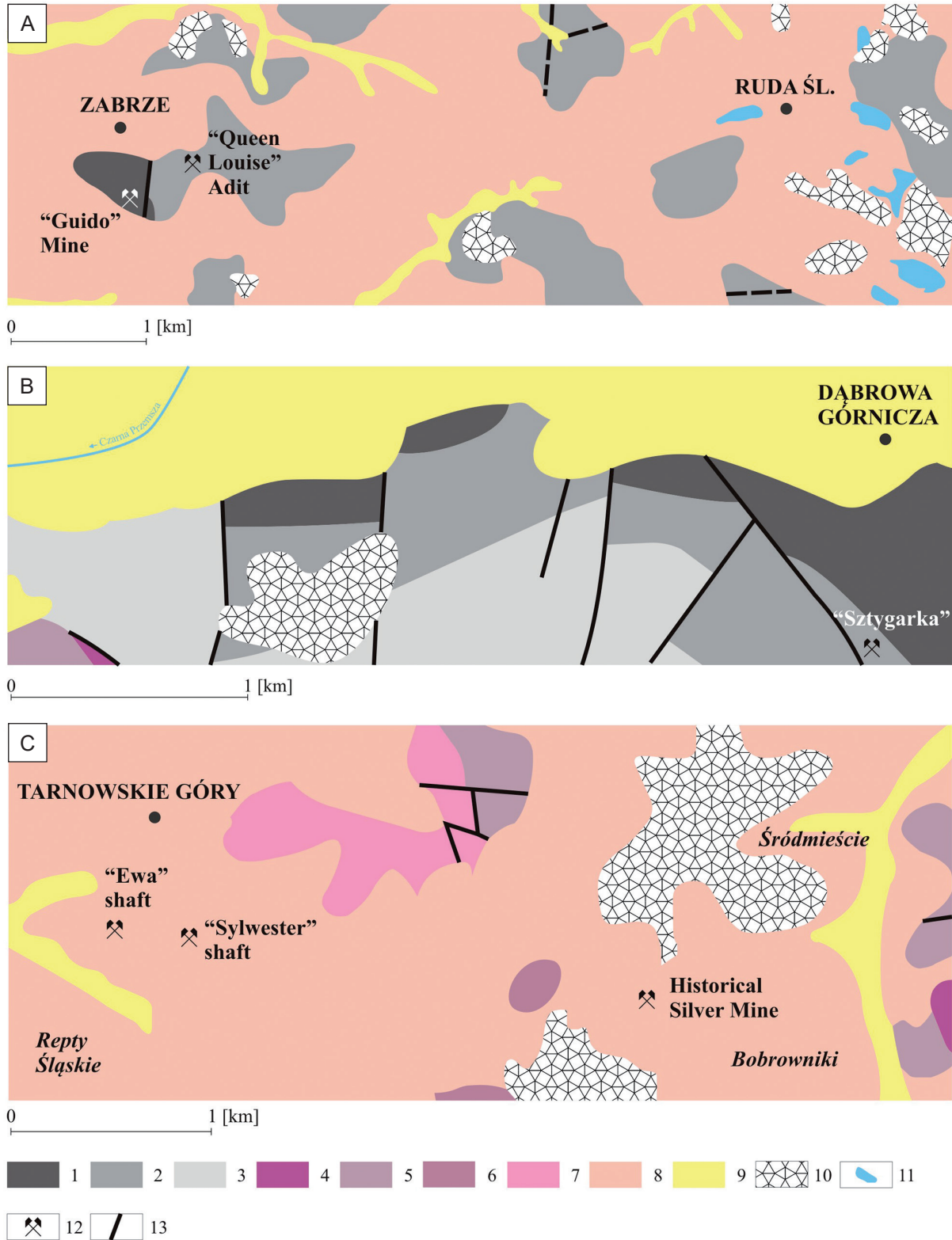


Fig. 2. Simplified geological sketch maps: A – Zabrze area; B – Dąbrowa Górnicza area; C – Tarnowskie Góry area (after Wilanowski *et al.*, 2009; Wilanowski, 2016; Wilanowski & Lewandowski, 2016). Explanations: Upper Carboniferous: 1 – Poręba Beds: claystones, mudstones, sandstones and coal seams; 2 – Anticlinal and Rudy Beds: sandstones and coal seams; 3 – Orzesze Beds: mudstones, claystones, sandstones and coal seams; Middle Triassic: 4 – Błotnica and Gogolin Beds: limestones; 5 – Ore-bearing Dolomite; 6 – Jemielnica and Tarnowice Beds: dolomites and limestones; 7 – Rybna, Boruszowice and Miedary Beds: limestones, dolomites, clays, claystones, mudstones and shales; Quaternary – Pleistocene: 8 – glacial sands, gravels and loams; Holocene: 9 – fluvial sediments; 10 – mining waste dump; 11 – reservoir; 12 – location of historical mines/adits/shafts; 13 – faults

The area around Tarnowskie Góry town is built mainly of Middle Triassic sediments hosting metal ore deposits (Tab. 1; Fig. 2C). The ore-bearing dolomite is the host rock to lead and zinc minerals. Galena (PbS) is the most common lead mineral occurring in the Silesian Upland and the carrier of silver admixtures, especially in the Tarnowskie Góry ore deposits (Gabzdyl, 1999; Tab. 1; Fig. 2C). In general, the carbonate rocks around Tarnowskie Góry town are strongly karstified (Żero, 1968; Wilanowski & Lewandowski, 2016).

Historical coal mining in Zabrze town

In Zabrze, some parts of the two historical mines have been opened for tourists and have become geotourism attractions: the “Królowa Luiza” Adit and the “Guido” Mine (Drobnik *et al.*, 2020; Gola, 2020; www3; www6; Fig. 2A).

The “Królowa Luiza” Mine has been developed in 1791 due to high demand for coal from the intensively growing Upper Silesian metallurgical industry. First ironworks have started operations in 1784, in Strzybnica, which is now a district of Tarnowskie Góry town (Dzięgiel, 2007; Gola, 2020). Bituminous coal seams were extracted in a number of surface excavations and underground workings. The shafts were sunk down to the depths from 30 to 800 m below surface.

For the first time the “Królowa Luiza” Mine had been opened to the public in the years 1965–1979. Visitors could observe the operation of mechanized longwall, located close to the Carnall Shaft (www4; Fig. 3). This industrial tourism attraction was managed by the Intercompany Mining Branch of the Polish Tourist and Country-Lovers’ Association. Over 10,000 tourists a year visited the mine in that period. However, in 1979, it had to be closed to the public because of some mine safety problems (www4).

In 1998, the mine has halted production because of reserves exhaustion. However, as early as in the late 1980s, in its inactive parts located around the “Wilhelmina” and the “Carnall” shafts (Fig. 3), the Coal Mining Museum in Zabrze has established one of its branches named “The Królowa Luiza Mining Open-Air Museum” comprising selected mine workings. It has been available to the visitors since 1993 (Dzięgiel, 2007; Żurek *et al.*, 2010; Frużyński, 2012; Gola, 2020). Currently, this trail is called the “Family Route” of the “Królowa Luiza” Adit (Gola, 2020; www4; Fig. 3).

Since 2018, “The Queen Louise Mining Open-Air Museum” has been integrated with the final section of the old Main Key Hereditary Adit (Jurkiewicz, 2002; Jurkiewicz *et al.*, 2009). This is an underground tunnel, which development had lasted from 1799 to 1863. Its task was to drain the coal mines “Królowa Luiza” in Zabrze and “Król” (“King”) in Chorzów, and the other, neighbouring ones, as well as to transport the coal from the “Królowa Luiza” to the steelworks in Gliwice town through the Kłodnica Canal. Unfortunately, the growth

of mining industry and the progress in water-pumping technologies, together with the exhaustion of shallow coal deposits contributed to relatively quick decline of the importance of this adit. It finally stopped operation in 1953. In order to regain the adit for tourists, the Society for the Restoration and Promotion of the “Królowa Luiza” Adit in Zabrze, “Pro Futuro”, has been established in 2000 (Gałązka-Salamon, 2012). Local authorities of Zabrze town implemented a consistent promotion strategy based on principles of the industrial heritage tourism. Therefore, they decided to revitalize and adapt for tourism the final section of the Main Key Hereditary Adit and to connect it with the “Królowa Luiza” old underground workings (Jurkiewicz *et al.*, 2009; Żurek *et al.*, 2010; Bugaj & Głosz, 2012; Gola, 2020). Thus, since 2018 the “Królowa Luiza” Adit has been the site of two underground tourist trails: the “Water Route” and the “Family Route” (Figs. 3, 4A–4D) (Gola, 2020; www3).

The “Water Route” (www7; Fig. 3) is one of the most amazing underground tourist trails in Poland. The visitors pass its first section on foot through the original 19th century drift, about 1 km long, cut 40 m below the surface. The drift is cut, entirely within the 6-m-thick coal seam No. 510 (in Polish coal seams identification system) belonging to the Upper Silesian Sandstone Series (Wilanowski *et al.*, 2009; 2015; Tab. 1). The visitors can observe a mining face worked in No. 510 coal seam, with roof support of the upper coal bench built of timber racks (Fig. 4A). The last section of the route, 1,130 m long, is a unique underground boat trip (Fig. 4B). It runs along the stone-lined, former Main Key Hereditary Adit illuminated by special lighting system and leads to the adit mouth located in the center of Zabrze (www3; Fig. 3).

The “Family Route” (www7; Fig. 3) is situated 35 m below surface and runs along a 1.5-km-long gallery. This is an extraordinary adventure, combining the observations of the authentic mine workings with the views of huge mining machines, and providing fun and educating experience for the youngest tourists. The visitors can examine the coal shearer operating along the long wall and protected by self-advancing supports (Fig. 4C). At the end of the trail, the visitors can travel with the historical underground train named “Karlik” (Fig. 4D), which carries them along some 1.5-km-long crosscut. The crosscut of that railway ride is lined with steel arches (Fig. 4D).

In the future, the third underground route in the “Królowa Luiza” Adit is to be opened to the public, connecting the “Carnall” and the “Wilhelmina” shafts (Fig. 3; www4).

The “Guido” Mine (Fig. 2A) has been in operation since 1855. It included a system of workings and shafts cut down to 300 m depth below surface. Coal was extracted until the 1930s. In 2007, the local authorities decided to open for tourism some selected old workings (Figs. 4E–4H) (Walerjański, 2008; Walerjański & Szczypkowska, 2010; Dzięgiel, 2011). Underground tourist trails are located at two former mining levels: 170 m and 320 m below surface (Frużyński, 2012; Piątek, 2013).

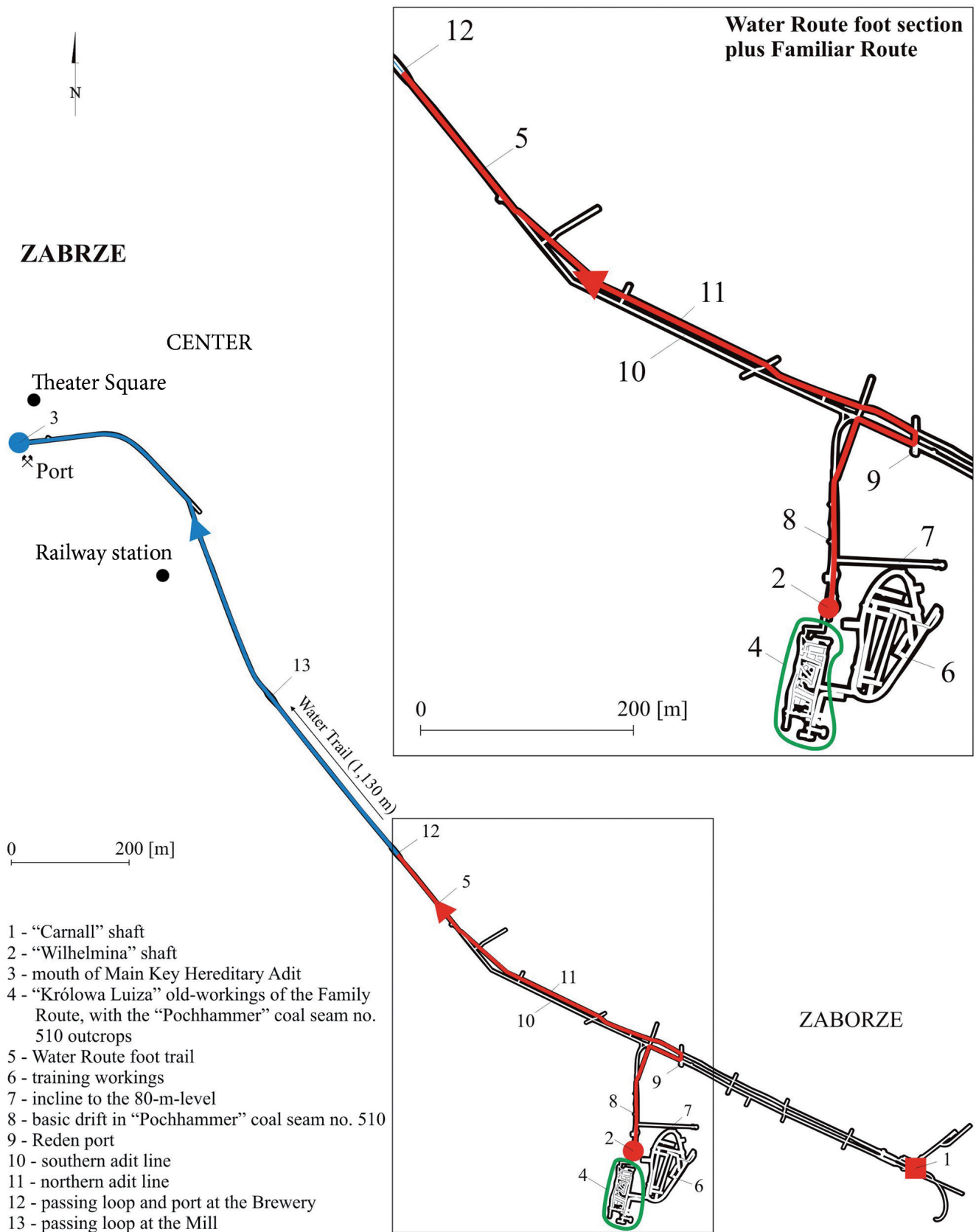


Fig. 3. Map of the "Królowa Luiza" Adit (after Chybiorz, 2018)

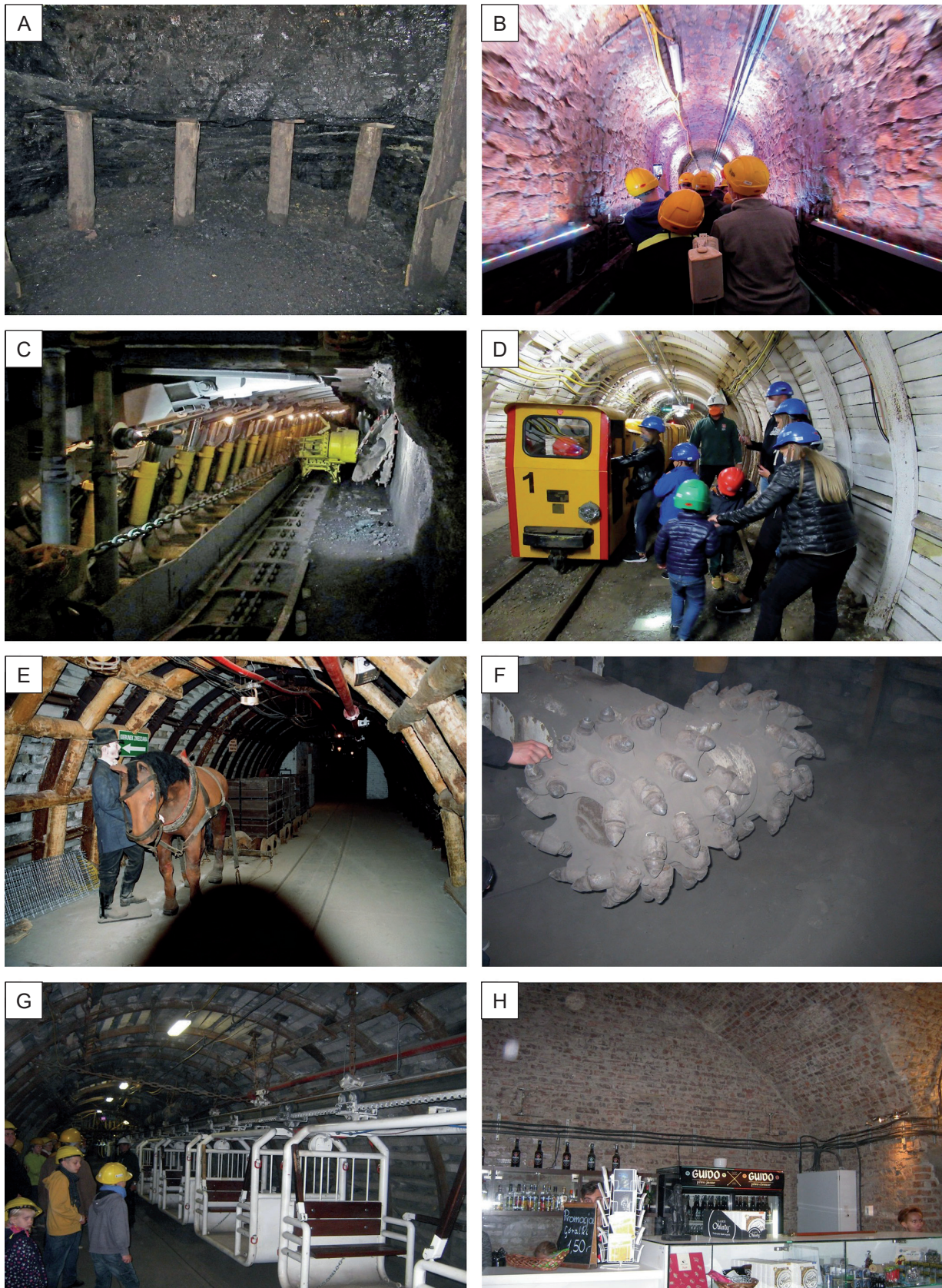


Fig. 4. Photographs of the “Królowa Luiza” Adit and the “Guido” Mine. Explanations: Water Route: A – mining face cut in the “Pochhammer” coal seam No. 510 with roof of the upper coal bench supported with timber racks; B – underground boat trip along the “Królowa Luiza” Adit with sandstone lining, illuminated by special lighting system; Family Route: C – presentation of longwall mining system: shearer, self-advancing support and face conveyor; D – electric train, one of the most common means of underground transport of miners, coal and equipment; “Guido” Mine, 170 m mining level: E – Ventilation Crosscut and mine carts pulled by horses; 320 m level: F – cutter drum of long-wall shearer; G – electric suspension train; H – the deepest-seated pub in Europe. All photos after M. Dzięciel

The tourist trail at the 170 m level enables the visitors to walk along the Ventilation Crosscut where they visit a 19th century horse stable. Horses were used for pulling the hauling carts. The crosscuts are lined with wooden bars and steel arches (Fig. 4E). At the end of this crosscut, there are some rooms with the exhibition of old mining tools, lamps, rescue equipment and maps presenting traditional coal exploitation systems. There is also a small geological museum and St. Barbara Chapel.

At 320 m level, tourists walk through a network of historical workings: shafts, drifts, inclines and chambers where a collection of mining machinery is exposed. These are authentic devices used for coal extraction throughout the 19th and the 20th centuries. The drifts are partly lined with steel arcs and anchors. Total length of this trail is about 2.5 km. Visitors can recognize the mining methods used in the 19th century. They can also watch the operation of the conveyor belt protected by mixed roof support: steel props and timber posts with caps and the face shearer as well as some outcrops of coal seams of the Paralic Series (Wilanowski *et al.*, 2009, 2015; Tab. 1; Figs. 2A and 4F). Since 2011, an additional adventure available for the visitors has been the only electric underground suspension rail in Poland (Fig. 4G) and a unique pub located in an old chamber (Fig. 4H). Quite a high number of concerts and theatrical performances are held there (www3). The Coal Mining Museum in Zabrze has also the exhibition of coal specimens from the USCB area (www3).

The interest in the two geotourism attractions in Zabrze was always very high. In the years 1995–2012, the total number of visitors varied from 45,107 up to 63,051, with an exception of 2005, when it decreased to 37,136. However, in 2013, it dropped down to 5,591 (www8; Tab. 2). The underground trail of the “Królowa Luiza” Mine was closed in the years 2011–2017, because of restoration works. In 2014, the surface facilities of the mine have been opened for tourists. This explains a noticeable increase of attendants to the Zabrze “mining heritage sites”. Since 2014, the number of visitors to these two geotourist attractions in Zabrze has risen from 121,483 up to 182,374. Since the two new underground trails of the “Królowa Luiza” Adit have been developed for tourism: the “Familiar Route” (since 2016) and the “Water Route” (since 2018), the total number of visitors to all three sites in Zabrze have increased up to the top value of 223,820 in 2019 (www8; Tab. 2).

In 2020, the “Królowa Luiza” Adit and the “Guido” Mine were recognized by the President of the Republic of Poland as a monument of history under the name of the “Zabrze – a Complex of Historic Coal Mines”. Thus, these were included into the most valuable historical buildings in Poland. Owing to its international importance, Zabrze town now plays the role of the European centre of industrial heritage, related to the “black gold” historical mining (Gola, 2020).

Table 2. Annual numbers of visitors to the selected geotourism attractions in Zabrze, Dąbrowa Górnicza, Wieliczka, Złoty Stok and Nowa Ruda (after Kruczek & Szromek, 2011; Kruczek, 2019; www8)

Year	“Guido” Mine + “Queen Louise” Adit + Coal Mining Museum in Zabrze	“Szttygarka” Training Mine + City Museum in Dąbrowa Górnicza	Tourist Route and Saltworks Museum in Wieliczka	Gold Mine in Złoty Stok	Underground Tourist Trail at the coal mine in Nowa Ruda
1995	49,462	–	500,000	–	–
1996	52,366	–	540,000	No data	No data
1997	57,287	–	560,000		
1998	51,702	3,082	580,000		
1999	52,491	2,644	600,000		
2000	63,051	3,435	640,000		
2001	58,100	4,034	700,000		
2002	57,164	5,654	750,000		
2003	48,323	3,306	820,000		
2004	47,393	3,826	870,000		
2005	37,136	1,523	920,000		
2006	46,337	1,150	960,000		
2007	45,107	2,457	980,000		
2008	52,487	5,320	1,000,500		
2009	59,799	4,682	1,000,200		
2010	60,084	5,826	990,000		
2011	46,939	8,800	1,060,957	145,000	30,365
2012	51,852	12,323	1,117,158	155,000	32,149
2013	5,591	12,317	1,209,708	175,000	35,765
2014	156,423	16,951	1,178,601	250,000	40,000
2015	121,483	14,187	1,279,341	185,000	50,000
2016	161,641	14,645	1,474,383	217,000	50,000
2017	162,856	19,294	1,710,692	214,000	50,000
2018	182,374	18,997	1,911,186	211,000	50,000
2019	223,820	10,717	1,863,000	No data	No data

The “Szygarka” Training Mine in Dąbrowa Górnicza town

The “Szygarka” Training Mine is located in the south-eastern part of the former “Paris” coal mine in Dąbrowa Górnicza town (Fig. 1). The “Paris” Mine has been established in 1876, by merging the “Łabecki” Mine, existing since 1865, and the “Nowa” Mine, in operation since 1867 (Ciepiela, 2007; Bielecki, 2008).

In 1889, the Mining School has been established in Dąbrowa Górnicza, as a secondary technical school dedicated to education and practical training of foremen for mines, smelters and ironworks. In 1919, the school evolved into the State Mining and Metallurgical School, known under the nickname of “Szygarka” (“szygar” in Polish means “foreman” and “szygarka” is a slang name of chamber, in which foremen work). Practical training required underground workings, hence, since 1927, a system of galleries has been cut at 10–15 m depth below surface (Wójcik & Chmura, 2008; Cygnarowska, 2017).

The practical training at the “Szygarka” Mine has ceased in 1994. The “Paris” Mine was closed in 1995 due to reserves’ exhaustion. In the following years, the local authorities debated the adaptation of existing mine workings for a mining museum, as it was the only existing remnant documenting the long history of mining activity in Dąbrowa Górnicza. Hence, the “Szygarka” Training Mine was adapted for tourism in 2010 (Chmura & Wójcik, 2009; Glimos-Nadgórska, 2017; www2).

The “Szygarka” Training Mine has become a branch of the “Szygarka” City Museum (Sobota, 2007; Cygnarowska, 2017; www2), founded in 1997 and situated in its close neighbourhood (Fig. 5). Tourists can walk along selected old workings of total length about 650 m, cut at two mining levels vertically spaced by about 14 m and interconnected with the northern incline No. I (Duży & Preidl, 2011; Figs. 5, 6). The deepest No. III level, (Figs. 5, 6A), is currently inaccessible for visitors. At the upper, No. I level, in the southern drift (Figs. 5, 6A), visitors can see the brick lining (Fig. 7A) and a collection of various types of mine carts used for coal haulage (Fig. 7B). In the western drift (Figs. 5, 6A), ventilator and fully equipped electric switchboard are exhibited. When walking along the northern incline (Figs. 5, 6B), the tourists recognize the ventilation pipe delivering fresh air to the workings (Fig. 7C).

At the lower, No II level, in the overwall drift (Fig. 5), tourists can see the outcrop of a coal seam belonging to the Rudy Beds (Wilanowski, 2016; Tab. 1; Fig. 7E). The overwall drift has a steel arc lining (Fig. 7D). The No. II longwall, started at the beginning of the southern incline (Fig. 5), is equipped with a shearer (Fig. 7F) and a conveyor belt (Fig. 7G) whereas its roof is protected by steel arches and hydraulic props (Fig. 7G).

In the “Szygarka” City Museum, visitors can also examine the collection of coal specimens taken from various outcrops within the Upper Silesian Coal Basin area (Fig. 7H).

Despite the fact that the underground trail at the “Szygarka” Training Mine is much shorter than the other such objects in Zabrze, the interest in this facility and the City Museum was always very high. They have become a geotourism attraction widely known in Poland and in the world. In the years 1998–2009, total number of visitors to the “Szygarka” City Museum varied from 1,150 to 5,654 (www8; Tab. 2). When the underground trail has been opened for public in 2010, a noticeable increase was observed of total number of tourists visiting these two facilities: from 12,317 up to 19,294. However, in 2019, the number decreased to 10,717 (www8; Tab. 2). When the tourist trail at the “Szygarka” Training Mine is extended by opening the drifts at No. III level (Polko, 2018; Figs. 5, 6A), the significant increase of tourist flow is expected.

Historical lead-zinc-silver ore mining in Tarnowskie Góry town

The ore mining in Tarnowskie Góry town dates back to around 1490. These mineral resources were the basis for metallurgical industry in Poland and in Central Europe (Pawlak & Filak, 2017). Large number of surface excavations, shafts and galleries were cut in Triassic dolomites, in order to reach silver, lead and (later) zinc orebodies. Total length of these old-workings is about 150 km. At the beginning, only primitive, manual methods were used with hammer as the most popular rock-cutting tool. The output was transported to the shaft stations and hoisted in kibbles. The galleries had to be drained when operations were run beneath the groundwater table. Hence, kibbles were used for draining the mine, but inflows were too high due to karstification of dolomites. Thus, special drainage adits had to be cut. In addition, horse-driven windlasses were used for mine drainage, as well. In the 17th century, ore exploitation ceased due to the Thirty Years’ War and later Prussian–Austrian war in the Silesia. In 1784, a new “Fryderyk” (“Frederick”) mine was constructed in Tarnowskie Góry. Its workings were drained by water adits (Moszny, 2003). The last adit, named the “Głęboka-Fryderyk” (“Deep-Frederick”, recently the “Czarny Pstrąg” Adit) was cut between 1821 and 1835. Its small part, about 600-m-long, has been adapted for tourism (Piernikarczyk, 1984; Dzięgiel, 2008; www4).

The ore mining in Tarnowskie Góry was stopped in 1922 due to reserves’ exhaustion (Szlachcic-Dudzicz, 2006; Dzięgiel, 2008; Wyciszczak, 2008; Pawlak & Filak, 2017).

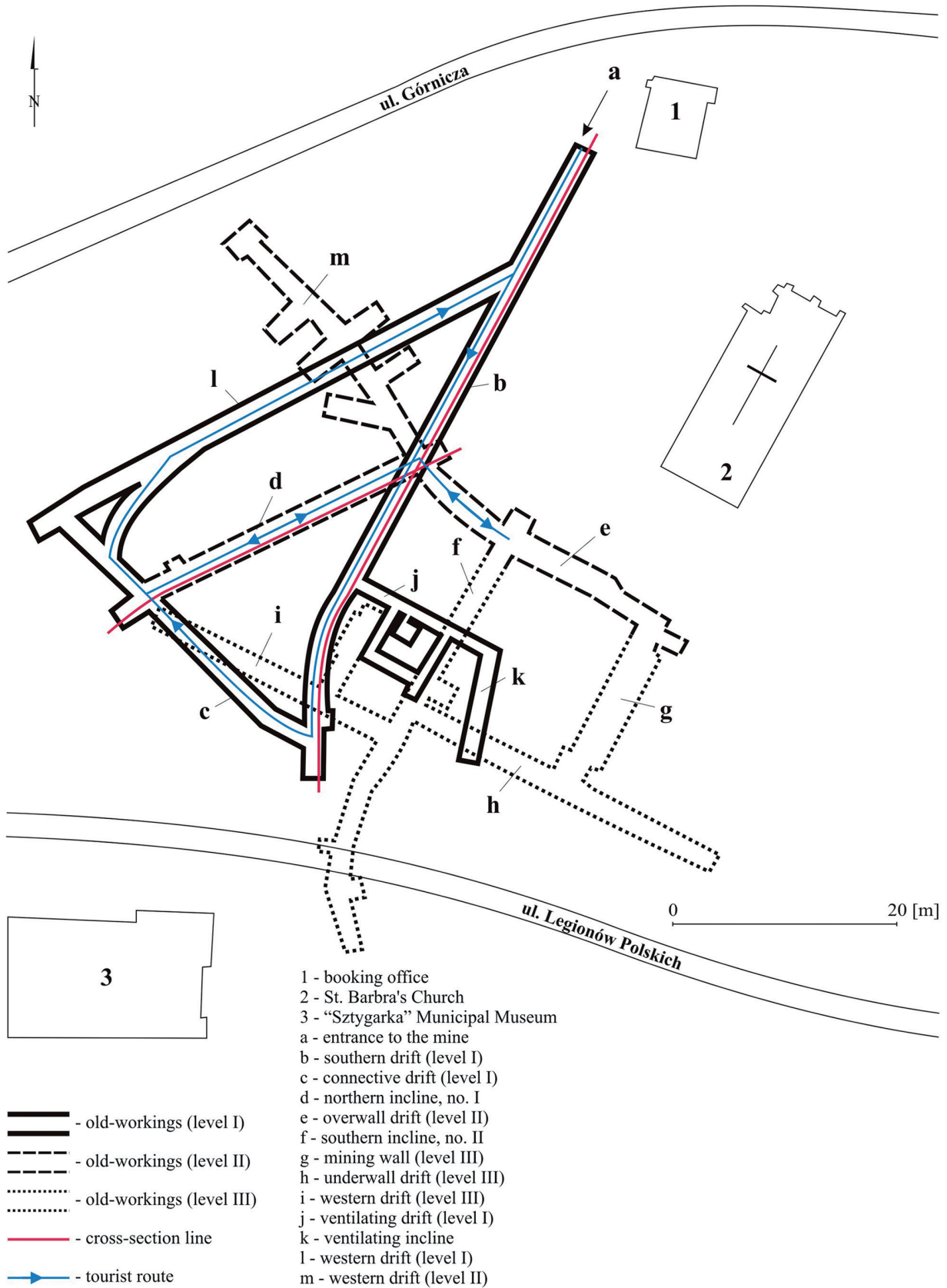


Fig. 5. Map of the "Szttygarka" Training Coal Mine workings (after Duży & Preidl, 2011)

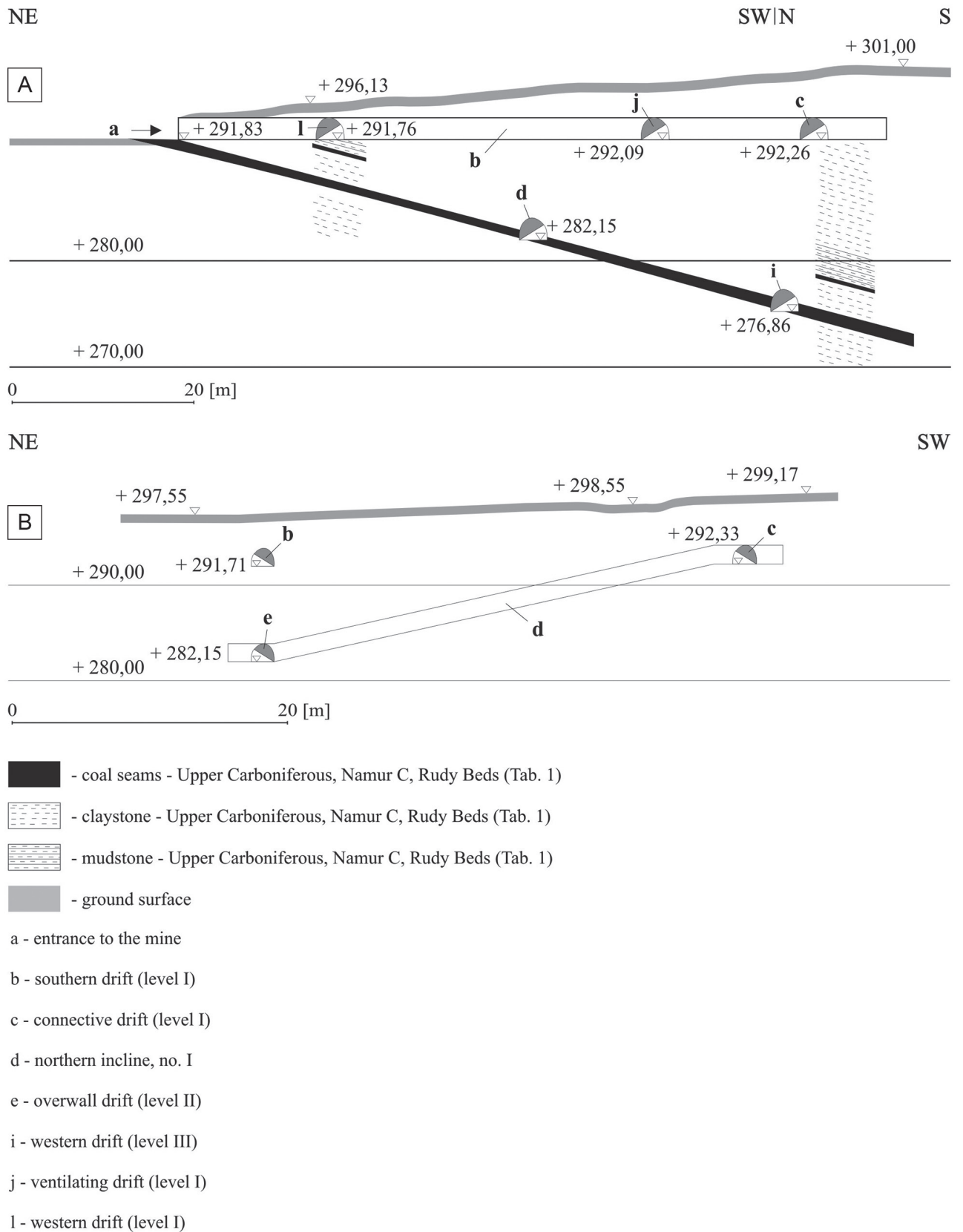


Fig. 6. Cross-section through the “Szygarka” Training Coal Mine working (Fig. 7) with geological sequences along the southern drift (A) and the northern incline No. I (B) (after Duży & Preidl, 2011)



Fig. 7. Photographs of the “Szttygarka” Training Mine. Explanations: A – entrance to the mine; B – mine carts in southern drift (mining Level I); C – northern No. I incline; D – sidewalk lined with metal arches in overwall drift (mining Level II); E – coal seam outcrop in overwall drift wall (Level II); F – shearer in southern No. II incline (mining Level II); G – hydraulic props of powered roof support in southern No. II incline, (mining Level II); H – coal specimens from the Upper Silesian Coal Basin exhibited in the “Szttygarka” City Museum. All photos after M. Dzięgiel

In 1953, the Tarnowskie Góry Land Lovers Association has been founded and it has started the arrangement of some part of the old ore mine old-workings for tourism. Finally, the “Czarny Pstrąg” Adit has become accessible to the public since 1957 and the Historical Silver Mine has started operation since 1976 (www4; Fig. 2C).

The Historical Silver Mine is located around the “Anioł” (“Angel”) Shaft (Fig. 8A), about 40 m below surface (Szlachcic-Dudzicz, 2006; Dzięgiel, 2008). The tourist trail is 1,740 m long and connects three shafts: “Anioł”, “Szczęść Boże” (“God Bless You”) and “Żmija” (“Viper”). The most important stops along the exposed old workings are: the outcrop of an accumulation of sulphide minerals (mostly galena) with some veinlets protruding into the surrounding, weathered, Middle Triassic, ore-bearing dolomite in the Collapse Chamber (Fig. 8B), the “Szczęść Boże” Shaft (Fig. 8C) and about 270-m-long gallery connecting it with the “Żmija” Shaft. The visitors row along that gallery by boat (Dzięgiel, 2008; Fig. 8D). There is also a mining museum in the building of the “Anioł” Shaft (Fig. 8A).

The second underground geotourism attraction in Tarnowskie Góry is the “Czarny Pstrąg” Adit (Piernikarczyk, 1984; Moszny, 2003; Dzięgiel, 2008; Wilanowski & Lewandowski, 2016; Figs. 8E–8F). The visitors walk down the “Sylwester” Shaft (Fig. 8E) to the gallery, 30 m below surface and then row by boat about 600 m along the adit (Fig. 8F) to the “Ewa” Shaft. The adit was cut in the Middle Triassic ore-bearing dolomite (Fig. 8F). Finally, the tourists walk up the staircase from ca 20 m depth to the surface.

Until now, these two underground trails have been managed by the Tarnowskie Góry Land Lovers Association (www4), and in 2004 the objects were recognised by the President of the Republic of Poland as a monument of history owing to their exceptional values and authenticity. Currently, these objects also belong to the group of 28 different venues in Tarnowskie Góry, Zbroslawice and Bytom called “The Tarnowskie Góry Lead-Silver-Zinc Mine and its Underground Water Management System”, which were included into the UNESCO World Heritage List in 2017 (Pawlak & Filak, 2017; Ziarkowska, 2019). That success was achieved thanks to the five-years-long efforts of the Tarnowskie Góry Land Lovers Association, in cooperation with many foreign organizations related to industrial heritage preservation (www1).

The tourism statistics for the Historical Silver Mine and the “Czarny Pstrąg” Adit in the years 1958–2018 recorded by the Tarnowskie Góry Land Lovers Association (Ziarkowska, 2019; www4) has reflected the great interest in these sites since the beginning of their adaptation for tourism (Tab. 3). The “Czarny Pstrąg” Adit has been the first to be opened for public in Tarnowskie Góry in 1957. During the first two years, the tourist attendance was rather low, up to 6,432 persons. But in the following years, until 1975, the adit has been visited by many more people: from 12,922 to 53,637 per year. Only in 1962, this figure decreased to 10,600 (Tab. 3).

Table 3. Combined annual numbers of visitors to geotourism attractions – the Historical Silver Mine and the “Czarny Pstrąg” Adit in Tarnowskie Góry (after Ziarkowska, 2019)

Year	Visitors number	Year	Visitors number
1958	1,800	1989	128,583
1959	4,631	1990	114,649
1960	6,432	1991	116,122
1961	12,922	1992	153,840
1962	10,600	1993	142,847
1963	15,752	1994	159,256
1964	20,206	1995	165,267
1965	22,873	1996	142,793
1966	26,092	1997	163,883
1967	33,500	1998	147,152
1968	41,456	1999	147,084
1969	44,287	2000	142,378
1970	50,241	2001	105,574
1971	45,794	2002	124,925
1972	46,177	2003	108,867
1973	46,796	2004	108,516
1974	48,607	2005	105,350
1975	53,637	2006	108,024
1976	48,776	2007	119,527
1977	79,081	2008	119,138
1978	88,021	2009	98,605
1979	84,992	2010	75,475
1980	88,887	2011	87,768
1981	77,862	2012	96,051
1982	71,973	2013	96,218
1983	88,879	2014	115,677
1984	108,030	2015	103,208
1985	94,937	2016	122,493
1986	119,994	2017	131,355
1987	122,966	2018	138,287
1988	117,688		

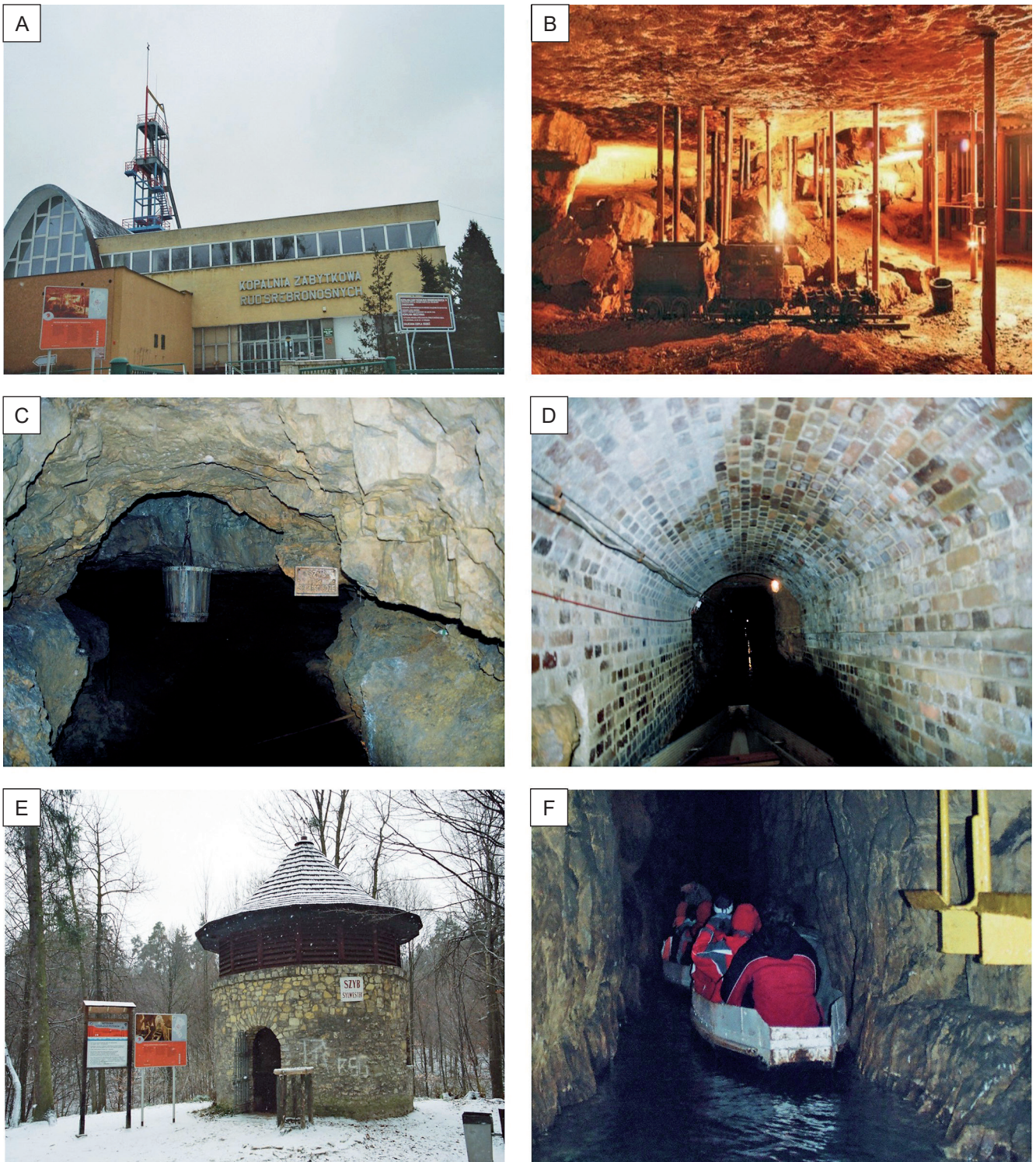


Fig. 8. Photographs of the Historical Silver Mine (HSM) and the “Czarny Pstrąg” Adit (CPA). Explanations: A – headframe of the “Aniol” Shaft (HSM); B – Collapse Chamber – sulphide minerals outcrop and mine carts (HSM); C – “Szczęść Boże” Shaft with water bucket – a part of old mine drainage system (HSM); D – brick-lined gallery connecting the “Szczęść Boże” and the “Żmija” shafts (HSM); E – “Sylwester” Shaft (CPA); F – underground canal (CPA). All photos after M. Dzięgiel

The patients of the Upper Silesian Rehabilitation Center (in operation since 1961), situated near the adit were especially numerous among the visitors to the “Czarny Pstrąg” Adit. When the Historical Silver Mine was also opened

for tourism in 1976, the total visitor number of both sites has increased noticeably, from 79,081 in 1977 to 88,887 in 1983. In 1984, the attendance exceeded, for the first time, 100,000 visitors (Tab. 3). The Historical Silver Mine was

occasionally modernised in the past, which resulted in the increase of tourist attendance in the following years. From 1986 to 2018, annual number of visitors varied from 105,350 to 165,267, except for the years 2009–2013 when the total attendance at these two facilities decreased slightly below 100,000. But since 2014, the number of visitors has again exceeded 100,000 and achieved the values of 131,355 in 2017, and 138,287 in 2018 (Tab. 3). This last noticeable increase could be related to the entering the UNESCO World Heritage List in 2017 (Pawlak & Filak, 2017; Ziarkowska, 2019).

Conclusions

Statistical data analysis of tourist flow in the underground trails of the central part of the Silesian Upland indicates that their geotourism attractiveness and popularity are very high. Currently, number of tourist visits to the Historical Silver Mine and the “Czarny Pstrąg” Adit in Tarnowskie Góry, and to the historical coal mines in Zabrze: the “Królowa Luiza” Adit and the “Guido” Mine are higher than those to the popular Coal Mine in Nowa Ruda town and, for a few years, have been almost equal to the attendance to the Gold Mine in Złoty Stok town (Tabs. 2, 3) (Kruczek & Szromek, 2011; Ziarkowska, 2019; www8; www9). This perfectly documents the increasing dynamics of the tourist flow in the historical mines.

The geotourism attractions in Tarnowskie Góry were the first post-industrial underground mining heritage monuments in the Upper Silesia adapted for tourism in 1957 and 1976. Hence, since the 1980s, they have been visited more frequently than the historical coal mines in Zabrze and in Dąbrowa Górnicza (Tabs. 2, 3). As these sites have already been included into the UNESCO World Heritage List, the Tarnowskie Góry Land Lovers Association (www4) in cooperation with the local authority attempted to design the future Upper Silesian Metal Ore Mining Geopark. Owing to that, these facilities could become even more widely recognised all over the world.

The tourist visits at the “Królowa Luiza” Adit and the “Guido” Mine in Zabrze have increased noticeably only in the recent years (Tab. 1). Therefore, the local authorities, in cooperation with numerous foreign organizations associated with the industrial heritage protection and some other European international institutions, should make an effort to include also these objects into the UNESCO World Heritage List. This may help to make these sites more recognizable and to achieve an additional great success, despite the fact that Zabrze already plays a significant role as the European centre of industrial heritage related to the “black gold” mining. Hence, the local authorities may also attempt to develop the Upper Silesian Coal Mining Geopark. At the beginning, it could include only the two historical coal mines in Zabrze, but in the future, it may be extended to some other sites in the USCBA area, when the recently operating mines cease their activity and their relics become accessible for visitors.

As a result of the creation of the Upper Silesian Metal Ore Mining and Coal Mining geoparks, some exchange of experiences and information concerning the restoration and modernization of the sites among local authorities can be much easier. This could lead to the increase of their global rank and reputation.

The “SztYGarka” Training Mine in Dąbrowa Górnicza is still much less known as a geotourism attraction than the other objects described above. First of all, this underground trail is much shorter than the others, except for the “Czarny Pstrąg” Adit. It has been the latest object, opened to the public in 2010 except for the two new trails developed later at the “Królowa Luiza” Adit. Hence, it could not be effectively promoted and, thus, so widely known, as yet. However, after extension of the trails at No. III mining level (Figs. 5, 6A) and after general restoration, the “SztYGarka” Training Mine will gain a potential to be much more popular in Poland and in the world, particularly if included into the future Upper Silesian Coal Mining Geopark. The perspectives of tourism development in the central part of the Silesian Upland, based upon their industrial heritage and geoheritage attractions of the central part of the Upper Silesian Coal Basin seem to be very optimistic.

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