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Quest for the Lost World, or palaeontological geotourism

W poszukiwaniu zaginionego świata, czyli geoturystyka paleontologiczna

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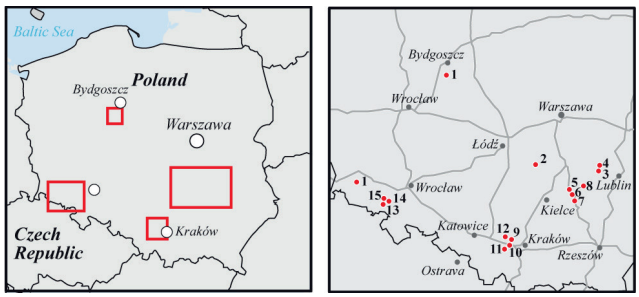

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Abstract: *Palaeontological geotourism could be one of many forms of propagating geological values of a country. It can meet the expectations of many tourists. For this broad category of people, paleontological tourism can instill curiosity about the extinct world, offering them places where they can feel like explorers, visiting these sites with a hammer and a chisel. Many of them will cherish the memories of adventures made during the search in the future, and some will find a new passion. Similar practices are used in Germany, for example, in Solnhofen or Holzmaden, where fossil exploration is available for a small fee. In most regions of Poland, you can find numerous places with fossils that anyone can search for. The greatest number of such sites can be found in the south of Poland, in the uplands and mountains, but also at the seaside, where the practice of palaeontological geotourism is possible. In the Holy Cross Mountains, the Sudetes, or in the Silesian-Cracow region, there are places where one finds fossils of plants or animals, including trace fossils. The only effort required in addition to the search for fossils is to develop guidelines and prepare guides for amateurs that quest for the lost world.*

Key words: *geotourism, geology, palaeontology, fossils*

Treść: *Geoturystyka paleontologiczna może być jedną z form propagowania walorów geologicznych kraju. Może spełnić oczekiwania wielu turystów. Wiele osób można zainteresować wymarłym światem, umożliwiając im zwiedzanie miejsc, gdzie mogą poczuć się jak odkrywcy, odwiedzając je z młotkiem i dłutem. Część z nich będzie w przyszłości pielęgnować wspomnienia o przygodach w trakcie poszukiwań, a niektórzy odnajdą swoją pasję. Podobne praktyki stosuje się np. w Niemczech – w Solnhofen czy Holzmaden, gdzie za drobną opłatą można poszukiwać skamieniałości. W większości regionów Polski można znaleźć liczne miejsca ze skamieniałościami, których poszukiwać może każdy. Najwięcej takich stanowisk spotkamy na południu Polski, w strefach wyżyn i gór, ale i nad morzem uprawianie paleontologicznej geoturystyki jest możliwe. W Górach Świętokrzyskich, Sudetach czy rejonie śląsko-krakowskim są miejsca, w których znajdziemy skamieniałości roślin lub zwierząt, a także same skamieniałości śladowe. Wymaga to jedynie wysiłku opracowania wskazówek i przewodników dla amatorów poszukiwań zaginionego świata.*

Słowa kluczowe: *geoturystyka, geologia, paleontologia, skamieniałości*

Introduction

Among the wider population, and especially among the younger generation, there is a section of geology that is of particular interest, and which is neglected by geology popularisers. This section is palaeontology, more specifically the search for fossils. Several decades ago, geological guides for tourists were published, containing lots of information

about fossils findable in rocks of the region described. Today, such publications are very rare, and they are hardly accessible for tourists (Mizerski, 1994; Machalski & Stolarski, 2000; Mizerski *et al.*, 2017). Information about fossils can be found in some scientific publications (Dzik, 2011; Mizerski & Orłowski, 2017) or popular-science periodicals. However, they contain little exact information about the location of particular fossils. In libraries, one can still get the geological guides published in the 1960s and the 1970s for different regions of Poland, but currently they are practically unavailable (e.g. Kotański, 1968; Gradziński, 1972; Grocholski, 1969). Therefore, the proposal to extend the promotion of geotourism onto the problem of fossils occurring in rocks could widely reach the expectations of many tourists and receive a broad response. Certainly, there are collectors and enthusiasts who know what to search for and where to search. However, there is a broader group of people with curiosity about the extinct world, not only about the dinosaurs, for whom it could be useful to indicate the places to visit with a hammer and a chisel, where they can feel like explorers and discoverers. Certainly, many of them will cherish the memories of adventures during the search, and some of them will discover a new passion in it.

This article is not dedicated for geologists, but rather for tourists, organizers of tourism and teachers not based in Poland. The authors think that this form of geotourism will be interesting for many people. Geotourism is appreciated currently as very significant not only in Poland, but in other countries as well (for example Bruno *et al*., 2014; Henriques & Penna dos Reis, 2015).

Many regions of Poland abound in places with fossils that anyone can see. The greatest number of such sites can be found in the south of Poland, in the uplands and mountains, but the search for fossils is possible also at the seaside. Obviously, it is not necessary to collect everything. In the Holy Cross Mountains, on the Sudetes, and in the Silesian-Cracow region, it is possible to recommend places where only plant fossils, only animal fossils, or even localities with only trilobites, cephalopods or trace fossils etc. can be found. This just requires developing relevant guidelines and guides for amateurs searching for the lost world.

It is obvious that any collection of fossils must be legal. In Poland, gathering of fossils for private collection is permitted. In any case, however, we must sensitize tourists to protect geological objects from which fossil retrieval is forbidden. The aim of the authors is not to present the whole wealth of fossils collectible in Poland, but to show that they can be a good aid in the development of geotourism in a region. After all, JuraPark in Bałtów was created thanks to the imagination of some people who believed that the fossils of the region would bring tangible benefits to it.

Fossils

To illustrate the possibilities of fossil gathering in several regions of Poland, let us look at some suggestions for one-day palaeontological tours. In the following article, selected paleontological sites from the north of Poland, through Central Poland, to the south are described. Discussed points in this article are located on the schematic map of Poland (Fig. 1).

Fig. 1. Location in Poland of the discussed point in the text: 1 – Wapienno/Bielawa; 2 – Owadów Brzezinki; 3 – Kazimierz Dolny; 3 – Nasiłów; 5 – Doły Opacie; 6 – Bukowie; 7 – Gromadzice; 8 – Bałtów; 9 – Krzeszowice; 10 – Zalas; 11 – Kwaczała; 12 – Karniowice; 13 – Pogorzały; 14 – Lake Daisy; 15 – Lubiechów; 16 – Radłówka

On the Baltic Sea shores, fossils can be found directly on the beach. They occur in the rocks brought during the Pleistocene by the ice sheet from the Scandinavian Peninsula and from the Baltic Sea floor. They come from different geological periods, because the ice sheet carried fragments of rocks of different ages. These are mainly invertebrates that usually inhabited shallow seas. On the Polish beaches, we will find nautiloids, corals, sponges, brachiopods, gastropods, bivalves, sea urchins, crinoids, graptolites and even trilobites and belemnites.

Heading southward from the Baltic Sea, we reach the Kujawy region with the villages of Wapienno and Bielawa, between Inowrocław and Żnin (Fig. 1 – point 1). In this area, there is the largest limestone mine in Poland and one of the largest in Europe. In the Wapienno/Bielawa quarry, as many as 14 lithostratigraphic units have been identified in the formation rank, distinguishing 12 different lithologies containing very diverse fossils (Matyja & Wierzbowski, 1981; Matyja

et al., 1985). Exploitation of rocks is carried out in the Upper Jurassic (Oxfordian) limestones, offering numerous fossils, among others, starfish (*Sphaeraster*), stalked (*Cyclocrinus*) and free-living (*Semiometra*) crinoids, echinoderms (*Rhabdocidaris* (Fig. 2) and *Plegiocidaris*), polychaetes (*Pannoserpula*) and numerous ammonites, brachiopods and sponges (Radwańska, 2007). Because it is an active quarry, we must get permission if we want to enter its area and look for fossils.

Fig. 2. Echinoid of the genus *Rhabdocidaris*, Upper Jurassic, Oxfordian (coll. Geological Museum PGI–NRI of Warsaw), photo K. Skurczyńska-Garwolińska

Eighteen kilometers southeast of Tomaszów Mazowiecki is the Owadów-Brzezinki quarry in Sławno near Opoczno, where Upper Jurassic (Tithonian) limestones are exposed (Fig. 1 – point 2). This is a unique site called the "Polish Solnhofen", where you can find very well-preserved fossils of marine and terrestrial organisms (Kin & Błażejowski, 2012) (Solnhofen – the most famous palaeontological site of Fossillagerstätte, i.e. a sedimentary deposit of fossils with exceptional preservation, providing valuable palaeontological data, located in southern Germany). In the Owadów-Brzezinki quarry, the most abundant fossils are bivalves of the species *Corbulomima obscura*, and slightly less numerous representatives of the genus *Mesosaccella.* There is also a wide range of cartilaginous and ray-finned fish, lobsters, shrimp and crabs (two new species of *Limulus darwini* and *Crenatolimulus sp. nov.* – the latter undescribed yet). We can also find there rare ammonites, remains of small sea reptiles and flying pterosaurs, as well as dragonflies and beetles (Kin & Błażejowski, 2012).

The carbonate rocks exposed in this quarry are assigned to three complexes (Kin & Błażejowski, 2012). The lowermost complex I is represented by limestones with numerous ammonites of the species *Zaraiskites zarajskensis*. These deposits were accumulated in a moderately deep-water environment. Complex II is represented by very shallow-marine platy limestones containing abundant sedentary polychaetes (Sedentarida). The uppermost exposed rocks are lagoonal deposits of complex III, containing an exceptionally rich accumulation of abundant and diverse marine and terrestrial faunas – the so-called corbulomina horizon (the name comes from numerous bivalves of the genus *Corbulomina*). We must have permission to enter the Owadów-Brzezinki quarry area and look for fossils.

Heading east from Sławno, we reach Kazimierz Dolny nad Wisłą (Fig. 1 – point 3). South of the town centre, upon the Vistula River, is an abandoned quarry of Upper Cretaceous rocks. The siliceous marls (opoka) and limestones offer an abundance of fossils (Machalski, 1998). The most numerous among them are molluscs, including frequent cephalopods. The rocks contain belemnites represented predominantly by the genera *Belemnitella* and *Belemnella*, and ammonites of the genera *Hoploscaphites*, *Discoscaphites*, *Baculites* and *Sphenodiscus*. Bivalve fossils are also numerous – the most frequent are representatives of *Ostrea*, *Pholadomya* and *Lyropecten* (Pożaryska & Pożaryski, 1951; Błaszkiewicz, 1980). Among gastropods, the dominant genera are *Turritella* and *Aporrhais*. There are also fossils of sponges, brachiopods, remains, and even entire branchlets of coniferous plants and shark teeth.

It is also worth to go to the quarry in Kamienny Dół in Kazimierz Dolny, where one can find grey-green gaizes with bulbous layers of hard limestones, representing the Paleocene (lowermost Cenozoic). These rocks bear a regional name of "siwak". Remains of a Paleocene crocodile from the genus *Thoracosaurus* (Żarski *et al.*, 1998) were discovered in the rocks in 1995 (Fig. 3). It is the first such finding in Poland and the fourth in Europe. The skeleton fragment is part of the tail, including the thoracic and sacrum bones, and armour plates. Analysis showed that the sea in which the crocodile lived was no more than 80 m deep, and its waters had a temperature of about 18 degrees and salinity typical of open seas. Currently, this specimen is stored at the Geological Museum of the Polish Geological Institute in Warsaw.

When in Kazimierz Dolny nad Wisłą, it is worth taking a ferry to the other bank of the Vistula River to visit the Nasiłów quarry (Fig. 1 – point 4). This area is composed of rocks similar to those observed in Kazimierz – predominantly light-coloured, grey-yellow thick-bedded opokas with marl interbeds, and light grey gaizes with interbeds of limestones. They are Paleocene in age and overlie the Cretaceous rocks. These rocks contain abundant fossils (Machalski, 1998). The opokas host frequent ammonites of the genera *Hoploscaphites* and *Baculites*, nautiloids of the genera *Eutrephoceras* and *Cymatoceras*, and belemnites of the genus *Belemnella* (Fig. 4). We can find well-preserved sponges and bivalves, among others, of the genus *Pholadomya*. If we are lucky, we also find teeth of large predatory mosasaur reptiles and shark teeth (Abdel-Gawad, 1986; Machalski, 1998).

Fig. 3. Skeletons elements of *Thoracosaurus*, Paleocene (coll. Geological Muzeum PGI–NRI of Warsaw), photo K. Skurczuńska-Garwolińska

Southwest of Nasiłów, we encounter a real "fossil basin" which is the Holy Cross region. Among the many areas abounding in fossils, we are going to be acquainted with only one – the environs of Ostrowiec Świętokrzyski. In the Nietulisko area, northwest of Ostrowiec, there are numerous borrow pits, where Lower Triassic sandstones have been mined for a long time. In the Doły Opacie quarry (Fig. 1 – point 5), we can even notice that these rocks overlie Devonian dolomites exhibiting a disconformity. Lower Triassic sandstones of this area are represented by several rock complexes, including the Labyrinthodont Beds that contain bones of amphibians – labyrinthodontes, as well as footprints of reptiles called *Isochirotherium* and *Chirotherium* (Ptaszyński, 1996, 2000). We can imagine that lots of animals lived around an inland water body in this area, and its soft, muddy and flat shores favoured the preservation of footprints of these animals. It is worth mentioning, that the fossil tracks of Mesozoic reptiles were the main reasons for the creation of legends of evil paws and diabolical stones. In the cherry-coloured calcareous sandstones, which occur as interbeds, you can also find *Gervillia* mollusc fossils and, sometimes, fossil fish scales and bones.

Among interesting places in this region, with Middle Triassic rocks exposed on the surface, is a gorge at Bukowie, south of Kunów (Fig. 1 – point 6). The marls and limestones host a very wide range of fossils. Cephalopods are represented by nautiloids of the genus *Germanonautilus*, and ammonites of the genus *Ceratites* (Fig. 5). There are plenty of bivalves, i.a., of the genera *Costatoria*, *Entolium* and *Lima*, *Coenothyris* brachiopods, and *Encrinus* crinoids. Sometimes, it is possible to encounter fragments of skeletons of marine reptiles of the genus *Nothosaurus*.

Fig. 4. Belemnite of the genus *Belemnella*, Upper Cretaceous, Maastrichtian (coll. Geological Muzeum PGI–NRI of Warsaw), photo K. Skurczuńska-Garwolińska

Fig. 5. Ammonite of the genus *Ceratites*, Middle Triassic, Muschelkalk (coll. Geological Muzeum PGI–NRI of Warsaw), photo K. Skurczyńska-Garwolińska

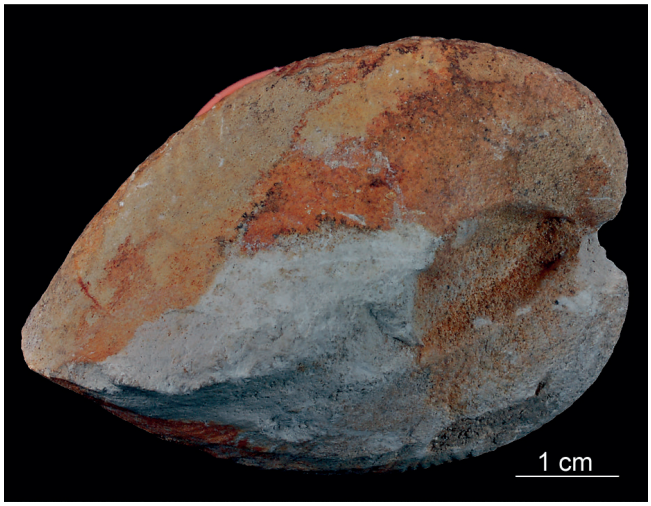

Fig. 6. Bivalve of the genus *Pholadomya*, Upper Jurassic, Oxfordian (coll. Geological Museum PGI–NRI of Warsaw), photo K. Skurczyńska-Garwolińska

It is also worth visiting the valley of the Kamionka River, near the village of Gromadzice to the south of Ostrowiec Świętyokrzyski (Fig. 1 – point 7), where Lower Jurassic rocks outcrop. The best exposures are situated on the eastern slope of the valley, north of the village. This site is called Las Godziny by the locals. The valley scarp and numerous pits expose sandstones and siltstones that accumulated initially in fluvial and lacustrine environments and later in deltaic and nearshore settings. The rocks contain en masse occurrences of flora remains. About 50 plant species were described from them already almost 100 years ago. These are the Ginkgoaceae of the genera *Ginkgo*, *Czekanowskia* and *Baiera*, cycads of the genera *Pterophyllum* and *Nilssonia*, and pteridosperms of the genera *Cladophlebis* and *Dictyophyllum* (Makarewiczówna, 1928). Moreover, with good fortune, you can find footprints of several species of both predatory and herbivorous dinosaurs (Gierliński & Pieńkowski, 1997) and, in the upper part of the section, marine bivalves of the genus *Cardinia*.

When exploring the Holy Cross region, it is worth visiting Bałtów (Fig. 1 – point 8), not only for its Jura Park known worldwide, but also for numerous exposures of Upper Jurassic rocks offering very abundant fossils. The well-bedded limestones contain ammonites of the genera *Perisphinctes* and *Aspidoceras*. Particularly numerous are bivalve fossils of the genera *Trigonia*, *Modiola*, *Lopha*, *Plagiostoma*, *Astarte* and *Pholadomya* (Fig. 6). There are also gastropod fossils of the genus *Nerinea*, brachiopods of the genus *Terebratula*, and sponges of the genus *Laocaetis*. Some exposures in this area reveal reefal limestones of the same age. About 20 species of colonial corals have been described from these rocks, including those of the genus *Isastrea* (Gutowski, 2004).

From the Holy Cross region, we move to the Krzeszowice area (Fig. 1 – point 9) west of Cracow, where we encounter fossils originating from several geological periods. The beautifully located abandoned quarry in Dębnik and smaller pits usually overgrown with dense vegetation expose the black hard Dębnik Limestones of the upper Middle and lower Upper Devonian. Their intensive extraction started as early as the 16th century, when Queen Bona brought Italian stone masters there. In Renaissance and Baroque times, "Marble Dębnik" was among the most valuable building materials used not only in Poland, but also in many other European countries. The limestones offer beautifully preserved fossils of stromatoporoid sponges of *Amphipora* and *Stromatopora*, tabulate corals of *Macgeea* and *Alveolites*, and brachiopods of *Cyrtospirifer*, *Spinatrypa* and *Stringocephalus* (Baliński, 1979).

The best sites for collecting the Lower Carboniferous fossils in the vicinity of Dębnik are in the valley of the small river of Eliaszówka. The limestones exposed, among others, in the Czatkowice quarry (entry permission required!) yield brachiopods of the genus *Gigantoproductus* (Fig. 7), tetracorals of the genus *Zaphrentis*, and stromatoporoids. We can also find trilobites, predominantly of the genera *Phillipsia* and *Brachymetopus* (Hoffmann & Uchman, 2008).

South of Krzeszowice, in old pits on Czerwieniec Hill, there are calcareous sandstones containing numerous Middle Jurassic fossils. Here, we can find ammonites mainly of the genus *Macrocephalites*, bivalves of the genera *Pholadomya*, *Pecten* and *Trigonia*, gastropods of the genus *Pleurotomaria* (Fig. 8), and brachiopods – predominantly *Rhynchonella* and *Terebratula* (Giżejewska & Wieczorek, 1976).

Fig. 7. Brachiopod of the genus *Gigantoproductus*, Carboniferous, Visean (coll. Geological Museum PGI–NRI of Warsaw), photo K. Skurczyńska-Garwolińska

Fig. 8. Gastropod of the genus *Pleurotomaria*, Middle Jurassic, Bathonian (coll. Geological Museum PGI–NRI of Warsaw), photo K. Skurczyńska-Garwolińska

In the nearby village of Zalas (Fig. 1 – point 10), there is also a quarry exposing Middle Jurassic rocks. In the lower part, these are marine sands and less common quartz sandstones and conglomerates, containing well-preserved fossils of ammonites, including those of the genus *Macrocephalites*, and fragments of belemnites, bivalves, gastropods, echinoderms and corals of the genus *Isastrea*. The upper part of the section is composed of sandy crinoid limestones rich in fossil crinoids of the genera *Balanocrinus* and *Cyclocrinus* (Salamon & Zatoń, 2006), bivalves, e.g. of the genus *Ctenostreon*, brachiopods of the genera *Rhynchonella* and *Terebratula*, and less frequent ammonites, belemnites and nautiloids (Giżejewska & Wieczorek, 1976). In the Zalas quarry, there are also Upper Jurassic limestones that provide many other fossils. These are mostly ammonites, among others, of the genera *Holcophylloceras*, *Sowerbyceras*, *Peltoceratoides*, *Perisphinctes* (Fig. 9) and *Cardioceras* (Matyja & Tarkowski, 1981).

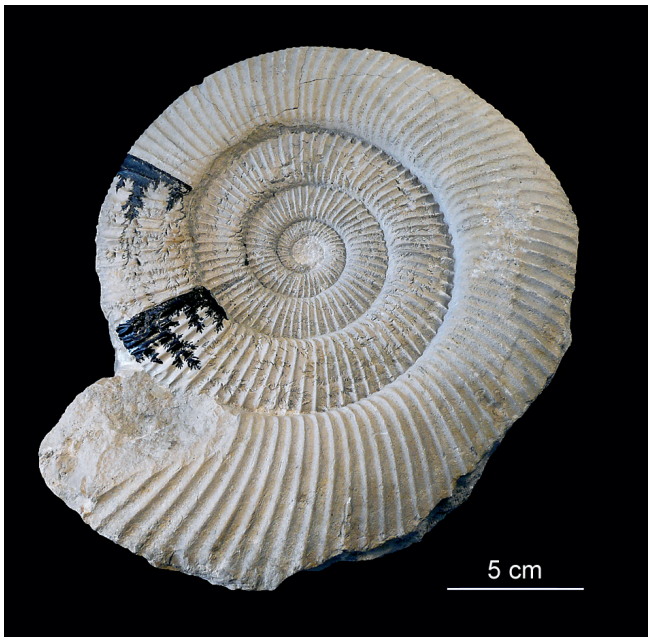

Fig. 9. Ammonite of the genus *Perisphinctes*, Upper Jurassic, Oxfordian (coll. Geological Museum PGI–NRI of Warsaw), photo K. Skurczyńska-Garwolińska

A few kilometres southwest, we can visit the village of Kwaczała near Alwernia (Fig. 1 – point 11). This trip can give us an idea of some Carboniferous plants. In the largest gorge, located north of the village, there are large exposures of rocks called the Kwaczała Arkose. These are sandstones, locally with large pebbles, which contain not only quartz, but also numerous feldspar and mica grains. Occasionally, they include thin interbeddings of clays. The Kwaczała Arkose contains fossil tree trunks of Araucaria of the genus *Dadoxylon*, with the trunk diameter up to 1.2 m and length up to 7.5 m (Zastawniak, 2001; Stanisz & Ziobro, 2013).

Between Krzeszowice and Chrzanów is the village of Karniowice (Fig. 1 – point 12), known for the Lower Permian travertines – the Karniowive Travertine (Ćwiżewicz & Szulc, 1989). In an area of 6 km^2, tors, abandoned quarries and pits overgrown with dense vegetation reveal 2–6-m thick

beds of freshwater limestones. The travertine was discovered in 1870 by the Cracow botanist Marian Raciborski. It has a massive, porous structure and contains freshwater gastropods, among others of the genus *Dendropupa*, and imprints of plant leaves and stems, i.a., of the fern Sphenophyllum.

The lovers of fossils from Lower Silesia can also find some interesting things in the Sudetes. About 1.5 km northeast of Pogorzała (Fig. 1 – point 13), near Świebodzice, there are two exposures of conglomerates. Limestone pebbles composing the conglomerate contain Upper Devonian fossils. These are Tetracoralla of the genera *Disphyllum*, *Macgeea* and *Marisastrum*, and brachiopods (Fig. 10) of the genus *Atrypa* (Halamski, 2013). About 3 km to the northwest of these exposures there is a quarry of Upper Devonian reefal limestones, inactive for over 100 years now. The quarry bottom is occupied by a lake called Lake Daisy (Fig. 1 – point 14). This place is well known for its abundance of fossils that can be found in both the limestones and the interbedding mudstones and marls. These rocks contain goniatites of the genus *Manticoceras*, Tetracoralla of the genus *Peneckiella*, brachiopods of *Schizophoria*, *Productella*, *Cyrtosipirifer* (Fig. 11) and *Pugnax*, as well as bivalves, including those of the genus Buchiola (Gunia, 1962a).

If we go about 3.5 km further northwest from Lake Daisy to the village of Lubiechów (Fig. 1 – point 15), we find thick-bedded conglomerates exposed, including pebbles of Upper Devonian limestones that yield fossils, among others, of *Alveolites* tabulate corals and *Amphipora* stromatoporoids, as well as brachiopods (Fig. 12) of the genus *Gypidula* (Gunia, 1962b).

Fig. 10. Brachiopod of the genus *Atrypa*, Middle Devonian, Givetian (coll. Geological Museum PGI–NRI of Warsaw), photo K. Skurczyńska-Garwolińska

Fig. 11. Brachiopod of the genus *Cyrtosipirifer*, Upper Devonian, Famennian (coll. Geological Museum PGI–NRI of Warsaw), photo K. Skurczyńska-Garwolińska

Fig. 12. Brachiopod of the genus *Gypidula*, Middle Devonian, Givetian (coll. Geological Museum PGI–NRI of Warsaw), photo K. Skurczyńska-Garwolińska

From the Świebodzice environs, we can move to the last region – in the vicinity of Lwówek Śląski (Fig. 1 – point 16). Several kilometres west of this town, near the village of Radłówka, there is a bushed quarry whose north-western edge approaches the road. The quarry exposes Upper Permian light grey thick-bedded limestones overlain by brownish sandy clay shales. In these rocks, it is possible to encounter fossil brachiopods of *Productus*, and bivalves, including the genera *Schizodus* and *Pseudomonotis*. If we are lucky, we can meet better- or worse-preserved imprints of fish representing the genus *Palaeoniscus*. In the village of Mojesz, located a few kilometres south of Lwówek Śląski, between

specimens are a reason to be proud. However, treated this way they are decorative only, and we should try to find out more about them, especially about the environment of ancient geological epochs. Many fossils provide very clear indications of the distribution of ancient seas and lands. Based on an analogy to modern relatives of fossils of ancient organisms, we can first determine whether they are fossils of ancient marine or terrestrial organisms. Animals such as corals, brachiopods, cephalopods, echinoids or starfish today live only in the sea. Thus, in past geologic epochs, they lived in similar environments. Therefore, the presence of the fossils in the rock proves that it originated in the sea. Thus, in the place where land is today, there must have been a sea long ago. The study of plant fossils allows us to answer the question whether the land inhabited by these plants was a desert or a wetland, swampy area.

Most of deposits that we see on the continents originated in the seas and oceans. It is no wonder, since oceans covered most of our planet's surface. The nature of sedimentary basins is reconstructable, based on both characteristics of the deposits and their fossil content.

Fossils of marine organisms will help to answer the question of what the sea was like: shallow or deep, warm or cool: of normal salinity, brackish or highly saline? If we find many fossils of corals, we are sure that these animals lived in a warm and normally saline sea. If we find bryozoan fossils, then they surely prove that the sea water in which they lived must have been highly saline.

Here are other examples. In the beautiful gorge of „Prągowiec" located in the Holy Cross Mountains, we will find abundant fossils of extinct hemichordates – graptolites – in Silurian shales. The shales are full of fossils. Such a large amount of these planctic organisms indicates that the shales were deposited in an open-marine basin. However, if we meet a large number of colonial tabulate corals in Middle Devonian limestones in the Bolechowice quarry near Chęciny, we will be sure that the sea was not only warm, but also shallow, as colonial corals attach to the substrate and can live only in a zone of constant water movement (Bottjer, 2016).

Different marine organisms inhabit only shallow or only deeper parts of the sea. They live in colonies in shallow seas, and only single individuals dwell in deeper-marine areas. Organisms live different lifestyles: they inhabit the sea floor (benthos), actively swim (necton), or passively float in the water (plankton). Organisms living on the sea floor include those inhabiting only specified depth zones. Fossils of these organisms allow, in many cases, for a very precise determination of the environment in which the rocks of certain age were formed.

As mentioned above, fossils are not only organic remains, but also exhibit traces of their life activity (moving, feeding and dwelling) preserved in a fossilised state. The former are called structural fossils, and the latter are trace fossils or ichnofossils. Trace fossils, which tell us many things about the sedimentary environment, can be preserved on the surface of sediment layers or inside them. The sediment surface can reveal traces of creeping and crawling of organisms, known as organic hieroglyphs. Examples of such hieroglyphs are traces of trilobites – Palaeozoic marine arthropods. The most beautiful ones can be found in Poland in the active quarry of Wiśniówka Wielka near Kielce, where Cambrian sandstones are exploited. Trilobites (Fig. 13), crawling on the sea floor, lived in shelf (and thus shallow-water) seas. As such the conclusion that the rocks mined in the quarry, which are about 500 million years old, were deposited in a relatively shallow shelf sea, seems to be justified (Bottjer, 2016).

Fig. 13. Trackway of the Cambrian Trilobite (coll. Geological Museum PGI–NRI of Warsaw), photo K. Skurczyńska-Garwolińska

Traces of paws of vertebrates on bedding surfaces are called tracks. These can be found in many places of the Holy Cross region (e.g. in Doły Opacie, Sołtyków, Gliniany Las, Bałtów) in Triassic and Jurassic rocks, as well as in Tłumaczów, Lower Silesia, in Permian deposits. It is well known, that dinosaurs were terrestrial animals, but their tracks are sometimes found in limestones, which are marine sediments. Thus, we are going to draw the logical conclusion that, at those times when the track-forming dinosaurs lived, there must have been a very shallow sea with numerous shoals and flat islands barely rising above the sea level. The most famous, however, is the „Zachełmie" quarry near Zagnańsk north of Kielce, where tracks of the world's earliest tetrapods were discovered in Middle Devonian rocks (Niedźwiedzki *et al.*, 2010). Another type of trace fossils are burrows produced in the sediment by various animals and the remains of borings in the rocky substrate by some bivalves, sponges or echinoids. They also point to a very shallow, nearshore marine environment during their life activity.

Palaeontological tourism in quarries and outcrops

Most of its achievement palaeontology owes to arduous investigations and the quest for traces of the lost world. However, remarkable progress can sometimes occur by mere chance, or when someone completely unfamiliar with fossils inadvertently finds an unusual specimen that will later reach the hands of a paleontologist.

Our country is also not free from unexpected discoveries of great importance to palaeontology. Until recently, dinosaurs were known in Poland just by their tracks. Only the discoveries in the Krasiejów coal mine (Opole Silesia region) and in Lisowice allowed discovering bone remains of not only animals well known to science, but also pradinosaurs and their ancestors that are unknown to science (Dzik *et al.*, 2000).

What can we say about the rather unexpected discovery of the tracks of the oldest tetrapods on Earth in the Holy Cross region? They had been known for some time, but no one knew what they were. Only studies of palaeontologists have shown that these are the traces of tetrapods that moved onto land earlier than *Ichthyostega* did, which was considered the oldest tetrapod. The same applies to the footprints of Jurassic dinosaurs, which had long waited for scientific interpretation, and had been considered "devil's feet" by the locals.

The rocks preserve a fraction of percent of representatives of the extinct world. Thus, a tourist interested in palaeontology can make an important discovery that may change or complement our knowledge of the organic world in the geological past. We have to encourage this.

Fossils cannot always be extracted from rocks in an easy fashion. If there is a problem with this, and the discovery appears valuable, it is better not to risk destroying it, but rather to notify a competent institution. We should not try to extract from hard rocks anything that can be of great importance to science, which may break into pieces, or crack at the blow of a rock hammer.

When entering the active quarry, permission from its management is always required, especially since the operation of some quarries is carried out using explosives. We should also remember to be particularly careful when penetrating active, abandoned and vertical walls of exposures. It is best to get a helmet in such cases.

Let us also remember that fossils cannot be collected without proper permission in areas of nature reserves, national parks and inanimate nature monuments. This is forbidden by law.

Unfortunately, the vast majority of fossils go through the hands of people who are unaware of the importance they may have for science. The number of miners, stonemasons and other people processing rocky material is far greater than the number of scientists studying life on Earth. Hence, many of the most important findings are often lost to science. We should try to prevent this by making everyone aware of the importance of fossils and of what they tell us about the history of the Earth.

At this point, we have to appeal to the Reader to remember that also he or she can contribute to the significant increase of our knowledge about the history of life on Earth by collecting fossils. It is important to pay attention to the fossils that are different from the "ordinary" and well-known forms in the rocks of a given age. We should try not to destroy them, but visit competent persons who will be able to evaluate their scientific value. Through this, we can become a participant in an important discovery and go down in history of science. It is of particular significance to search for the missing intermediate forms in the evolutionary chain. Secondary school students can ask for help from geography or biology teachers. There are also scientific centres in various cities, primarily higher education institutions, which have geological, geographic, biological or environmental protection departments. Appropriate departments in the Voivodeship Offices or Marshal Offices would also provide assistance. Finally, there are specialised scientific or museum centres, such as the Polish Geological Institute in Warsaw, which has six regional branch offices, the Institute of Palaeobiology of the Polish Academy of Sciences, the Institute of Geological Sciences PAS, or the Museum of the Earth PAS. Assistance would certainly be offered by regional museums in many cities. These may be the first step on the path to an important scientific discovery. Let us also remember that, according to geological and mining laws, important discoveries of fossils should be reported to the appropriate voivodeship authorities.

Conclusions

It seems that palaeontological tourism has a chance to become a more widely practiced type of geotourism. This is favoured by the presence of numerous fossil sites, by the easy access to many of them, and due to the natural desire, especially among young people, to unveil secrets. Palaeontological geotourism is certainly of great educational value, as it fosters the development of knowledge about the past of our country's land recorded in stone. Undoubtedly, it requires an increase in the amount of publications targeted to a wider audience, in which the tourist will find exhaustive information about where and what to search for to get into the mysterious past from millions of years before. This creates a huge role for researchers, especially palaeontologists, to bring the worlds of the past to all those interested. Such activity should certainly be as much appreciated as scientific activity.

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The influence of lithology and tectonics on the development of the karst landscape in the Dong Van Global Geopark, NE Vietnam

Wpływ litologii i tektoniki na ukształtowanie krajobrazu krasowego Geoparku Dong Van, NE Wietnam

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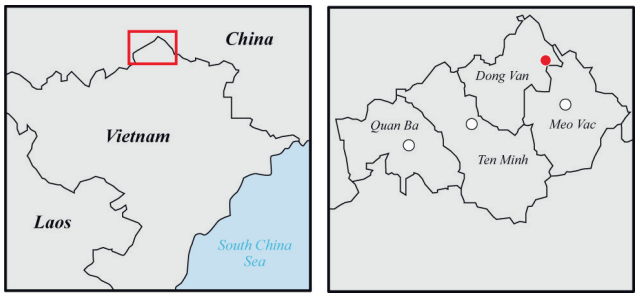

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Abstract: *The Dong Van Karst Plateau Geopark is located in the mountainous area of the northern part of Vietnam. It became the 77th member of the Global Geoparks Network in 2010. The Dong Van Karst Plateau Geopark is a unique combination of breathtaking scenery and culture of ethnic groups, with many potential values such as its geoheritage, biological diversity and historical places, which attract many domestic and foreign visitors. Up to 60% of the area of this geopark is covered by karst. Its topography is strongly dissected by deep river gorges with steep slopes, and this area has experienced several deformational phases from the Middle Cambrian/Early Ordovician, to the Cenozoic. These elements contributed to the breathtaking scenery of the Dong Van Karst Plateau Geopark, the first global geopark in Vietnam and the second in South-East Asia.*

Key words: *Dong Van Global Geopark, karst geomorphology, ethnic groups, sustainable development*

Treść: *Geopark Dong Van Karst Plateau położony jest w górzystym rejonie północnej części Wietnamu. W 2010 roku, jako 77 geopark, dołączył do Światowej Sieci Geoparków (Global Geoparks Network). Wyjątkowość krajobrazu Geoparku Dong Van Karst Plateau wynika z obecności form rzeźby krasowej, jak również geodziedzictwa, różnorodności biologicznej i historycznej miejsc. Przyciąga on wielu krajowych i zagranicznych turystów. Istotne jest również, że zamieszkują tu różne grupy etniczne. Obszary krasowe silnie rozcięte głębokimi dolinami rzek o stromych stokach zajmują 60% powierzchni geoparku. Teren ten został poddany kilku fazom deformacyjnym, trwającym od środkowego kambru/wczesnego ordowiku do kenozoiku. Powyższe elementy tworzą wspólnie obecny charakter krajobrazu Geoparku Dong Van Karst Plateau, pierwszego światowego geoparku w Wietnamie i drugiego w południowo-wschodniej Azji.*

Słowa kluczowe: *Geopark Dong Van, rzeźba krasowa, grupy etniczne, zrównoważony rozwój*

Introduction

The Socialist Republic of Vietnam is a country located in South-East Asia, bordered by the ocean on the east and south, China on the north and Cambodia and Laos, on the west. With the area of 329,000 km^2, it has about 93,7 million inhabitants. Hanoi is the capital city of Vietnam, located in the central part of the Red River Delta, where Ho Chi Minh published the Independence Declaration on September 2nd, 1945.

Until now, Vietnam was sometimes still imagined through the lens of war by many foreigners, but in reality, we cannot deny that it is a beautiful country with natural landscapes and peaceful life. It has been over four decades since the official unification of the country and two decades since the end of the US trade embargo imposed on Vietnam. People in this Far-East country have done appreciable work. Obviously, Vietnam is a specific recommendation among travel destinations. With a 3,260 km long coastline and hundreds of river mouths, and wetlands, thousands of diversed islands and coral reefs, as well as a huge area of the marine region and continental shelf, Vietnam has a high potential of geoheritage and very good prospect for creation of a geopark and geotourism development (Pham *et al.*, 2000).

Tourism was not recognized as an important position in the business plan in the past, but it has become the current trend in Vietnam, satisfying both physical and mental needs of humans (The Political Bureau of the Party Central Committee of Vietnam, 2017). According to the statistics of the World Bank and the Vietnam National Administration for Tourism, the number of tourist arriving in Vietnam has increased significantly from 1,315,000 in 1995 to 10,013,000 in 2016, whereas the total international arrivals in the first 10 months of 2017 reached 10,473,230; meaning an increase of 28,1% in comparison with the same period of 2016 (www1). Chinese tourists account for the largest number of arrivals – 30.99% in total and Koreans take the second place with 18.46%.

Geological research activities applied to geotourism and geoheritage of Vietnam were started in the first decade of the 21st century by geoscientists. Several papers were published during this period (Deharveng *at al.*, 2004; Krobicki *et al.*, 2006; Pająk *et al.*, 2006). The most popular geotouristic objects are Ha Long Bay, Sapa, Lam Vien Plateau, Lan Ha Bay, Trang An complex landscape and Da Nang city.

With the support from the government and foreign organizations, some initial but noteworthy successes in setting up geoparks, and planning the geoconservation sites have been achieved, especially in the northern part of Vietnam. The Dong Van Karst Plateau Geopark (DVKP) became the 77th member of the Global Geoparks Network on October 10th, 2010. It became the first Global Geopark in Vietnam, and the second one in Southeast Asia (www2).

Methodology

The field trip was carried out with the support from the Department of Marine Geology, Faculty of Geosciences and Geoengineering, Hanoi University of Mining & Geology, Vietnam. The trip route was created based on the distribution of geosites and geological boundaries. The infrastructure of geosites was evaluated and documented based on the data provided by the Hanoi University of Mining & Geology and the Vietnam Institute of Geosciences and Mineral Resources of the Ministry of Natural Resources and Environment. Documentation management and literature study were carried out at the Department of General Geology and Geotourism, Faculty of Geology, Geophysics and Environment Protection, AGH University of Science and Technology in Kraków, Poland.

The Dong Van Karst Plateau Geopark

The foundation history

The Dong Van Karst Plateau Geopark (DVKP) is located in Ha Giang, the mountainous and northernmost province of Vietnam, about 431 km to the north of Hanoi. Sharing borders with China to the north (Fig. 1), Cao Bang province to the east, Lao Cai province to the west and Tuyen Quang to the southeast, the DVKP covers an area of 2,350 km^2, with 253,864 residents in four districts: Meo Vac, Dong Van, Yen Minh and Quan Ba, which equals 29.6% of the area and 35.8% of the population of the Ha Giang province. Its average elevation is 1,400–1,600 meters a.s.l., varying from 174 m a.s.l. to 2,265 m a.s.l. The climate of the DVKP has two seasons: rainy and dry. Up to 60% area of the DVKP is covered by karst, thus, it is the largest karst area in comparison with other regions of Vietnam.

Attempts to find a new, interdisciplinary approach to sustainable development and conservation of the area were actually started in 2001, with the first Belgian-Vietnamese speleological expedition, which led to the development of the VLIR (Flemish Interuniversity Council) Own Initiative project entitled: *Integrated capacity building through research-based geopark development in Northeast Vietnam* (2007–2012). This project was soon accompanied by a state-funded research project entitled: *Assessment of geoheritage potential and recommendation for geopark establishment in North Vietnam* (2007–2010), implemented by the same group of scientists from the Vietnam Institute of Geosciences and Mineral Resources (VIGMR) (Tran T.V. *et al*., 2011).

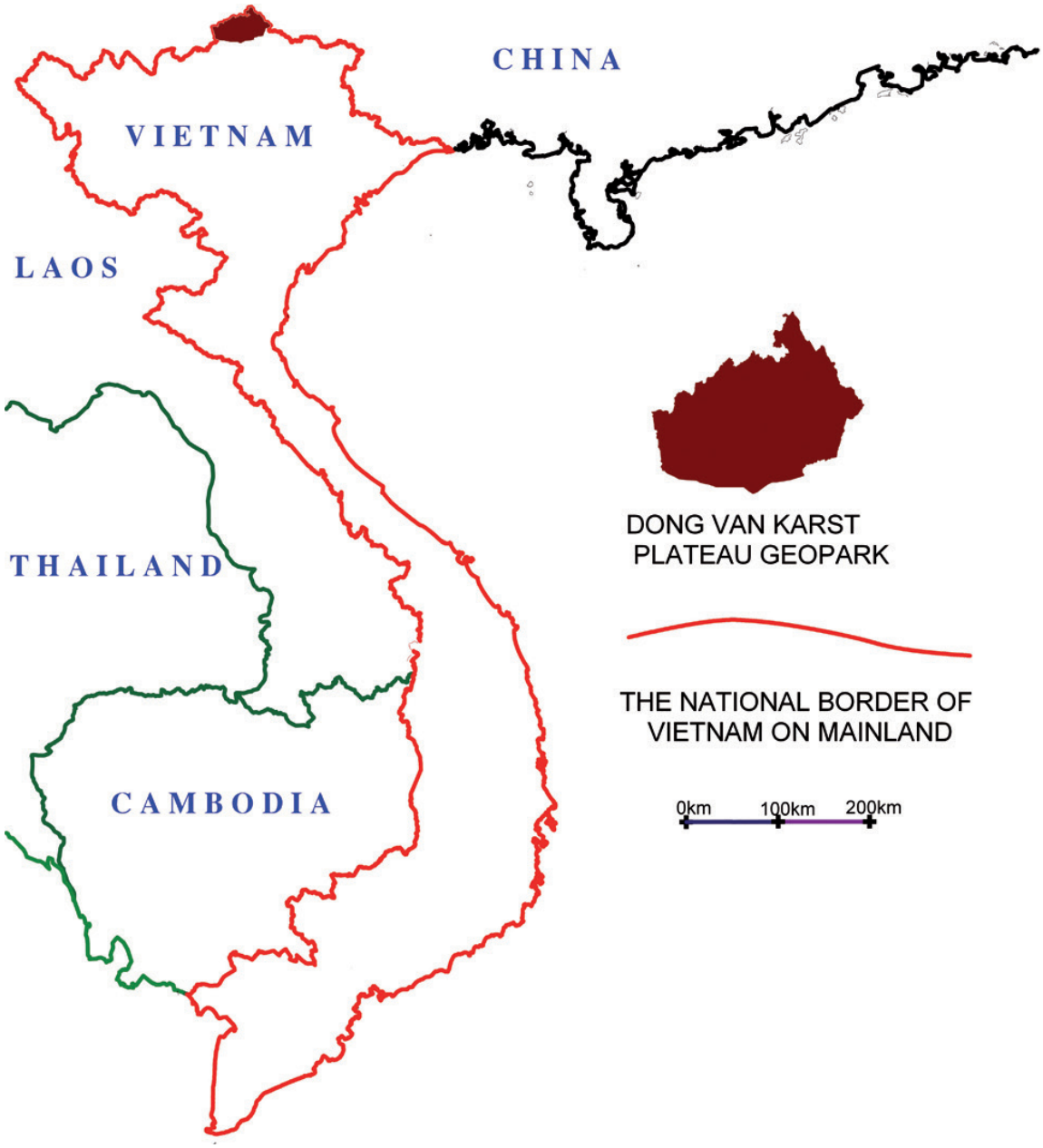


Fig. 1. The location of the Dong Van Karst Plateau Geopark (according to the Ministry of Natural Resources and Environment of Vietnam, 2016)

In September 2009, the International Workshop on the establishment of the DVKP was co-organized by the Ha Giang Province People's Committee, the VIGMR and the Vietnam UNESCO Natcom. Then, the Decisions No. 4844/QD-UBND, 4845/QD-UBND and 4846/QD-UBND were published by the local authority on November 19th, 2009, in order to set up the DVKP, its Steering Committee and its Management Board, and to verify the development plan for the DVKP for the next few years. As a result, the DVKP has become the first geopark in Vietnam. In summary, the DVKP became the 77th member of the Global Geoparks Network on October 3rd, 2010 (www2).

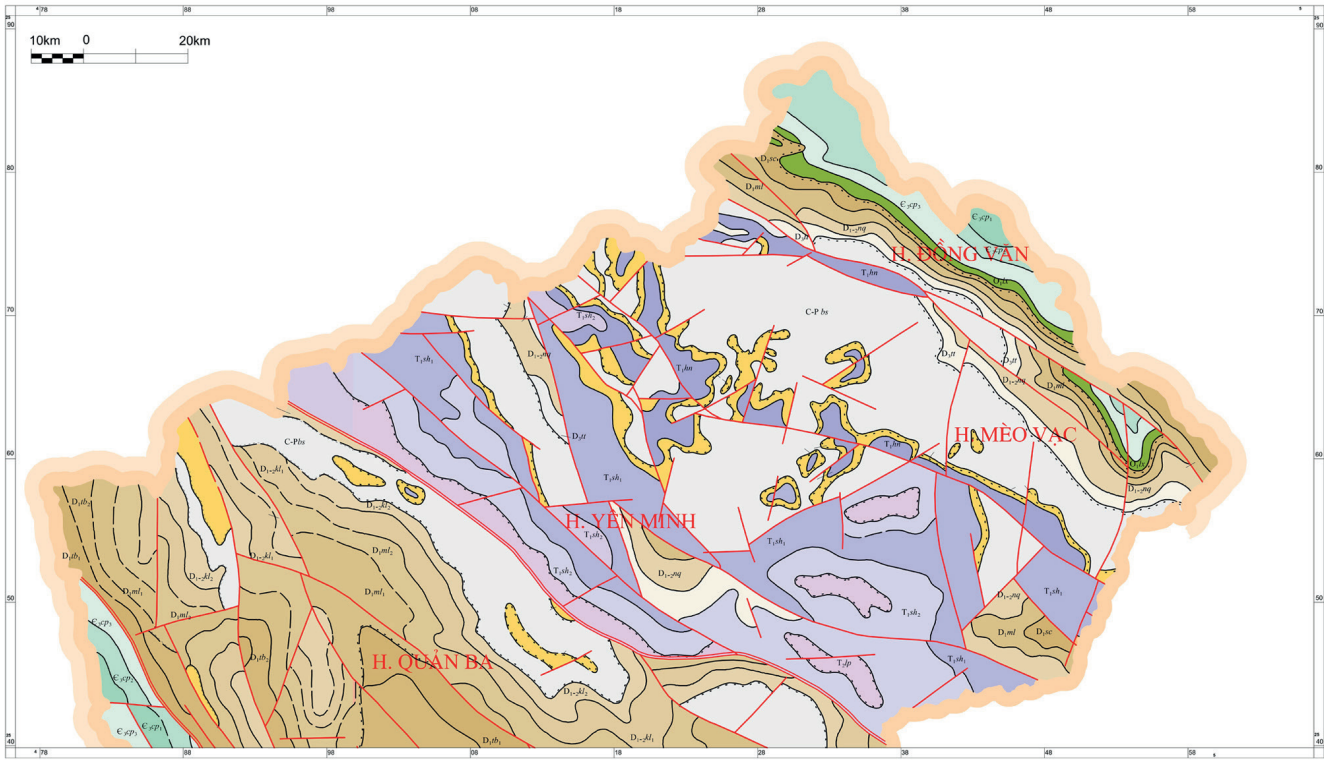
The DVKP (Fig. 2) is a unique combination of breathtaking scenery and culture of ethnic groups, with many potential values such as geoheritage, including fossils, biological diversity and historical sites, which attract many domestic and foreign visitors. Especially, the community of 17 ethnic groups inhabiting the DVKP area contributes to engaging tourists in visiting features of this area in the form of traditional ethnic group performances and handmade crafts. It is believed that the geopark model will be the optimal solution to balance economic development and conservation in this area.

Fig. 2. The welcome panel of Dong Van Karst Plateau Geopark, photo Dao Quoc Bao

Karst geomorphology of the Dong Van Karst Plateau Geopark Geology and tectonic evolution

The first geological investigation of the Dong Van Karst Plateau was carried out by a French geologist G. Zenin and his team in 1907 (Nguyen, 2011). Until now, several geological investigations have been completed by both Vietnamese and foreign scientists, providing in-depth knowledge about the geological characterization of the DVKP (Fig. 3). This area is divided into seven stages of geologic evolution: 1) Middle Cambrian-Early Ordovician, 2) Middle Ordovician-Silurian, 3) Devonian-Early Carboniferous, 4) Early Carboniferous-Middle Permian, 5) Late Permian-Late Triassic, 6) Jurassic-Cretaceous, and 7) Cenozoic (Tran T.V. *et al*., 2011). From the paleogological point of view, 19 fossil groups have been found in the DVKP: 1) brachiopods; 2) tabulate corals; 3) rugose corals (Tetracoralla); 4) stromatoporoids; 5) trilobites (Fig. 4); 6) paleofish; 7) foraminifers; 8) tentaculites; 9) conodonts; 10) pelecypods; 11) gastropods; 12) cephalopods; 13) bryozoans; 14) crinoids; 15) ostracods; 16) crustaceans; 17) paleoflora; 18) algae; and 19) chitinozoans (Tran T.V. *et al.*, 2011).

The oldest known rocks in the DVKP include marly shales, clayey shales, oolithic limestones, cherty limestones and limestones deposited under the continental margin condition and quiet tectonic regime during the Middle Cambrian-Early Ordovician (Nguyen, 2011). The Middle Ordovician-Silurian sedimentary rocks are absent from this region, but the surveying data of neighbouring areas show that from this stage (app. 470–415 Ma ago) sedimentary basins developed between the orogenic belts, as a result of the strong regional differentiation all over the South China plate (Tran T.V. *et al.*, 2011). During the Devonian-Early Carboniferous stage (app. 415–360 Ma ago), there was a strong lateral differentiation of sedimentary environments that formed several types of sedimentary rocks. These deposits unconformably cover the older rocks and contain an abundance of fossils: paleofish, paleoflora, brachiopods, gastropods and ostracods of the Early Devonian (Lochkovian) age (La *et al*., 2011). The Lower Devonian rocks comprise mottled calcareous siltstones, shales and micaceous sandstones deposited in the coastal sedimentary environment, with continental contribution exposed in a narrow band along the outcrops of the older rocks. The red and yellow shales and clayey limestones are distributed along the northern and southeastern margins of the DVKP, whereas the black limestones with siliceous and calcareous shales occur along the northern margin of the Geopark (Tran T.V. *et al*., 2011). During the Late Devonian-Early Carboniferous period, the thin bedded limestones, clayey limestones and siliceous shales were formed in the form of belts surrounding the Carboniferous-Permian limestone massifs.



Q	**Undivided Quaternary**	sand, pebble, granule, clay
T_2lp	**Lan Pang Formation**	clay shale, sandstone, tuffaceous sandstone
T_1sh_2	**Song Hien Formation** – **Upper Subformation**	tuffaceous sandstone, clay shale, sandstone
T_1sh_1	**Song Hien Formation** – **Lower Subformation**	marlaceous shale, siltstone, calcareous sandstone
T_1hn	**Hong Ngai Formation**	marl, oolitic limestone
$P_2đđ$	**Dong Dang Formation**	bauxite, coaly shale, cherty clayey limestone
C-P *bs*	**Bac Son Formation**	massive limestone, oolitic limestone, clayey limestone
D_3tt	**Toc Tat Formation**	red-veined limestone, cherty limestone
$D_{1-2}kl_2$	**Khao Loc Formation** – **Upper Subformation**	clayey limestone, limestone
$D_{1-2}kl_1$	**Khao Loc Formation** – **Lower Subformation**	quartz sericite-chlorite schist, quartz feldspar- mica schist
O_1lx	**Lutxia Formation**	marlaceous shale, limestone
$\in_3cp_3$	**Chang Pung Formation** – **Upper Subformation**	limestone, oolitic limestone
$\in_3cp_2$	**Chang Pung Formation** – **Middle Subformation**	oolitic limestone, cherty limestone, marlaceous shale
$\in_3cp_1$	**Chang Pung Formation** – **Lower Subformation**	clay shale, marl, oolitic limestone
$\in_2hg_2$	**Ha Giang Formation** – **Upper Subformation**	marble, motley limestone, clayey limestone
$\in_2hg_1$	**Ha Giang Formation** – **Lower Subformation**	coaly shale, cherty shale, actinolite schist, manganese-bearing cherty limestone
$D_{1-2}nq$	**Na Quan Formation**	marble, cherty shale, cherty limestone
D_1ml_2	**Mia Le formation** – **Upper Subformation**	sandstone, siltstone, clay shale, marlaceous shale
D_1ml_1	**Mia Le formation** – **Lower Subformation**	black-grey sandstone, greenish-grey clay shale
D_1sc	**Song Cau Group**	conglomerate, sandy siltstone, clay shale, marl
D_1pp_2	**Pia Phuong Formation** – **Upper Subformation**	sericite schist, quartzitic sandstone
D_1pp_1	**Pia Phuong Formation** – **Lower Subformation**	clay sericite shale, black bituminous claystone, phyllite
D_1tb_2	**Tong Ba Formation** – **Upper Subformation**	limestone, quartz porphyry, orthophyre, iron ore seams
D_1tb_1	**Tong Ba Formation** – **Lower Subformation**	limestone, cherty shale sericite schist, trachyte, porphyritic felsite
QUAN BA DISTRICT	Location of the administration	
	The Vietnam - China border	
a b	Geological boundary: a- Accurate; b- Supposed	
a b	Non - classified faults: a- Accurate; b- Supposed	
a b	Unconformable boundary: a- Accurate; b- Supposed	
a b	Deep-seated fault: a- Accurate; b- Supposed	

Fig. 3. The geological map of DVKP (after Hoang, 2010)

Fig. 4. Commemorative plate placed where trilobite fossils (500 Ma) – the most ancient of DVKP Geopark were found (Lung Cu village, Dong Van District), photo Dao Quoc Bao

The shallow marine deposits, 1,000–1,200 m thick, representing the Early Carboniferous-Middle Permian stage (app. 360–260 Ma ago) are divided into two successions: lower (dolomitic limestones and dolomites) and upper (grey, light-grey, fine- to coarse-grained, fossiliferous limestones). Several fossils: foraminifers, corals and brachiopods were indentified within this sequence. This type of sedimentation has continued during the Late Permian-Early Triassic stage (app. 260–245 Ma ago). In the Late Permian, bedded limestones, clayey limestones, siliceous limestones, and calcareous cherts were formed. These sediments were overlain by the Lower Triassic thin-bedded clayey limestones, calcareous shales, dolomitic limestones and oolithic limestones in the northern part of DVKP, and by variegated shales, siltstones, sandstones, calcareous shales with effusive and tuffaceous intercalations in the remaining part. The youngest Upper Triassic sediments were formed in the shallow continental shelf environment and include basal conglomerates, sandstones-gritstones, siltstones, and shales. The Jurassic-Cretaceous rocks were not evidenced due to the lack of outcrops, although magmatic activity (app. 200–65 Ma ago) took place in the whole Northeast Vietnam during this period (Tran T.V. *et al.*, 2011; Tran, 2009).

In terms of tectonic evolution, this area belongs to the northeastern part of Vietnam, where rocks were deformed during several tectonic phases lasting from the Middle Cambrian-Early Ordovician to the Cenozoic (Tran T.H. *et al.*, 2011). The Cenozoic was the most important era that contributed to the unique geomorphology of the DVKP landscape and created favorable conditions for development of karst landscape by the uplift of limestone terrains and the rejuvenation of ancient faults and fracture zones (Pham, 1985).

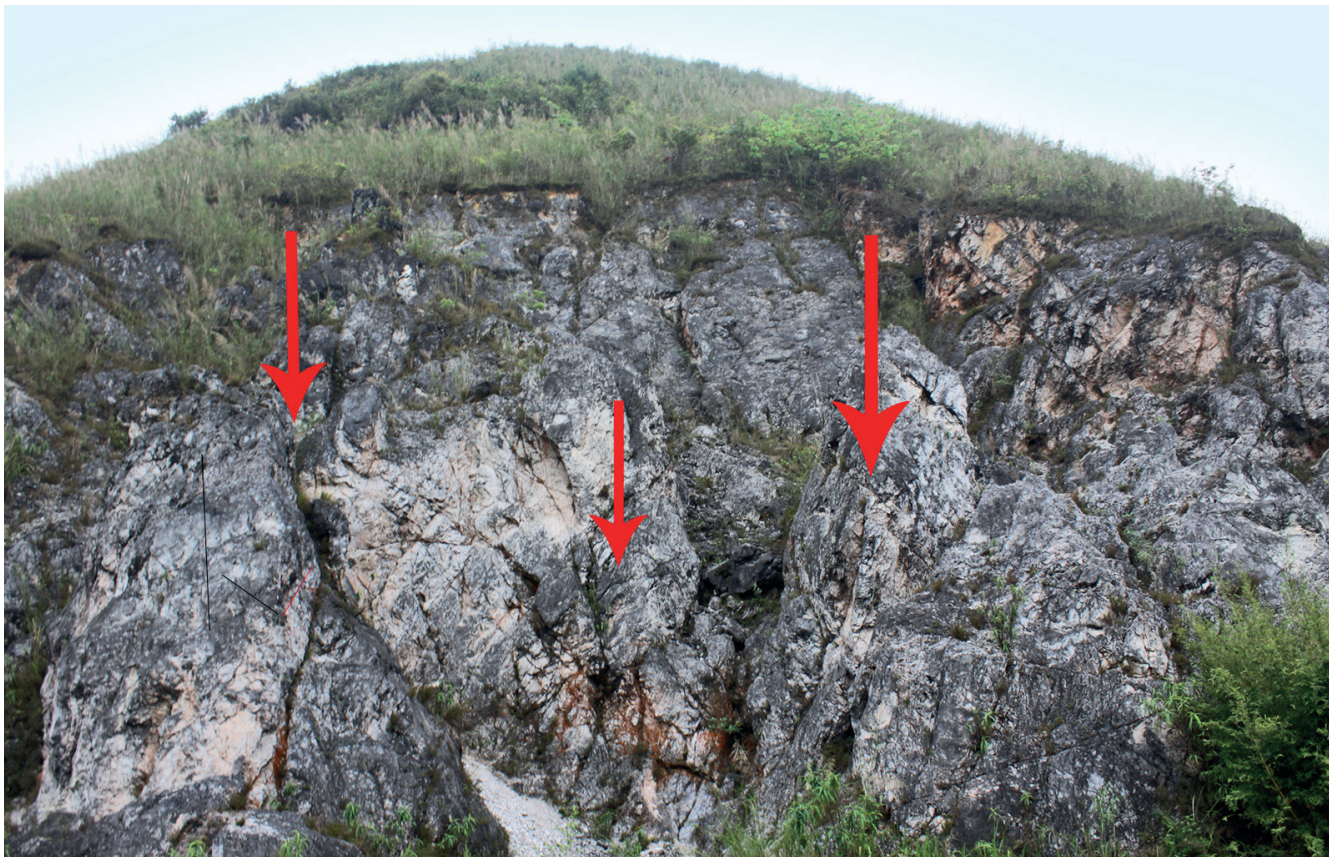


Fig. 5. The fault mirror (slickenside) and deeply crushed limestone zone at Quan Ba district, photo Dao Quoc Bao

The regional structural pattern was affected by the NW-SE-striking fault system, and was a result of the collision between the Indian and the Eurasian crustal plates, which led to the uplift and the erosion (Tran T.H. *et al.*, 2011). Full-scale geological research of this area was carried out by the cooperation between Belgium and Vietnamese geologists, bringing an overview of DVKP tectonic evolution. Hence, the study area was separated into 3 main parts: Song Gam (Gam River); Song Hien and Lung Cu, separated by two major faults; the Song Gam Fault (in the SW) and the Ma Lau-Dong Van-Lung Thang Fault (in the NE). The noteworthy faults in the Geopark area are: the Nho Que Fault and the Quan Ba-Huong Cha Fault. The Nho Que deep, dextral, strike-slip, NW-SE--directed fault extends along the Nho Que River, from Chu Sa to Sika, over about 40 km. It provided favorable conditions for circulation of groundwater, which generated local erosion in the Meo Vac district (Vu & Batelaan, 2011).

The NW-SE-striking Quan Ba-Huong Cha Fault, cutting through Devonian limestones, produced a deeply crushed zone that could be observed in the Quan Ba district, which facilitated the weathering processes in limestones. This was the latest phase of neo-tectonic activity in the DVKP.

The steep fault surface at Quan Ba (Fig. 5) and the Tam Son fault surface (Fig. 6) indicate the strike-slip movement during the formation of the fault and represent evidence of the Quan Ba – Huong Cha fault. The surfaces of both the Quan Ba and the Tam Son faults are covered with red iron oxides resulting from the circulation of meteoric waters in the fault zone.

Fig. 6. The fault surface at Tam Son town, photo Dao Quoc Bao

Karst landforms and processes

Carbonate rocks cover up to 60% of the area of the DVKP (Fig. 7), mainly in both the Dong Van and the Meo Vac districts. From a topographical point of view, the DVKP relief is strongly dissected by deep river gorges of steep slopes. Thus, it is subjected to severe erosional and denudation processes and rarely covered with topsoil layer (Tran T.V. *et al.*, 2004). According to data after the Vietnam Institute of Geosciences and Mineral Resources, nearly 100 karst caves have been discovered in the DVKP up until now. Both the karst caves and the sinkholes in the DVKP were classified into four groups, considering the elevations of their entrances: 300–600, 600–900, 900–1,200 and 1,200–1,500 m a.s.l respectively.

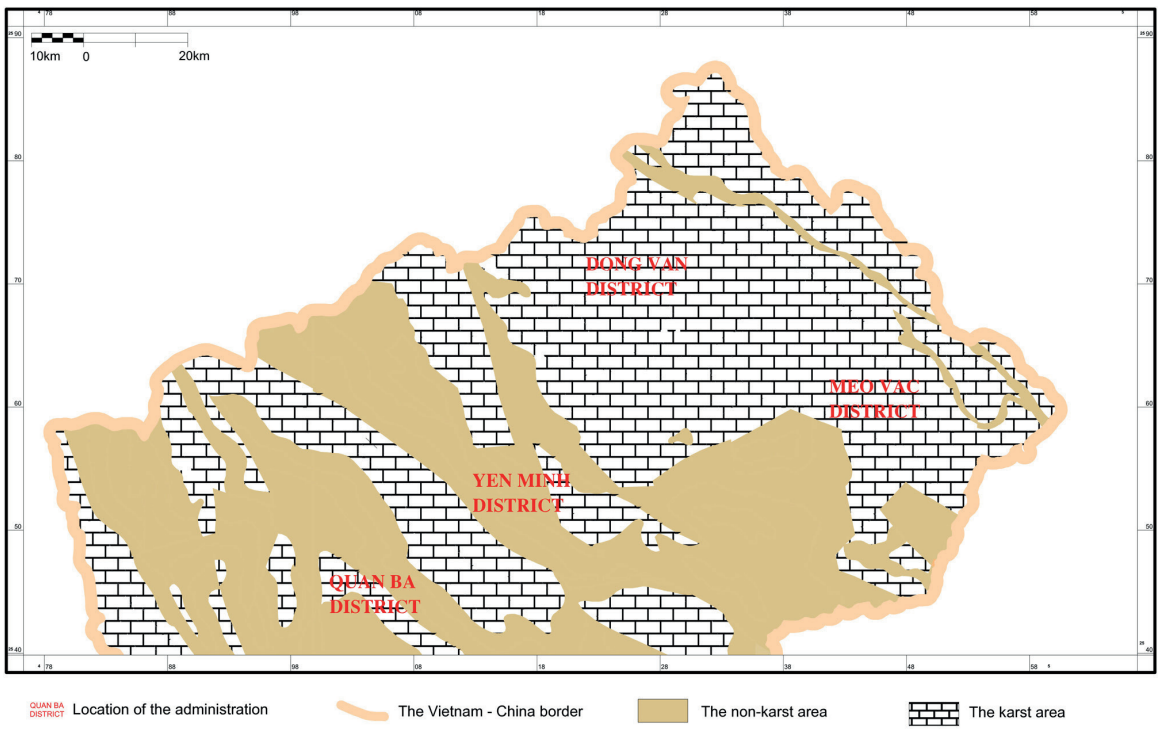


Fig. 7. Distribution of the karst area in DVKP (after Hoang, 2010)

The elevation group that has the highest density of caves is 300–600 m, and the average density of sinkholes per 1 km^2 is 1.4. The DVKP relief comprises slopes with inclinations: 5°–15°, 15°–30° and 30°–45°, accounting for 53.9%, 21.9% and 16.5% of the study area, respectively (Pham *et al.*, 2013). The DVKP area belongs to the karstified regions of the northeastern Vietnam. In summary, this area experienced the same tectonic events as all karst areas in the northeastern part of the country.

The results of recent geological research show that all the rocks in the northeastern part of Vietnam experienced multiple phases of tectonic events under ductile, brittle-ductile and brittle strain conditions (Tran T.H. *et al.*, 2004; Nguyen, 2005; Nguyen, 2006; Tran & Vu, 2009). Between the Middle Paleozoic and the Cenozoic, three major tectonic events had happened in this area (Tran T.H. *et al.*, 2011).

The strongest regional tectonic event widely recognized in Vietnam and in southern China took place during the Ordovician/Silurian period (Faure *et al.*, 2009; Tran, 2009). It led to both the uplift and the erosion of carbonate successions, not only in the DVKP, but in the whole of northeastern Vietnam, and produced the thrust zone and fold systems, that deformed the carbonate rocks (Tran T.H. *et al.*, 2011). During the Mesozoic, northeastern Vietnam had been affected by crustal plate collisions and terranes accretion, which formed the proto-southeastern Asia (Hutchison, 1989; Metcalfe, 2005). As a result, carbonate rocks in this area were deformed by widespread, ductile to brittle-ductile, thrust/reverse shearing and associated folding (Tran T.H. *et al.*, 2011). During the last major tectonic event in the Cenozoic, carbonate rocks had been crushed, by brittle, reverse, normal and strike-slip faulting, and extensive fracturing, by the post-orogenic and intra-continental tectonic activities (Tapponnier *et al.*, 1990; Searle, 2006; Tran & Vu, 2009). In addition, the DVKP is located in a transition zone from the Yunnan Plateau in Southern China, of the elevation 3,000 m a.s.l. to the strongly differentiated mountainous area of northeastern Vietnam located at lower elevations (Tran T.V. *et al.*, 2011). In the W-E direction, it is the transition zone from the Song Chay dome-like uplifted block (3,000 m a.s.l.) to Bac Son-Ha Lang zone located at 1,000 m a.s.l. (Tran T.V. *et al.*, 2011). The thrust/reverse shear, fold and fault zones in the DVKP, which resulted from numerous deformations, play an important role in the circulation of both the groundwaters and surface waters, which influence the karst morphology (Tran T.H. *et al.*, 2011).

Due to the joint action of lithostratigraphic and tectonic factors, the voids within the carbonate bodies became enlarged facilitating the circulation of groundwaters, which gave rise to the erosion and dissolution of crushed carbonate rocks. Hence, caves and sinkholes were formed. The groundwater in this region is at different depths, varying from 18–25 to 80 m deep at Quan Ba, especially at Meo Vac district, where groundwater is observed at 700–800 m deep (equivalent to local base level of the Nho Que River). Results of geophysical measurements and exploration drilling conducted in this zone indicate that karstification develops from the surface (Nguyen *et al*., 2013). In Yen Minh and Quan Ba district, the groundwaters supply the Mien River. In Dong Van and Meo Vac district, the ground waters mainly supply the Nho Que River.

Exogenous processes, supported by tropical mountain conditions, strongly adjust the uplifted areas, leading to the slope surfaces and cliffs of different types (tectonic, erosion, erosion-denudation, gravity, e.g. many varieties of cuesta landforms) and accumulative reliefs (river bed, floodplain, and lake deposits). Otherwise, karst landforms are extremely variable and well-symbolized in all kinds of carbonate rocks (peak-cluster cones, karst depressions, caves, blind valleys, sinkholes and underground rivers, travertine terraces, karst pediments, epikarst, residual and rejuvenated karst) (Tran T.V., 2011). Previous studies also show that there are two types of topographic developments in the DVKP. The first topographic type, distributed in a NW–SE direction, was formed by tectonic movement and influenced by major faults. The second, distributed mainly in a NE–SW direction, was formed by exogenous geomorphological processes and also affected by major faults. Geological analysis indicates that ten stratigraphic formations crop out in the study area, but only six of these have correlations with karst landscapes (Pham *et al.*, 2013).

Having a variety of geological structures, embracing a variety of carbonate rock types, and experiencing multiple phases of tectonic evolution and slope erosion (Fig. 8), the DVKP has a spectacular karst landscape. The geosites in the DVKP were classified into four main types: 1) geomorphological; 2) structural-tectonic; 3) stratigraphic–paleontological–lithological paleoenvironmental; and 4) karstic (La *et al*., 2011). Typical geosites that were classified into geomorphological types are: The Thach Son Than erosional monadnock (Fig. 9), the "rock deserts" (Vietnamese nomenclature) (Fig. 10), the karst cones known in Vietnam as the "Fairy Bosom" Mountains at Heaven's Gate (Fig. 11) and the karst canyon of sub-meridian direction (Fig. 12). The Thach Son Than erosional monadnock is an isolated surviving erosion rock that stands above the surrounding area. "Rock desert" is a sort of landform that is rarely seen elsewhere; hence it could be quite scenic to tourists. The karst cones known as the "Fairy Bosom" Mountains at Heaven's Gate resulted from tectonic activities and washing away processes. The limestone was extremely crushed into powder by the fault and then was washed away, resulting in very soft and gentle relief. The karst canyon of sub-meridian direction is the outcome of strongly dissected relief.

Fig. 8. Karst erosional valley developed within a slope on the Na Khe pass, photo Dao Quoc Bao

Fig. 9. The Thach Son Than erosional monadnock, photo Dao Quoc Bao

Fig. 10. Limestone ribs and the bare limestone rocks called "rock deserts" in Dong Van district, photo Dao Quoc Bao

All these geomorphological-type geosites resulted from the combined action of weathering processes, different susceptibility of rocks to erosion, deeply dissected relief and dissolution or washing down limestones by seasonal flows (Tran T.V. *et al.*, 2011). Meanwhile, the surface of Quan Ba-Huong Cha Fault (Fig. 5) is a structural-tectonic geosite and the geosite where trilobite fossil (500 Ma) was found. This most ancient trilobite fossil in the DVKP Geopark represents the stratigraphic–paleontological–lithological-paleoenvironmental type.

The karst landscape in the DVKP is important not only for studies on karst processes, but also for tourist inspiration. The road crosses a hogback, the view from the Ma Pi Leng Pass (Fig. 13), and the slopes in Quan Ba district (Fig. 14) are good stopover stations to enjoy the gorgeous scenery of the DVKP.

Fig. 11. Karst cones known as the "Fairy Bosom" Mountains at Heaven's Gate, photo Dao Quoc Bao

Fig. 12. The Tu San Canyon of sub-meridian direction, photo Dao Quoc Bao

Fig. 13. View from Ma Pi Leng Pass to Nho Que river, photo Mai Phuong Nguyen

Fig. 14. The slopes in Quan Ba district, photo Dao Quoc Bao

Geoconservation in the geopark

Sustainable development is a central goal in geotourism, and to be sustainable, it needs to be carefully planned and managed. In accordance with the current trends, tourists intend to visit natural sites (Newsome & Dowling, 2010). This is an opportunity and an advantage of the DVKP to become an international tourist attraction. This can only be facilitated by sustainable geotourism development and geoconservation planning. The regional planning and development approach, which is an effective way of management for the DVKP is the Prime Minister's Decision No. 2057/QD-TTg: Approval of the comprehensive planning on tourism development of Dong Van Karst Plateau Geopark, Ha Giang province till 2025 with a vision to (www3). This plan aims to preserve and exploit the natural (including geological) and cultural resources in the DVKP for sustainable geotourism development.

The Management Board, which controls this plan is located in the city center of Ha Giang, and four other regional information centers were built in four districts: Dong Van, Quan Ba, Yen Minh and Meo Vac, in order to provide information and services and recommend the attractions to the tourists and students, both the domestic and foreign investors. The Management Board is a non-commercial unit under the control of the People's Committee of the Ha Giang Province, composed of one head, two deputy heads and three departments: the Department of General Admission, the Department of Heritage and Service Management and the Department of Information & Foreign Affairs, which are responsible for advising the People's Committee on the implementation of management, preservation, exploitation and promotion of the values of the Geopark, supporting the socio-economic development and contributing to poverty reduction in this area. The regional center in Dong Van district also includes a museum, which has a collection of regional rocks, fossils, publications about the geopark and historical antiques of local people living in the Dong Van Karst Plateau. Tourists can also get free copies of geological maps and leaflets and free Internet connection. The other regional centers in three remaining districts educate about famous sites and details of geological settings of each district.

The geoconservation strategies of the DVKP comprise the following elements: natural habitat protection, geosite protection and cultural conservation. In terms of natural habitat protection, two nature reserve forests named Du Gia (Yen Minh district) and Bat Dai Son (Quan Ba district) have been set up within the DVKP by the authorities of the Ha Giang province. Rare species of regional plants and animals occur there, for instance: *Taxus chinesnis* (Chinese yew) Rehder, *Pinus kwangtungensis* (Chinese White Pine) Chun ex and *Tsuga chinensis* (Chinese Hemlock) Pritzel ex Diels (Hoang *et al.*, 2016). Geosites are distributed within the whole DVKP. Until 2010, 139 geosites had been discovered (La *et al.*, 2011). The authorities of each district are responsible for controlling and protecting the geosites. The People's Committee of Ha Giang Province has declared an incentive policy to encourage both the foreign and domestic investors and provide the tax benefits to companies or groups which invest in geoconservation. All the DVKP is under a high level of protection. Every construction in this area needs an environmental impact assessment report to obtain a building license.

The educational, cultural and promotional activities in the Dong Van Karst Plateau Geopark

The Dong Van Karst Plateau is also famous for particular types of buckwheat. Numerous buckwheat fields are grown by local people with the financial support from the state budget and technical support from several associations. November is the best time for buckwheat flowering (Fig. 15), creating a wonderful scene – the roads and the mountains are covered by the white and pink flowers. Since 2015, "The Buckwheat Festival" has been organized annually that lasts for a month, starting from the early November till December, in order to encourage the preservation and development of ethnic cultures and create more jobs for the local population (www4).

Cultural activities are important elements of the conservation plan in the DVKP. In this area, 17 ethnic groups live together, bringing a unique architecture to this area. They trade goods together in a special fair (Fig. 16) and build a wall from the limestone rocks in the local area (Fig. 17).

Fig. 15. Buckwheat flowering in Yen Minh district, photo Thanh Nam

Fig. 16. Local fair in Yen Minh district, photo Dao Quoc Bao

Fig. 17. The wall made of limestone in Dong Van district, photo Dao Quoc Bao

Fig. 18. Local people building a rock wall for farming to keep water and avoid soil erosion using local material in the Dong Van district, photo Dao Quoc Bao

A cultural and tourism village is going to be built for preserving and promoting the traditional cultural values of the ethnic groups. This will create a venue for them to perform traditional songs and dances, play folk games and develop traditional crafts such as weaving, thus improving their living conditions (www3). Around all the tourist attractions in the DVKP, the local people have permission to run souvenir shops, to provide the local food and homestay services. Although the Ha Giang is one of Vietnam's poorest areas, with a low level of income, education and health service, the local people's perpetual survival is a testament to their indomitable spirits, using rocks to make small dams to keep water and avoid soil erosion. while cutting the sloping plain into a series of platforms, to make farming more effectively (Fig. 18). The authorities expect that the local residents will be able to improve their financial status in their motherland gained from these services and will also conserve their cultural tradition through these activities.

Fig. 19. Educational board describing the "Tam Son Fault Surface" geosite in the area of DVKP, photo Dao Quoc Bao

In terms of educational activity, all these geosites were documented, and each geosite has an information board (Fig. 19) in both English and Vietnamese, in order to provide clear information for tourists and students. Several classes and training courses have been organized for local people to expand their knowledge of the value of these geosites and to prevent any actions resulting in their damage. All of these activities are funded by the state budget. In order to enhance the understanding of Geopark ideas by geoscience students and by local communities, many students prepare scientific research projects concerning the DVKP, supported by universities and state authorities. It is expected that the new generation of geologists will inherit and expand the nature treasures of the DVKP.

Discussion and conclusion

The unique karst landscape of the Dong Van Global Geopark is influenced by the diversity of lithologies and several phases of tectonic evolution, which took place between the Middle Cambrian-Early Ordovician and the Cenozoic. Several karst caves from the total number of 100 caves in this area, together with sinkholes and other valuable objects of geological heritage, which formed due to the combined action of tectonic and erosional processes, represent tourist attractions.

The DVKP is highly rated by scientists for its geoscientific values, unique in the world, with many manifestations of geoheritage that have been formed throughout the last 540 million years. It is a tropical climate mountainous area, but it has the potential to become an international tourist attraction.

In order to raise the DVKP up to a higher level of geopark practice, the authorities still have much to do. This geopark must obtain the strong involvement of the local authorities, state investment and the development of specific concepts and proposals on how to generate a balanced combination of geological solutions, research and promotion solutions as well as the sustainable development of the economy, ensuring a better life for the local people. The development plan should be based on geological knowledge of the region and its inherent values. In parallel, environmental protection activities; training human resources in a professional manner, improving the quality of services and creating more new tourism products could also contribute to the beauty of the DVKP, attracting domestic and international tourists alike.

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Mining tourism and the search for its origins

Turystyka górnicza – w poszukiwaniu początków

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Abstract: *The article defines concepts related to mining tourism and the reasons why some destinations are chosen as the sites of hundreds of thousands of visitors per year, while others are only visited by "regional fans" of mining history. The authors attempt to ask questions, which will be clarified by formulating a better definition and understanding of mining tourism. Issues discussed include marketing and management of mining tourism, as well as tourists' preferences. The article focuses on definitions of different forms of tourism, to ultimately argue that mining tourism is a separate type of tourism. A substantial part of the article is devoted to historical personalities, whose activities and interests in historic mining regions of present-day Slovakia can be considered as the beginnings of mining tourism.*

Keywords: *mining site, mining tourism, historical mining regions, definitions, the origin of mining tourism*

Treść: *W artykule zdefiniowano pojęcia związane z turystyką górniczą i opisano powody popularności niektórych obiektów górniczych, przyciągających setki tysięcy turystów rocznie, w sytuacji gdy inne budzą zainteresowanie jedynie lokalnych miłośników historii górnictwa. Autorzy zadają pytania i próbują znaleźć odpowiedzi, proponując nowe, lepsze definicje pojęć i nowe rozumienie zjawiska nazywanego turystyką górniczą. Omawiane są problemy marketingu i zarządzania w turystyce górniczej. Autorzy przedstawiają też definicje różnych form turystyki i dochodzą do wniosku, że turystyka górnicza stanowi osobną gałąź przemysłu turystycznego. Duża część artykułu poświęcona jest postaciom historycznym, których działalność i zainteresowanie historycznymi okręgami górniczymi na terenie dzisiejszej Słowacji mogą być traktowane jako początek turystyki górniczej.*

Słowa kluczowe: *miejsca eksploatacji górniczej, turystyka górnicza, historyczne regiony górnicze, definicje, geneza turystyki górniczej*

Introduction

The history of exploitation and extraction of raw materials is as old as the human history itself. The beginnings of mining of minerals, especially of stones, can be found in the Stone Age. The mining pits as the first "prehistoric" mines were created after a "rapid" depletion of surface "deposits" in places of the most abundant stone occurrence. Many mining pits have gradually been transformed into small shafts, in which adits had been excavated following the veins of the

mineral's raw material, thus creating the first underground spaces. The well-known and currently frequently sought-after underground mining pits are found in Krzemionka Opatowskych in the Silesian Mountains in Poland, while similar, but slightly smaller pits have been found in Hungary, Austria and the Czech Republic.

The most important destinations of montane tourism, often listed on the UNESCO World Heritage List, have gradually begun to emerge from these first prehistoric mining pits to form ancient and medieval mines. Ancient mines are known, e.g., from Egypt, the Middle East or Spain. Significant medieval mining sites in Europe are concentrated in modern Slovakia, Romania, Czech Republic, Austria, Germany, Spain the United Kingdom,Scandinavia and other countries.

However, we can see a perspective for developing mining tourism in the regions with scattered relics after historical mining. It is a chance for many areas affected by the disappearance of mining activities, with unemployment and lower standards of living in comparison to surrounding regions.Today there is a chance, with the help of mining tourism, as well as geotourism, to give these regions a new economic restart.

Identifying the beginnings of any human activity is always a problem. It depends, above all, on the criteria that define such action. In the article, this is defined by the alchemists, polymaths, scholars, members of the royal and noble families, members of learned societies, and travelers who visited major mining towns and regions, the places of application of new and inexplicable technologies, associated with mining and the production of non-ferrous metals (copper cementation) alike. Their professional and social activities during these journeys are entirely in line with the current modern approach to mining tourism.

Mining tourism

If we divide the term "mining tourism" into two separate words, then paradoxically, we may have more difficulty explaining the term "mining" than "tourism." The reason is that the term mining was historically linked to various activities, technologies, and the relationship of the population to mining.

In prehistoric times, it was primarily about collecting raw materials on the Earth's surface for their further use. Also, all other activities related to raw materials and their processing can be included under the term mining. Even in the next phase, when the collector went from the raw material collection stage to working underground, the term "mining" (in connection with its nowadays presentation in "mining tourism") includes all activities – from prospection up to processing of raw materials and metallurgy.

Over time, a growing share of sophisticated activities became closely related to mining alchemy, natural sciences, but also mining geometry, drawing of mining maps, mining law, mining technology development, water management, forestry, metallurgy, participating of kings, nobility and high clergy in mining, monetagium and acunation, mining and commerce with raw materials and finished products, scientific and cultural activities based on mining activities, the establishment and development of mining schools and universities, the development of energy resources used in mining, occupational medicine, the development of mining communities, arrivals of mining and metallurgical experts into mining regions, gold and silver fever, the emergence of ghost spirits after their departure, the world of fairy tales and mining dwarfs, mining garments. All these and many other elements make up the mining heritage.

The meaning of the second part of the phrase "mining tourism" should not be problematic to explain, mainly if we stick to the economic and logistic attributes of tourism.

An organized form of mass and long-term tourism in underground spaces is conducted in open public caves, or in mining works mass-attended by the public, respecting the visiting rules. These rules are the case concerning organized visits to historic mines in Poland (Wieliczka) (Figs 1, 2), Slovakia (Banská Štiavnica) (Figs 3, 4), Austria (Hallstatt), Germany (Rammelsberg), Bohemia (Kutná Hora), Romania (Salina Turda) and elsewhere. The list above of sites is not based on any criterion, as it is used only as a demonstration of the successful implementation of montane tourism in Central Europe (Figs 5, 6, 7). The interested person is given here an interesting and dedicated explanation of the visited mining site, which is mostly accompanied by expert explanations. Another benefit of such an organized form of a visit to the underground is that the mining site visited acquires some protection. Neither of those is perfectly efficient, but it helps to achieve the following goals:

- to provide the visitor with a selection of the most attractive parts of the visited object, to guarantee his security and provide him with knowledge related to the mining object, the history of the mining region, the development of mining technology in the region, and so on- to ensure the maximum possible protection of the visited object from the potential environmental protection point of view;
- to provide the sustainable development of the mining site, and the region in all three components – economic, social and ecological.

Fig. 1. Visitors in Wieliczka mine (Poland), photo V. Paprčka

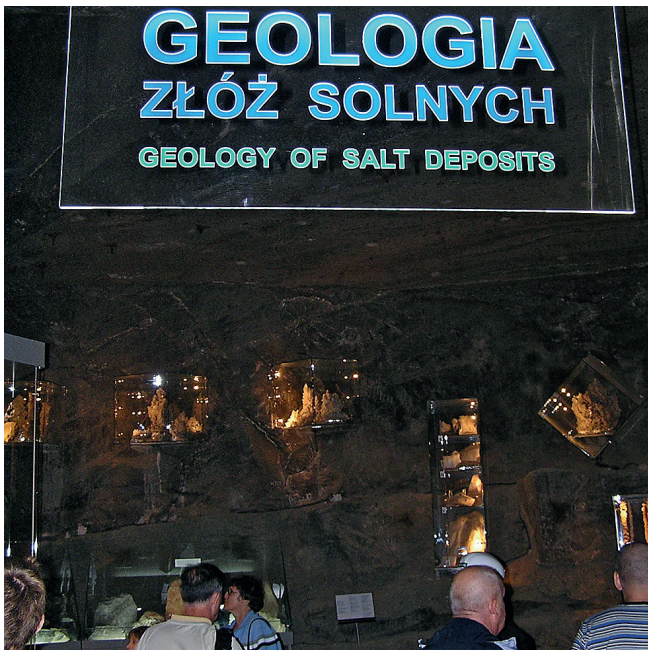

Fig. 2. Expositions in Wieliczka mine (Poland), photo V. Paprčka

Fig. 3. Open-air mining museum in Banská Štiavnica, Bartolomej gallery (Central Slovakia), photo V. Čech

Fig. 4. In the underground of the Bartolomej gallery in an Open-air mining museum in Banská Štiavnica, photo V. Čech

Fig. 5. Mining tourists in the opal mine Libanka, Jozef gallery near Červenice in Slanske vrchy Mountains (East Slovakia), photo P. Hronček

Fig. 6. Individual (mining) tourists on labeled walkways of the heap Maximilián in Špania Dolina (Central Slovakia), photo P. Hronček

Fig. 7. Organized visits on the mining trail at Ľubietová – Podlipa (Central Slovakia), photo P. Hronček

However, mining tourism can be built on the presence of elements of mining heritage, as follows:

- influence of celebrities and noble families affecting the development of mining and processing of mineral raw materials in the region,
- the development of science and technology disciplines conditioned by mining,
- the presence of historical distinguished mining institutions (royal chambers, mints, courts, mining archives, universities, schools, etc.),
- the development of mining towns, or mining traditions in the region, and so force.

The geotourism-related facts characterizing the mining site, such as geological development and structure of the territory, geology, mineralogy, paleontology, and geography characterizing the visited object, also form parts of the mining heritage as well.

To realize the intention to include our mining sites among destinations with a large number of tourists, let us ask the fundamental question: what attracts a large number of tourists to visit the objects offered by mining tourism?

Here are some sub-questions. Is it the information that the object was included in the UNESCO World Heritage List? Indeed yes, because from a marketing point of view, this is an excellent promotion for tourists. However, will this automatically provide a mass influx of tourists? Will they travel by airplanes or other public and individual means of transport hundreds or thousands of kilometers to see one mining site listed in the most prestigious list? Probably not.

Is it the knowledge that the object is in a well-known area that guarantees collection or purchase of minerals and samples that can enrich mineral collections? Certainly yes, but it is a matter of experts and collectors rather than the public, which highlights the determination of the mining site for individual mining tourists or, tourists in this case.

Is it the information on the location of the oldest (or one of the oldest) scientific or educational institutions in the world? Absolutely, but again, it is a challenge especially for students and professionals in the field of (predominantly mining) education.

Dozens of similar questions can be defined. Instant answers will be probably parallel to those in the previous text. Responses indicate that the promotion of partial or individual attractions of the proposed location attracts mainly individual mining tourists. The more significant the site is from the scientific and research point of view, the less attractive it is for the general public. However, this does not imply, that for well-implemented mining tourism, only "cheap" attractions which meet the requirements of the common public are meant to be successful. The success lies in a "well-made cocktail" of rare, attractive and "cheap" offers. The following will always apply: if the tourist cannot get good food, accommodation at different levels to choose from, entertainment possibilities, relaxation, retrieving of typical souvenirs, or the possibility of mineralogical collections, the tourist will not be interested in undergoing a long voyage to the site.

Another important question that might be helpful in defining the term "mining tourism" is, what does a tourist expect from mining tourism and what interests him?

Here are conclusions as the results of the analysis conducted together with prof. C. Drebenstedt from TU Freiberg, Germany, where one of the authors of the article (prof. Rybar) has lectured on mining tourism and geotourism for several years. Data were obtained by studying the opinions of visitors from the region rich in mining tourism sites in Saxony's underground and surface public accessible and active mines (Saxony, Germany) (Rybár 2016).

A mining tourist is particularly interested in:

- mining traditions,
- unique machinery,
- modern mining technology,
- illegal visits of underground mines (adrenaline, adventure, illegal collection (robbery?),
- special events in the underground (weddings, concerts, masses, celebrations),
- sports activities (adrenaline sports: rock climbing, motocross, mountain biking, underground collective sports: football, table tennis)
- recreation and wellness (recultivated mining works after surface mining), swimming, sunbathing, walking, in modified spaces of underground mines: health stay rehabilitation (resting, sleeping) in the unique conditions of some types of rocks, jogging, nordic walking,
- geology, mineralogy, paleontology, collecting, ecology, and biology, unique fauna moreover, flora occurring during and after the mining activity as well as in the recultivated area,
- free time activities utilizing vast spaces (mostly connected to surface mining – tank driving (!), paintball, cross golf).
- other.

Moreover, what about the influence of mining tourism on the environment, and the role of management in the goal – not to increase the harmful effects of the growing number of tourists on the environment?

Safe and attractive routes are essential for underground visitors so that they do not tend to leave them, which could be dangerous for both the visited object and the visitors. In this case, it is the responsibility of the management willing to maintain or promote the visit rate of mining objects:

- to make other underground routes and spaces available, to make the existing hiking trails more attractive while keeping visitors safe in themining work;
- to intervene with the intent to boost business economically, but at the same time to maintain the values of significant environmental parameters at the site.

The definition of term "mining tourism"

The first part of the term – "mining" refers to mining activities from prehistory to the present. The term "mining" represents an extensive range of concepts and events associated with mining. Here are some examples: mining technologies which characterize contemporary used techniques, their development over time, the architecture and architectural complexes built for the miners and financial sources from mining, and related mining activities, the development of natural and technical sciences, mining schools, universities, museums and lot of other connected areas. Other examples are, for instance, relicts of historical objects of mining, or manifestations of miners mental life, and many others.

Mining tourism is a form of adventure tourism, where the presence of a tourist in underground mining areas is providing him with new feelings and sensations. Mining tourism is defined as a phenomenon describing unique mining machinery and facilities, enabling exploration of the underground spaces with specific abiotic and biotic components, allowing one to admire the cultural heritage linked to historical mining, which is opened to the general and professional public (Rybár, 2016).

The position of mining tourism among other related forms of tourism

It is necessary to define the expanding mining tourism, which is becoming an increasingly popular form of tourism, against other similar forms of tourism. Until today, mining tourism was considered to be a part of geotourism, or industrial tourism respectively. The issue of conceptualization of mining tourism as a separate tourist sector within the thriving world travel industry, as well as defining its position among other related forms of tourism (tourist industry) comes into question, due to its massive development on a global scale. Mining tourism is prosperous not only at mining sites and regions (both historical and active ones), but also in those cultural centers, which were built using knowledge and techniques of the miners. Tourism has become a global phenomenon because of the worldwide interest in the living and inanimate nature has widely grown in the recent years. Numerous excursions to significant and less significant geological and mining events are organized across the globe, and the territory of Slovakia is not an exception.

"Tourism" as the second part of the term "Mining tourism," means a set of activities aimed at satisfying needs related to traveling and staying out of the place of residence, usually in the leisure time. Goals of these activities are recreation, education, health, entertainment, cultural and sporting activities, business trips, e.g., gaining a comprehensive experience (Gúčik *et al.*, 2006; Gúčik 2010). Tourism involves the movement of persons traveling to a place outside their natural habitat for a transitional period of less than one year for rest, recreation, business trips and other objectives, but not for pursuing a gainful activity in the visited country (UNWTO, 1991). Tourism is a sector with direct impact on the sphere of business, social affairs, and ecology, like: economy, industry, trade and services, investment, transportation, regional development, culture, health, education, sport,

environmental protection, forestry and aquaculture, agriculture, employment and competencies of local governments (Gúčik *et al.*, 2006; Gúčik, 2010). The previous list needs to be completed by technology spheres like deep mining, quarrying, geological exploration and all related mining activities regarding geotourism and mining tourism above all. An essential classification feature of tourism is the form of tourism. It expresses the various causes and their consequences, related to travel and staying visitors in a foreign location. "Forms of tourism are distinguished from a geographical point of view (internal, national, foreign, international, regional), as well as of the number of participants (individual, collective, mass, ecological), the age of visitors (youth, family, senior), according to the season (seasonal, off-season, year-round), according to the form of organization (individual, organized), means of transport (railway, naval, aerial, car), the sociological point of view (visits of relatives and friends, social, ethnic) and other forms" (Gúčik, 2000, 2008, 2010; Gúčik *et al.*, 2004, 2006).

The type of tourism expresses the purpose (motive) of traveling and the short stay of the visitors at the destination. The basic types include recreational, sports, adventure, cultural, spa, health and business tourism (Gúčik *et al.*, 2006; Gúčik, 2010). Schejbal lists the most advanced types of tourism, that have developed only in the recent decades, such as ecotourism, sustainable tourism, adventure tourism and, last but not least, geotourism (Schejbal, 2005).

Slovak dictionary "Tourist industry – Hospitality" (Gúčik *et al.*, 2006) does not mention the term "**tourism."** Tourist industry professionals (especially economists and marketing specialists, whose works are also used by geographers) narrow the term to designate sporting activities related to movement and staying in nature to discover their home country, natural beauties and cultural heritage (Chorvát, 2006; Kompasová, 2010). This term is replaced in Slovak language dictionary with terms "turizmus", "turistika." The term tourism is increasingly used in Slovakia as well, because of increasingly globalizing trends with the English language as the main means of communication. Czech and Slovak experts on geotourism (Schejbal, 2005; Rybár *et al.*, 2010) consider the concepts of the tourist industry and tourism as synonymous. The term tourism is perceived as an internationalized term, and for this reason, it is preferred in their works. In the geotourism research, the term tourism is used instead of the tourist industry.

The conceptual difference between the terms tourist industry and tourism, as understood in the Central European space in Czechia and Slovakia, is in detail explained and clarified at the theoretical level in the work of I. Chorvát (2006). He understands tourism in a broader sense as the tourist industry, which is recognized as sort of economic industry referring to a set of services. Tourism is not only a set of activities to meet the needs of tourism operators, but also includes other areas such as interpersonal relationships, the social organization of community relations, lifestyle, mobility, leisure time, migration, distribution of labor, customs and presentation of local culture and traditions (Chorvát, 2006).

Geotourism has been specified as a separate sector of tourism only over the last few years. A recently well defined and established form of tourism, becomes a global phenomenon (Newsome, Dowling, 2010). Despite its relative short modern history, it has been described by many different authors (e.g. Hose, 1995, 1996; Słomka, Kicińska-Świderska, 2004; Joyce 2006; Dowling, Newsome 2006; Sadry, 2009; Newsome, Dowling eds., 2010; Rybár *et al.*, 2010; Hose, 2012). Moreover, research in the field of geotourism have brought many authors to define of various geotourism forms, including underground geotourism (Garofano, Govoni, 2012), rural geotourism (Farsani *et al.*, 2013), urban geotourism (Rodrigues *et al.*, 2011; Ferreira *et al.*, 2012), health & wellness geotourism (Farsani *et al.*, 2013) alternatively, roadside geotourism (Štrba *et al.*, 2016) (Figs 8, 9, 10, 11).

Geotourism was a first time defined by Thomas A. Horse in 1995 (1996) as an independent and, above all, a new form of tourism with ever increasing potential and interest of clients. However, it was only a "geological" definition – and geological understanding of the issue, and it also highlighted the geological and geomorphological aspect of sustainable development. He described geotourism as abiotic nature-oriented tourism. Providing interpretational and service facilities to enable tourists to obtain knowledge and understand the geology and geomorphology of the site (including its contribution to the development of geosciences) beyond the limits of a purely aesthetic perception. A similar but extended version of the definition was published in 1999, where the geotourism is characterized as "providing interpretational facilities and services to support values and social benefits of geological and geomorphological sites and their materials and ensuring their protection for use by students, tourists and occasional tourists" (Hose, 1999).

The understanding of these definitions was above all adopted by geologists and specialists from the British Commonwealth, and of AGH Krakow in Poland.

On the other side, R. Buckley (2003) does not give geotourism a high chance as a separate type of tourist industry in his work from the year 2003, but sees it only as a small specialized part of ecotourism.

The issue of geotourism was dealt with by E.B. Joyce (2006) in the middle of the first decade of the 21st century, which perceives geotourism in a wider perspective. He understands it as a new sector of the tourist industry in relation with geological and geomorphological attractions and features of individual sites or parts of the landscape.

Fig. 8. A specific type of mining tourism in groundwater flooded quarries. Tourist resort Senec – Zlaté piesky (Western Slovakia), photo P. Hronček

Fig. 9. A specific type of mining tourism in groundwater flooded quarries. Sandpit at Veľké Leváre (West Slovakia), photo P. Hronček

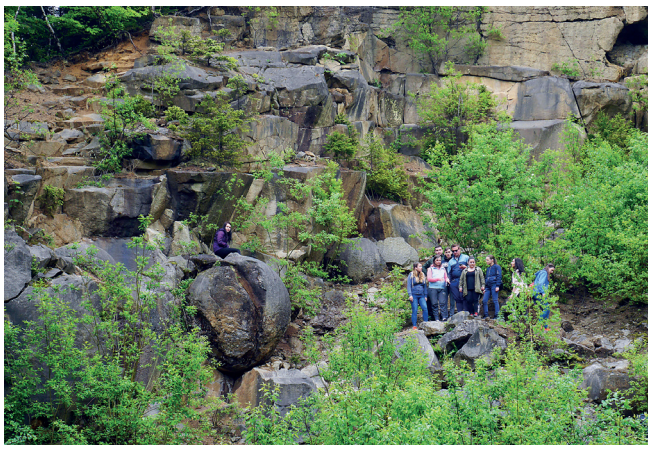

Fig. 10. Geological and mining-oriented excursions of students in the quarries. Stone quarry Megonky, the Kysuce region (North Slovakia), photo P. Hronček

Fig. 11. Terrain lessons in stone quarries. Stone quarry Driečany (South Slovakia), photo P. Urban

A new definition of geotourism had been proposed in this work, where geotourism means "the targeted movement of people to a particular place to see and learn about one or more aspects of geology and geomorphology." The definition was based on the context of Australian nature and its national parks and geoparks. Geotourism offers a greater understanding of the landscape, geosites and their origins, and also provides cultural experiences, improving the way the sights are observed.

One of the foremost experts on geotourism, as a growing global type of tourism, R.K. Dowling, published some works on geotourism along with D. Newsom (Dowling, Newsome, 2006; Dowling, 2011). Based on these works, geotourism characterized as sustainable tourism with a primary focus on exploring the landscape from a geological point of view aimingto promote ecological and cultural awareness, appreciating and protecting the environment by preserving a beneficial state of the sites. Geotourism is a product that protects, describes, promotes and sells geosites as part of the geological heritage of humanity. These works mostly focus on natural sites.

Another concept and insight into geotourism derived from geography was brought by the National Geographic magazine in 2011 (NGM, 2011) defining geotourism as a form of tourism that emphasizes the geographical character of the site – its "environment", culture, aesthetics, heritage, health and the welfare of the population. The term "environment" may also include geology. Such a definition emphasizes a wider context (in the landscape) and not just the particular individual object.

This definition was adopted especially by American geologists and geotourism specialists. Such a form of description supports the creation of geoparks and mass-visited sites. This definition (sometimes called the American approach to geotourism) is preferred and developed by the Department of Geo and Mining Tourism at the Institute of Earth Resources

of the Faculty BERG of the Technical University in Košice under the leadership of prof. P. Rybár (Rybár *et al.*, 2010; Rybár *et al.*, 2012; Rybár, 2016; Rybár, Štrba, 2016).

Some other definitions of geotourism had been created in 2011, for example, Dawling (Dowling, 2011) outlines five fundamental geotourism principles. The product called "Geotourism" is characterized by the following: 1) it is built on geology, 2) it is sustainable, and 3) it is educational and next two principles are of a general nature: 4) it has local benefits and 5) it provides satisfaction for tourists.

Another approach to the problem is presented in the Arouca Declaration (UNESCO congress in Portugal, 2011). It is the mixture of the conservative geological approach and a liberal geographic approach to geotourism definition (Arouca Declaration, 2011): "(...) tourism, which maintains and enhances the identity of the territory, considering its geology, environment, culture, aesthetics, heritage and the benefits of its inhabitants."

Industrial tourism promotes many tourism sectors. It may be mining, metallurgy, sugar industry, food industry and many others. It highlights technologies and technological objects within these industries. Industrial tourism was introduced to support industrial areas and is intended primarily for individual tourists and groups of professionals.

As mentioned by Otgaar *et al.* (2016), from the scientific point of view, industrial tourism is a relatively unexplored topic with very limited concepts and definitions. The first complex definition of industrial tourism was introduced by Dodd and Bigotte (1997), defining industrial tourism as "visits by consumers to the production facility site and can include educational tours of the facility and tasting of the product that is produced." According to Frew (2000), "industrial tourism involves visits by tourists to operational industrial sites where the core activity of the site is not-tourism oriented." In this definition, the word "industry" refers to the sector, not to manufacturing Otgaar *et al.* (2016).

Mining tourism – approaches and definition the new form of tourism

Mining tourism (some authors use the term "montanistic tourism") has been mentioned in many publications (e.g. Conlin, Jollife, 2011; Drebenstedt *et al.*, 2011; Kršák, 2011; Kobylańska, 2013; Lopez, Perez, 2013; Lorenc, Janusz 2013; Perez-Alvares *et al.*, 2016; Schejbal, 2016). Despite this fact, the first definition of mining tourism was presented by P. Rybár and Ľ. Štrba (2016) during an International conference on geotourism, mining tourism, sustainable development, and environmental protection, Firenze, 2016:

„There are significant differences between the nature of mining tourism and geotourism or industrial tourism. Mining tourism sites are often located in a natural environment with many geological features (e.g., mineral deposit exposures, rock formations exposed in mines, fossils, etc.), what can be a subject of interest of both geotourism and mining tourism". On the other hand, mining tourism covers the much broader area, including mining heritage in the form of mining insignia or spiritual heritage of miners that do not fit geotourism definition at all. Therefore, it can be assumed that mining tourism is not a part of geotourism (Rybár, Štrba, 2016). Consequently, they suggest that mining tourism is an individual form of tourism which, in many cases, is related to geotourism and industrial tourism but is on the same level as geotourism and industrial tourism. The authors of this article have modified the existing definition (Rybár, Štrba, 2016), and defined mining tourism in the manner, like this.

Mining tourism is a form of adventure and cognitive tourism for specialists and the general public . The interested person in mining tourism can take advantage of a combination of both experiences and knowledge of visiting in-situ mining sites and regions, visits of mining museums and from literature and archive studies, including mining documentation. In situ mine visits helps a tourist get to know used mining technologies and processing methods of raw materials throughout history. Visits of mining regions helps tourists to understand the boom and bust cycle of mining region, and to learn the habits of the miner community in different times of history. Visits of mining museums helps the visitor feel a bond with one of the oldest human activities – mining, developed mostly in the underground. All the mentioned above connect visitors with his/her ancestors.

Where is it possible (and how) to realize mining tourism?

To answer this question, the best is to start with a presentation of some world-class mining sites.

Wieliczka (Figs 12, 13), which lies near Krakow in Poland, is the most popular visiting mine in the world. At the same time, it is one of the most visited tourist attractions in Poland. Wieliczka is noted as the first of the mining objects and regions in the world on the UNESCO World Heritage List. Comparing the number of visitors, it ranks higher than the Austrian Hallstatt, the Swedish Falun, and the Columbian Zipaquirá. The number of Wieliczka visitors was close to 1,300,000 in 2013, and numbers were rising steadily. The ratio of home and foreign visitors was almost 1:1 in 2013. The largest number of foreign visitors were British (nearly 74,000), then Germans (over 57,000), Italians, French, and Spanish.

The first written mention of salt mining in Wieliczka in Poland came from the 11th century when Wieliczka was

called Magnum Sal. The Tyniec monastery Documents capture general knowledge about the beginnings of mining in the Krakow region in Poland. The oldest of these documents is the Privilegium of Kazimier I. from 1044, in which Wieliczka is mentioned as "Magnum sal alias Wieliczka." Bochnia is referred as the Small Salt Mine in Medieval documents.

From the 1105 document, it appears that salt mining with the center in Wieliczka already existed in Poland under the reign of Bolesław I Chrobry (995–1025). Stone salt was produced in the form of various large blocks of rock salt of a different shape. There was also a salt trade as salt had been sold in numerous small shops and taverns. Several markets were organized a few times a year in Wieliczka, and the salt from Wieliczka and Bochnia also had been traded to other monasteries nearby.

The right to cook salt was included in the church institutions, especially monasteries, from the 11th century. Monasteries were responsible for the documentation on the amount of salt produced. The oldest way to get salt was to cook it. The beginnings of rock salt exploitation are unclear. The most probable scenario is that the salt-makers had been digging deep wells and accidentally discovered salt. Stone salt is present at a depth of 15 meters in Wieliczka and could be probably found in shallower layers also. The oldest shaft of Stara Gora was excavated before the end of the 10th century and was already a shaft in the true sense of the word.

Fig. 12. The salt mine shaft in Wieliczka (Poland), photo V. Paprčka

Fig. 13. Chamber in the salt mine in Wieliczka – restaurant, photo V. Paprčka

For many centuries, salt was the economic base of the income of the Polish Kingdom. The share of salt business accounted for 30% of the State Treasury revenue in the 14th century. The Salt Mine was run by the Royal Chamber; salt trade routes were guarded by castles and the high-standing Poles. The salt from Wieliczka was also involved in the development of Polish science, because King Kazimír the Great, founder of the Jagiellonian University in Krakow (1364), financed the university only from the income from mining and business activities with salt.

The royal supervision over salt mines ended during the first division of Poland in 1722. The Habsburg monarchy, and later the Austro-Hungarian Empire brought not only administrative changes to the salt mines in Wieliczka but also new mining technologies introduced by foreign experts who came to Wieliczka.

The Austro-Hungarian Mining Law made Wieliczka a stable healing place, by improving the technical and economic conditions of salt mining in the 19th century. The expansion of the nearby city of Krakow was a great benefit for Wieliczka. It brought about the construction of a power plant and a rail link with Krakow. Underground works were mechanized, and steam engines were introduced. The economic stability of the mine also manifested itself between the two wars.

The first modification of the mine to museum exposition went hand in hand with investments in the development of production, but it was decided that the mine would serve as a guest mine and spa at the same time. World War II and the intended liquidation of mining after its end had a decisive effect on the destiny of Wieliczka. Historic mining was pushed closer to the risk of losing its values. The period of uncertainty ended with the UNESCO World Heritage List registration in 1978. Anew phase of development of the salt mine in Wieliczka was launched. It was decided that the world heritage in the underground must be protected and the related activities began in the early 1980s. After a waterlogging accident in 1992, it has been shown, that works related to the conversion of the mine to a tourist site must be accelerated. Wieliczka became a historical monument by the decision of the Polish President in 1994.

Successive steps of transformation of the mine into a tourist site had to meet several criteria, in particular:

- to preserve unique historical traits in underground works,
- to guarantee the safety of visitors in underground spaces,
- to support the economic advantage of turning the mine into a tourist site.

The requirements had to be processed in the following way:

- Unnecessary excavated spaces had to be closed, and the water inflow into the mine had to be eliminated to prevent the risk of underground accident, which in case of a massive water flow also represented a risk for surface objects, as well as the city situated above the excavated areas. The solution also required the end of mining in the nearby mine.
- Historic chambers including the reconstruction of individual historical mining elements had to be secured to ensure security in the chambers during excursions.
- Maintenance of mining operations and their functionality had to be guaranteed regarding ventilation, transport, lighting, shaft equipment. Their exchange and upgrading to support activities such as mass actions, restaurant, etc. should be made possible.
- Revitalization of post-industrial zones, including the restoration and modernization of surface objects for miners, as well as the restoration of the neighboring Barycz mine, had to be conducted.
- Historical excavation and restoration works had to be made available to the public, both on the surface and underground.

The "tourist route" is the flagship of mining tourism in Wieliczka. The tourist industry market is characterized by high sensitivity requiring constant adaptions to market requirements. The tourist route and the surroundings of the Daniłowicza shaft need to be continuously modernized and adjusted. Sections of a tourist trail designed for people with disabilities are a good example. It is necessary to be aware of young tourists' needs and to offer the history and technology with the up-to-date presentation. The interests of children of different age groups need to be taken into consideration.

The touristic trail consists of 21 mining stops and has a total length of 2.5 km, and it is located between the first (64 m below the earth's surface) and the third horizon (135 m below the earth's surface). The route leads through a pleasant, aesthetic, safe and interesting terrain. Modernization works focus on increasing the attractiveness of the route offered.

Hallstatt is probably the oldest salt mine in the world with the history of salt mining dating back to the Middle Bronze Age. It is located in Upper Austria near the Lake Hallstätter See. It is a UNESCO World Heritage Site together with the Dachstein Mountains and the Inneres Salzkammergut landscape and historical, cultural area.

During mining works, the miners found a body of a dead man who looked as if he had died only a few days ago in the first half of the 18th century. In fact, he was lying there for

a few centuries. Traces of Celtic settlers, including the mysterious "man in salt", were discovered in Hallstatt. A huge burial ground began to be found in the first half of the 19th century and became the most important prehistoric site north of the Alps. Celtic culture discovered in the Austrian village of Hallstatt spread from France to the Balkans.

The Celts mined "white gold" in the Salzkammergut Mountain and established their power and wealth by its means even before the foundation of Rome. They traded the salt for amber from the Baltic Sea area, weapons from Southern Germany, bronze pots from the Danube area, glass from the North Adriatic coast, and ivory from Africa. The Celts were probably the first in the world to operate until nowadays a functioning salt mine. After a period of decline in the Middle Ages, mining was taken over by the state. The so-called salt law was given to the inhabitants, who ensured drying, packaging, transport and trade of salt, as well as the operation of their docks to transport the salt by water. A settlement was established in the place where salt was processed, and salt trade developed. The first long-distance pipeline in the world would certainly not arise without the mining of salt. It was a 40 km long wooden pipeline from Hallstatt to Ebensee, along which a favorite hiking trail which has lasted until today.

The nobility discovered this piece of land in the 19th century when searching for medicinal baths. Mineral salt baths attracted many noble guests. Archduchess Sofia, who had the desire to become pregnant, was among them. The healing power of local sources had helped her because the Habsburg family, after two abortions, finally grew and three of Sofi's sons entered the history as "the salt princes." The firstborn Francis Joseph I, the future Emperor, remained faithful to his roots and chose Bad Ischl Spa as a summer residence. Salzkammergut won world fame with thriving tourism not only thanks to him but mainly thanks to salt. The duration of the tour takes at least 3–4 hours and is related to the choice of a wide range of possible routes for visitors.

Falun copper mines (Sweden) are documented in the 13thcentury. The town of Falun received the town rights in 1641. The biggest boom occurred after the construction of the railway and 56 factories. It is an administrative and educational center with several mines devoted mainly to copper mining. Falun once belonged to the essential copper mining areas in the world. Remnants of mining and copper production can be found around the town. Two-thirds of world copper production came from Falun at the time of its greatest boom. The dark red color Faluröd is the by-product known from typical Swedish houses. This color painting has been used for houses since the 16th century and during the 17th century has spread throughout the whole country. It became the national color of Swedish houses during the 18th century and is still widely used today.

Zipaquirá, Colombia – as a part of three Colombian cities, forms the Cultural Landscape of Salt Town, jointly listed on the UNESCO's Cultural Heritage List in 2012. Zipaquirá is the largest salt deposit in the world. The native people historically benefited from this mine, but Simon Bolivar also used the money from mining and salt trading to finance the national liberation movement in Colombia. Visitors can see a multimedia presentation of historical mining processes, a geological structure of the deposit, a museum, an exposition of "environmentally friendly" mining and sustainable development. The main attraction in the underground is the Salt Cathedral and the 4.2 m high Holy Cross carved out of halite. The Salt Cathedral is attended by 3,000 visitors and believers at the time of worship on Sundays.

Salar de Uyuni, Bolivia – the largest salt-pan in the world lies at an altitude of 3653 m above sea level. It is made up of the entirely straight salt layer, which is in average 1 m thick and covers an area of 10,582 km^2.

Several hotels, including furniture, are built entirely of salt. The first such hotel was built in the middle of the salt pan in the thirties of the 20th century. The hotel was demolished in 2002 for environmental reasons. Other hotels were built closer to road communications on the periphery of the salt pan. Another interesting tourist attraction – the "train cemetery" – is situated in a 3 km distance. Minerals extracted from the salt pan were transported by rail to Pacific ports in the past.

Salina Turda is a salt mine from the 17th century in Transylvania, Romania. The Business Insider magazine described it as the most beautiful underground place in the world and ranked it among the most famous tourist attractions in the world in the 22nd place. Today it is well-known as a museum of salt mining in Transylvania. Underground attractions include an amphitheater, a Russian (Ferris) wheel, bowling, underground lake with boats, minigolf and table tennis. More than 2 million tourists visited the salt mine since 1992. The mine is opened for visitors all year round. The extensive reconstruction of Salina Turda financed by PHARE funds took place between 2008 and 2010.

Kutná Hora is a historic mining town in Czechia. Approximately one-third of European silver production came from here in the 13th century. A record of the number of tickets was sold to the Kutná Hora monuments in 2014. Visitors bought 962,262 tickets, which is almost 30,000 more than in 2012 – historically the most successful year regarding visit rate. As each visitor visits three objects on average, the number of tourists slightly exceeded 300,000. The most visited monument of Kutná Hora is Kostnica (charnel house) in Sedlc, then St. Barbara's Church and the third most visited object is the Czech Museum of Silver at Hrádek. Visitors can also find two educational paths related to historical silver mining.

Banská Štiavnica (Figs 14, 15) is the most important mining town in Slovakia (situated within the Banská Bystrica Self-Governing Region). The town with its surroundings was listed on the UNESCO World Cultural and Natural Heritage list on the 11th of December 1993. The Open-air Museum of Mining (Banský Skanzen) in Banská Štiavnica (Fig. 16), is visited by approximately 20,000 tourists per year. There is a visible increase in the number of visitors over the extended weekends during the months out of season. The visit rate of these weekends is getting close to figures of the main touristic season. The average daily traffic in the season was 232 visitors per day (up to 90,000 per year) in 2014. The number of overnight stays is approaching 90,000 per year. Banská Štiavnica was mainly visited by Hungarian students from the successor Colleges of the Mining Academy out of season. The growth of Hungarian tourists was also observed in the time of public holidays in Hungary. Czech, English, German and Hungarian speaking tourists were the most numerous among the foreign visitors.

Fig. 14. The Old castle in Banská Štiavnica, photo P. Hronček

Fig. 15. The New Castle and calvary in Banská Štiavnica, photo P. Hronček

Fig. 16. Open-air mining museum in Banská Štiavnica, photo V. Čech

Mining tourism in the area with scattered relics of historical mining

Objects of massively visited mining sites usually centralized mining sites, which are characterized by the presence of an ancient mining mansion with some mining relics of various kinds and origins in its immediate background (Figs 17, 18). These mining destinations are currently the most sought after tourist destinations, especially thanks to well-built tourism infrastructure.

Fig. 17. The town Castle in Kremnica (Central Slovakia), photo P. Hronček

Fig. 18. The center of Špania Dolina, photo P. Hronček

Lesser-known or more or less currently unknown mining sites or objects, or mining relics scattered on relatively large areas, may be the objects of visits of mining tourism in addition to the centers above of mining tourism based on the mining heritage. Some montane monuments scattered throughout the landscape around small settlements can be found in the Central European countries. These are mostly less accessible or inaccessible and are unsuitable for mass public visits in their current state. Underground works available only in short sections, or even collapsed, flooded or non-accessible due to the protection of protected species permanently occupying or just wintering in these areas can be found quite frequently. Such mining works or their relics are the subjects of documentation, scientific research, and mapping of underground spaces, but they are also a place for unregulated adrenaline activities or plundering by unwanted visitors.

Central European countries with their unique mining heritage have numerous regions with many scattered remains of mining heritage. However, before their use in mining tourism, the following fundamental questions have to be asked:

- How to approach their identification in the region?
- How can they be protected against unwanted visits by vandals, "collectors" or accidental adventurers?
- Is it sufficient not to reveal information about their actual position?
- Is it appropriate to describe their historical and natural value in detail?
- Is it worth mentioning their natural and anthropogenic value obtained through site evaluation?
- How, in this case, is it possible to organize mining tourism for the masses of tourists and thus to put miners' tourism in the position of an attractive tourist sector in the region?

Integrated projects with the support of the so-called start-ups (demonstration, pilot projects), which demonstrate a return on investment over the expected period, implementation and analysis must be conducted if we want to develop mass mining tourism in such conditions and expect it to become the engine of economic development of the region. The share of foreign financial participation must begin to decrease, while the share of own funds from the successful implementation of the project must be increased after this period.

History of mining tourism – beginnings of mining tourism in Habsburg monarchy (Slovak mining regions) – a case study

When searching for the beginnings of migration movements or traveling in Upper Hungary during the Middle Ages, we must first examine the motivation that was the main factor of the migration movement (Chorvát, 2007). With regard to the analysis of the origins of mining tourism (migration or relocation), mining is just one of the main factors of the Middle Ages population mobility in Habsburg monarchy (Upper Hungary, Slovak territory), or migration to Upper Hungary from the bordering western countries.

Other motivating factors in this period were, for example, business, education, religion, military – these were related only to a very narrow group of the medieval population. With the exception of religious pilgrimages to Rome or Jerusalem, these movements did not have a mass character.

Motivation as the primary factor of Medieval migration gains importance from Medieval roads as a way of traveling. It should be emphasized here that there have been only unpaved roads that have been exposed to weather, bandits, wild animals, and other life-threatening circumstances. Muddy and mountainous roads often could not be used for wagons, and therefore were mainly used by horses or by foot.

When considering the medieval society of Upper Hungary, we have to realize, that the broad layer of villeins attached to the feudal soil had no other choice but to remain in a place that they knew and provided them with relative safety. Traveling meant suffering and fear of possible pitfalls and dangers for a medieval man. Thus, people preferred to remain in a familiar and a relatively safe environment (Lukačka, 2005). There was only a narrow group of higher-society citizens involved in the actual migration of the population, whether higher and lower nobility, clergy, soldiers, etc.

The arrival of new settlers especially from the German-speaking European areas (Marek, 2006) into the Upper Hungary geographical area after the Tatars' invasion from the second half of the 13th century, significantly changed the composition of the Upper Hungarian society. Settlers incoming from Germany encouraged the emergence and development of privileged medieval towns, of which the mining towns had the essential status. The inhabitants of these towns enjoyed a broad portfolio of privileges, the most important of which was the right to move freely through the country and the right to own property, as well as the right to have the disposal of the property (Lukačka, 2005). Many towns gained the right to search for and exploit mineral resources within their bounds freely. The original population (mostly rural) remained permanently attached to the land of its landlord.

The population's mobility in a new social situation was mainly driven by the fact that the wealthy entrepreneurs in mining and metallurgy had been engaged not only in trade relations within Hungary, but also throughout Europe. Education became the subject of mobility – the movement of specialists in the field of mining and mineral processing. European scholars begann to conduct first scientific journeys into economically prosperous areas and mines. These sites and the entire regions were visited by the highest nobility, clergy, traders, adventurers, etc.

Upper Hungary started to be visited by an increasing number of foreign scholars, as well as travelers attracted not only by the natural wealth, but also by reports of the extensive and remarkable Upper Hungarian mining and metallurgy. The first travelogues of these travelers described mining and metallurgy and also the technology used (Hallon *et al.*, 2006). Migration was still aimed primarily at work, education, research and knowledge of mining sites, rather than montane tourism or recreation. The existence of local "montane" tourism for relaxation could be considered in the wider area of Banská Štiavnica. Several historical reports generally state that the local thermal springs in Vyhnewere not only discovered but also used by the miners who found them during the excavation of an adit in the 13thcentury. The springs and spas had been owned by the town of Banská Štiavnica since 1564 (Pavúk, 2006). A similar situation could be seen in Sklenné Teplice, where the natural springs in travertine hills had been used by local miners since time immemorial. Allegedly, the specific spring of Parenica sprouting initially in the narrow travertine cave was expanded and enlarged by miners to suit their needs (Rebro, 1996).

The first documented visits to the Upper Hungary territory in connection with mining are recorded in the first half of the 16th century. The most significant visits to Upper Hungary include scientific journeys of an essential European Renaissance physician from Germany Theophrastus Bombast von Hohenheim (1493–1541, originally from Switzerland), known as Philipp Aureola Paracelsus. Paracelsus can be considered as a pioneer of mountain tourism in today's Slovakia, i.e., Upper Hungary, region (Fig. 19). His first trip to the Upper and Lower Hungarian mining towns and the surrounding towns in Slovakia took place in 1521. We can call it a "scientific" mining journey, as he was concerned not only with ore mining but also with mineral and cementation waters. His other trips were made to the town of Smolník in eastern Slovakia in 1526 and 1527, where he was particularly interested in cementation (vitriol) water (Herčko, 2002). We know that besides Bratislava, he also visited Banská Štiavnica (Figs 20, 21), Banská Bystrica, Smolník and other mining towns in Spiš, Central, and East Slovakia mining regions. His observations and information from the territory of Slovakia are summed up in his work *De Tinctura Physicorum*, published in 1570 (Paracelsus, 1570).

Fig. 19. Paracelsus – Theophrast von Hohenheim (*1493, Einsiedeln, Swiss – † 24 September 1541, Salzburg, Austria), Swiss philosopher, physician, and alchemist. We consider him the first mining tourist in the first half of the 16th centuries in the Habsburg monarchy, archive P. Rybár, P. Hronček

Fig. 20. Medieval hand-drawn galleries "kresanica" on a tourist route in Starovšechsvätých mine at Hodruša Hámre (Central Slovakia), photo P. Hronček

Other scholars interested in mining and related sciences were heading to Upper Hungary in the second half of the 16th century. Professor Gašpar Naumann from Berlin and mining authority Leonard Thurneysen (Tibenský, 1966) came to Banská Štiavnica ore district, as well as to other Central Slovakian mining towns in the year 1568. At the end of 1585, or early next year, two specialists Alexander Blingling and Vincent Reusen, which were sent to search and research minerals (Herčko, Weis, 2014), traveled to the seven mining towns in Central Slovakia.

John Baptista Merin, an English physician, visited mines in Banská Štiavnica in the year 1615. He described his trip in the travelogue *Journey to the Mines in Hungary* (Tibenský, 1968). In Banská Štiavnica he also visited the Main Chamber Earl Hudarlic Reitter, whose guest was his old friend Dr. John Beguin already in 1612. Thus, J.B. Merin was not the first English scholar to visit the Central Slovakian mining region. He traveled from Vienna to Bratislava by boat and from there to Banská Bystrica accompanied by four carriages. He examined the city and then went to Špania Dolina. Next, he had visited mines and surface facilities in Boca and then traveled on through Banská Bystrica to Banská Štiavnica. After a short stay in Banská Štiavnica, where he examined the mines, he headed to Kremnica known throughout Europe for its gold mine and mint, and stayed here from July to December 1615. During his five months stay, he could see many mining works thanks to his hosts (Herčko, 1976).

In 1620, another English scientist, Peter Mundy, visited the Central Slovakian Mining Region (Fig. 22), but there is no detailed information about his journey (Tibensky, 1966).

During this period, visits to mining areas were related only to scientific activities from abroad. Within the monarchy, they consisted primarily in sending working commissions of the Mining Chamber at regular or irregular intervals. Their task was to create and maintain a detailed inventory of mines and mining objects. A committee of several members, often counting more than ten experts, traveled from Vienna to the territory of today's Slovakia and spent several weeks, and often months, traveling through the mining areas and denoting everything that the Mining Chamber had benefited. In the state archive in Vienna, the first well-known record of the known visit of Central Slovakian mining towns in 1535 (Hronček, Budaj, 2017) was preserved in the range of nearly a hundred manuscript pages. Since then, some similar commissions had been sent to Slovakia, not only from Vienna but also from the Main Chamber Bureaus of Banská Štiavnica, Gelnica, and Smolník.

Fig. 21. Underground mining walled mine galleries on a tourist route in Starovšechsvätých mine at Hodruša Hámre (Central Slovakia), photo P. Hronček

Fig. 22. Manually excavated medieval mining galleries "kresanica" with a hammer and pick technology in the underground of Ľubietová (Podlipa), photo P. Hronček

If we do not consider the economic interest of the Mining Chamber in Vienna in the mines in Upper Hungary, we can say that the first visit to mines in Upper Hungary happened in the year 1620. We can assume that the targeted use of free time to explore the mining towns and mines themselves in order to gain knowledge aboutthe Lower Hungarian Mining Towns and this visit to Banská Bystrica and its surroundings already has elements that we can identify with montane tourism in the scope of its contemporary understanding.

The Hungarian Council, which elected Gabriel Bethlen, the Transylvanian count and the leader of the anti-Habsburg uprising, the king of Hungary (Fig. 23), was held in Banská Bystrica from June to August 1620. The Hungarian Council consisted of Betlen supporters, with the blessing of the Turkish sultan himself. He had not been crowned, probably on his own request, because he wanted to maintain the possibility of agreements with the Emperor. Emperor Ferdinand II, who was preparing for the war against the Czech nobility, then signed a ceasefire with Bethlen.

Fig. 23. Gabriel Bethlen (*1580 Ilia, Romania – † 1629 Alba Iulia, Romania), archive P. Rybár, P. Hronček)

Gabriel Bethlen was born in 1580 in Ilia in today's Romania and died on November 15, 1629, in Alba Iulia. The Hungarian Council, which took place under his direction, met in Banská Bystrica in a 16thcentury townhouse on Dolná Street no. 8 (the Central Slovakian Gallery is located here nowadays). The Latin inscription "BENEDICTIO DOMINI DIVITES TACIT" is preserved over its entrance until today – the Blessing of the Lord brings wealth. Gabriel Betlhen arrived in Banská Bystrica on June 10, 1620, and stayed in one of the historic townhouses with his companions. There were more people attending the Council than the city population itself, which was about two thousand inhabitants at the beginning of the 18th century. Bethlen's affiliated nobilities from Bohemia, Moravia, Austria, the ambassadors of the King of Poland, as well as the Turkish sultan (Martuliak, 2003) took part in the Council. The Hungarian nobility and clergy also attended the Council in large numbers.

The first wife of Gabriel Bethlen – Zuzana, took part of the escort together with their servants, and so the wives of many noblemen and guests. It is with the wives of the participants that we can relate the first trips of a montane tourism character to the surroundings of Banská Bystrica in the summer of 1620 on the basis of historical sources (Fig. 24).

While the ambassadors and the local attendants were discussing, their wives took trips to the town to "enjoy its splendor" (Jurkovič, 2005). Based on historical records, we know that the neighboring mining towns of Ľubietová, Brezno and the Ľupča castle were visited for sightseeing. Leisure walks and leisure activities took place in "extremely interesting and instructive mining settlements" (Jurkovič, 2005) in the cadasters of Banská Bystrica, Staré Hory and Špania Dolina.

The wife (the first wife) of Gabriel Bethlen, the baroness Zuzana, born Károlyi, visited Kremnica together with her royal companionship, on July 7, 1620. They traveled "over the mountains" (Matunák, 1928) via the old medieval (silver) mining road, which crossed the Kremnické Vrchy Mts and connected both towns of Kremnica and Banská Bystrica. It is more than likely that the escort also passed through the mountain tunnel (Gergey tunnel), which had been built during the Thurzo-Fugger Company period. Baroness Zuzana, accompanied by several noblewomen, had been welcomed in Kremnica with great pomp and made a detailed examination of the town. Her interest in mining and the associated activities was so intense that she eventually ventured into the mine (Jurkovič, 2005). The underground trip was undoubtedly limited not only for safety or hygienic reasons but also for the clothing of the noblewomen who wore a full dress according to the latest fashion. The spectacular sightseeing trip to Kremnica is also highlighted by a record stating that the journey of baroness Zuzana cost her husband a large sum of up to 203 gold and 23 denars.

According to historical records, the main motivation of these excursions was spending of the leisure time and the curiosity of the participants. The records show that the surroundings of Banská Bystrica, in particular, the mining sites, provided enough uniqueness of such a character, that they also interested the members of the higher (noble) society.

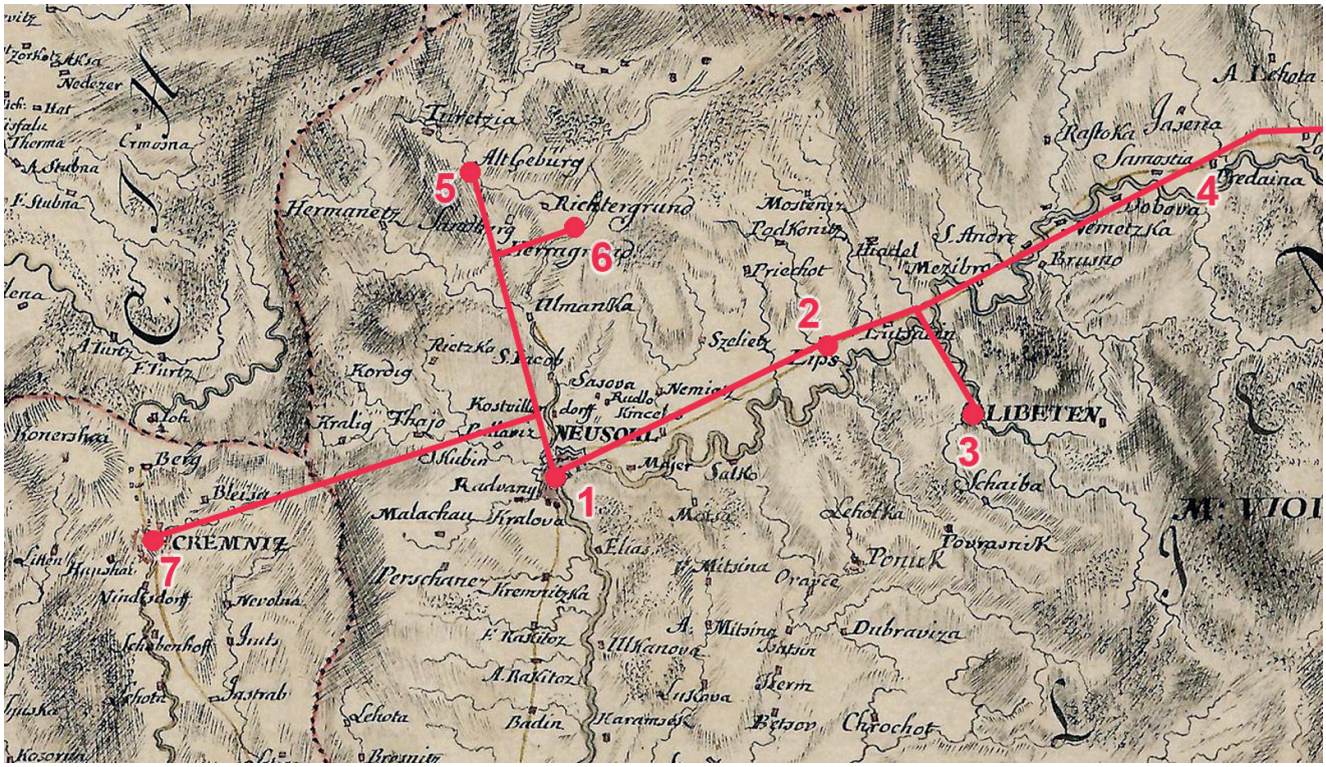

Fig. 24. Tour of the Baroness Zuzana (the first wife of Gabriel Betlen) in the summer 1620, of the mining sites around Banská Bystrica. Legend: 1 Banská Bystrica, 2 Slovenská Ľupča, 3 Ľubietová, 4 direction Brezno (5 km), 5 Staré Hory, 6 Špania Dolina, 7 Kremnica, compiled by authors on the map by S. Mikovini from 1725, archive P. Rybár, P. Hronček)

Noblewomen usually had completely different interests than mining or mining technology, which also resulted from their position in the society. These facts and circumstances taken from the written sources bring the first elements of modern mining tourism to our territory (i.e., to the territory of Upper Hungary) at the beginning of the 17th century.

Many scholars from all over Europe were coming to Slovakia in the following decades. Their journeys to Upper Hungary focused mainly on mining sites and studies of mining and geology. By the end of the 18th century, we can name the following, for example, Athanasius Kircher, Edward Brown, Alojz Ferdinand Marsigli, Franz Ernest Brückmann, Gabriel Jars, Ján Jakub Ferber, Baltazar Hacquet, Ján Ehrenreich Fichtel, Jeans Esmark, Róbert Townson and others (Tibenský, 1966).

Their scientific interests and the information they have gained have been published in some scientific works and travel books. Initially, these works had a polymath and travel character predominantly, but they had gradually begun to acquire scientific features (Schmidt *et al.*, 1964). The scientific knowledge published in the works of scholars who worked in Slovakia or had visited this area in the middle of the 18thcentury and later was focused on a narrower and more content-shifted content, into the polymaths content of individually forming branches of natural sciences (Herčko, Weis, 2014).

Daniel Speer, the native of Silesia, realized interesting travel at the beginning of the second half of the 17th century in the Northeastern and Eastern Slovakia. This travel should be considered as a sort of mining tourism. The teacher of music, traveler, and writer wrote adventure novel with an autobiographical character under the name *Ungarischer oder Dacianischer Simplicissimus* he described their trips along the High Tatras, Spiš, Liptov, Šariš, Eastern and Central Slovakia and a stay in Košice between 1650 and 1660 (published in 1683). The novel describes not only the local circumstances, but also information about mineral springs, geological landmarks, and mining sites.

The authenticity of his description of the underground mines and the work of miners shows that he also most likely visited the essential free royal mining towns of Banská Štiavnica, Kremnica and Smolník.

He described entering the mine in Banská Štiavnica as follows (Vlachovič, 1975): “I drove myself down into the deepest shaft or mine, I had to undress my clothes and put on a mining suit, because from the local atmosphere and the hot fumes everything will get yellow... Then, when we prayed, we sat down and drove down in the name of the Lord on a fifty fathom long rope attached to a winch. When we came to the bottom, we had to go further down using many ladders, and the man who was the supervisor of the miners

led me with his lamp fixed on his head into many, large and partly dangerous and narrow passages, which were also very well supported by boards and pillars. People were so subdued and pious underground that I would never assume of them in the inn. Greetings said: *"Zdar Boh!"* (meaning "May God give you success!"), and everywhere we met the miners, we had to greet (...)"

The cementation in local mines in Smolník was described very interestingly (Vlachovič, 1975): "later I got one hundred and thirteen-fathom famous deep mine on Spiš... This mining town was called Smolník, very well known for its vitriol water, which can decompose iron in a month so that they can rake it off in the chutes with whiskers. Good copper is exported to Venice. I have not got any deeper in my whole life." D. Speer further describes the process of producing copper by cementation, also pointing out a significant amount of copper icicles, hanging not only from rocks but also from mining reinforcements. He also wrote that the water flowing from the cementation into the Smolnícky brook was so unsuitable for the animals that there were no fish, otters, frogs or other animals. He also remarked that the copper ore gleames are as beautiful as gold and that he took some pieces with him.

Edward Brown (1642–1708), who was the court physician of King Charles IV, was one of the most important visiting travelers in the second half of the 17th century. He made his way to the Central and Southeast Europe from the initiative of the Royal Learned Society in London of which he was a member (Tibenský, 1966; Herčko, 2002). His observations from this almost five-yearslong journey (1668–1673) are published in a travel book (Fig. 25) *A brief account of some travels in Hungaria, Servia, Bulgaria, etc.*, published in London in 1673 (Brown, 1673).

Based on the description of Brown's journey, we are able to reconstruct his travel to the Central Slovakian Mining Towns (Fig. 26) and his professional interest in mining, mining technology, mining towns, mining underground, mineral springs, minerals, thermal springs and baths, and in the landscape and the life of people connected with mining in this part of Upper Hungary (Brown, 1980).

Edward Brown set out on his study trip from England in 1668 and came to Bratislava via the Netherlands, Germany, and Vienna. At the beginning of March 1671, he set out for mining towns in Central Slovakia and came to the town of Žarnovica on March 22. On the second day, continued through Hodruša to Banská Štiavnica. Besides the detailed knowledge of the city, which is confirmed by the description in his travelogue, he was also interested in mining underground and technical facilities in the underground. He was most attracted by the Saint Trinity shaft, which he examined quite closely and reached the surface on the other side of the hill. He drove down into the Vindšachta shaft, as deep as the water allowed him Here he observed the extensive technical equipment, capstans and water wheels that pumped water. He also mentions that the mine was so hot that he had to be half-naked. He was very interested in everything about mining, and therefore made trips from Banská Štiavnica to the surrounding area. He visited the Spa Sklenné Teplice, where he bathed in the local spring and in his travelogue he gave a detailed description of the spa springs appearance, where the local miners bathed together with him. He had also visited Paradajs and other surrounding mines. An interesting explanation is given about a visit to the underground of an unknown mine, which he entered along with the miner, whom he met at the spa spring in Sklenné Teplice "(...) that is why he came to visit me in Štiavnica for two or three days and brought miner's lamps and dress for two friends and me. We went with him to the underground until we came to a place where, on my great satisfaction, he showed me a great amount of vitriol that grows out of the rocks and the earth, the floor and the walls of the corridors and from the ceiling in the form of icicles, as I have also seen in many other places."

Fig. 25. Illustration from Edward Brown's travel book *A brief account of some travels in Hungaria, Servia, Bulgaria, etc.* printed 1673 in London, archive P. Rybár, P. Hronček)

After a week of staying in Banská Štiavnica, he set out for a trip to Kremnica on March 30. Here he made himself very carefully and thoroughly familiar with the city and the surface mining-metallurgical facilities.

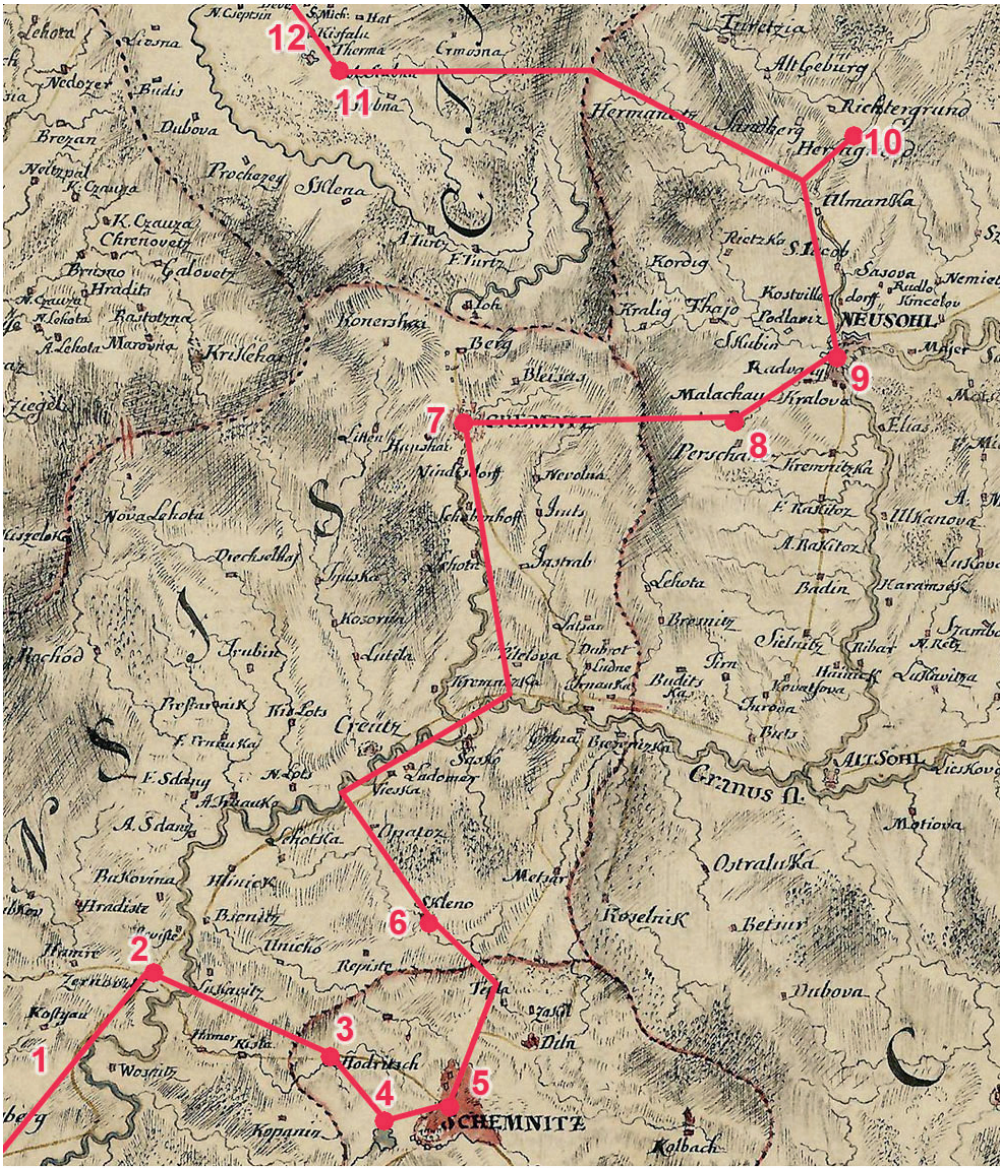

Fig. 26. Route of Eduard Brown in 1671. Legend: 1 – arrival from Bratislava, 2 – Žarnovica, 3 – Hodruša, 4 – Windšachta (today Štiavnické Bane), 5 – Banská Štiavnica, 6 – Sklenné Teplice, 7 – Kremnica, 8 – Malachov, 9 – Banská Bystrica, 10 – Špania Dolina, 11 – Štubňa, 12 – departure via Bojnice and Trenčin to Bratislava, compiled by authors on the map by S. Mikovini from 1725, archive P. Rybár, P. Hronček

He drove into the underground through the Emperor Rudolf's shaft, and after a few hours of the sighting, he left the underground through the Leopold shaft. After several days of staying in Kremnica filled with some sightings, observations, research, and trips, he passed to Banská Bystrica through Kremnické vrchy Mts. along with a small mercury deposit in Malachov. In his travelogue, E. Brown himself states that the director of the mining facility, where he was accommodated, had allowed him to "look at everything."

He also visited Špania Dolina, where he visited not only the surface facilities but also the underground. On a trip to the mines of Špania Dolina, he was given a dress made of cloth coat and trousers, a reinforced round cap resembling a hat's bottom, a leather apron, and two leather knee protectors used as a protection against impacts. He entered the underground through the Dachstoln shaft and stayed for several hours. The entrance to the mine was steep, secured by tree trunks with deep slits or notches that the descender's feet leaned against. The water from the mine flowed gravitationally, but there was dust that choked and irritated, as well as poisonous vapors in many places of the mine. He watched as they remove hazardous fumes using blasting bags that were used for several days. Many underground corridors were excavated in a solid rock without any reinforcements (Fig. 27). Some adits lied between solid rocks and eroded rocks, so they are reinforced with fir trunks. Mining corridors were not regular, some were neither horizontal nor close to vertical, but they were slightly declining or rising, and there were many cracks in them.

Fig. 27. Mining work according to the engraving of E. Brown from 1686, from private collection of I. Hercko

There were several sources of vitriol water, which converts iron into copper in the underground. The process of cementation and copper production using this technological process had been observed by him very carefully. After returning to the house of the mine supervisor, he had a detailed explanation of the course of the day in the underground with the use of a number of mining maps and drawings. He traveled along the river Váh back to Bratislava via Štubňa, Bojnice and Trenčín. He traveled all the way in a carriage, as indicated in several messages in his travelogue.

The territory of present-day Slovakia, especially the Central Slovakia mining district, was also visited by Jakub Tollius, a professor from Utrecht in 1687. In addition to the mines, mining techniques, and mineralogy, he was also interested in the landscape described in the form of letters in his travel book published in 1700 (Tollius, 1700). His travels primarily followed in the footsteps of E. Brown. A few years later, his work had impressed Matej Bel who published a very interesting and detailed description not only of the town itself but also of its surroundings, included in the description of the town of Banská Bystrica and its surroundings in his book *Notitia Hungariae novae historico-geographica* (Bel, 2017). The given an example is one of the oldest preserved travel descriptions of this significant mining town, which can be seen from the modern point of view as the first prototype of a travel guide of the given locality also intended for the "montane tourist." Tollius descriptions are still exciting and beneficial at the beginning of the 21st century.

As a preview sample of this unique text from the 17th century we present a description of the landscape around Banská Bystrica, according to the view that opened to J. Tollius when looking from the ridge of the Kremnické vrchy Mts. (probably from the peak Skalka) eastwards to the valley of Hron with the town of Banská Bystrica in the middle of the picture: "Not far from the town, a mountainous landscape is slowly formed descending from the high mountain peaks to the lower hills at first, then descending further into a small, but flat valley that extends alongside both riverbanks of the river Hron and from here up to the river spring itself, as well as in the opposite direction along the river stream that mouths to the river Danube. A traveler bowed down by the roughness of the mountains, is refreshed by this beautiful view of carefully cultivated land with numerous villages scattered everywhere. This experience is enhanced at sunset towards the river spring by the high mountain peaks which seem to enclose the valley sugared by the never disappearing snow (the peaks of the Nízke Tatry Mts.). A steep and majestic hill (Urpín) lies behind the town on the opposite bank of the river."

Tollius himself, despite having traveled many rich and developed regions across Europe in the second half of the 17th century, had been also excited about the splendor and

wealth of the town of Banská Bystrica, saying: "The town itself is much more spacious and more charming than other mining cities and lies a little further east, situated on a hill that protects the castle and decorated by a beautiful tower and a church. Two villages with a church and a mansion built in a very nice style lie near the town. The river Hron is widening here as if it would like to revere the town, while the brook Bystrica mouths into the river from the north. All this ensures that the town of Banská Bystrica surpasses the other mining towns by far. Visitors from every direction are coming here more often than before, and the local trading is famous. When I went to the market square the next day, I was bewondered and amazed because its extent was so spacious that it could easily embrace the entire town of Kremnica. With my own eyes, I saw that even in these unfavorable times when the neighboring places were exposed to the threat of war more than two thousand peasants gathered here, not mentioning the number of peasant women. With my own eyes, I also saw an incredible amount of bulls and horses, as well as few of the many forest and wild animals, not mentioning goods of every kind, which the richness of the fields and the work of skilled hands supplies the miners... Public and private houses encircling the square are magnificent, and quite splendid according to the fortunes of burghers, so by that sign, that is to say, from the very look of them, you will easily judge on the size of the yields from the mines."

Count Luigi Ferdinand Marsigli (1658–1730), who came from Bologna (Stoye, 1994) and was the essential naturalist who visited Slovakia, visited the territory of Upper Hungary (Slovakia) at the end of the 17th century (Fig. 28). He was a member of the most important scientific societies of the French Academy of Sciences, the Royal Society in Paris, London, and Montpeliere (Duka, 1974).

An extensive, six-volume work from his trip to Hungary in 1696 *Danubius Pannonico-Mysicus, observationibus geographiçis, astronomical, hydrographic, historical, physics, perlustratus et in sex Tomos digestus* (Danube in Pannonia and Moesia, researched by geographical, astronomical, hydrological, historical and physics observations and discussed in six volumes) (Marsigli, 1726) was published in 1726 in Amsterdam. The second volume of the work, which deals with mining is the most important for the "Slovak" mining and mineral deposits studies.

Based on the descriptions of mining sites in his work, we know that he traveled through some significant and human-made mining sites from Central Slovakia (Banská Štiavnica (Fig. 29), Kremnica, Špania Dolina) through Mineral Towns of Gemer to Spiš, where he very thoroughly studied cementation in Smolník (Figs 30, 31, 32, 33). In addition to mines themselves, he also dealt with mineralogy, conditions of deposits and mapping. His work also involves the first map of mineral deposits in Slovakia.

Fig. 28. Luigi Ferdinand Marsigli (1658–1730), archive P. Rybár, P. Hronček)

L.F. Marsigli was also engaged in collecting activities during his visit to the present territory of Slovakia. He collected some minerals he had sent to the Bologna collections to process them later. He also attempted to topographize them and thus record them on a map, which is the first map of this type from Slovakia (Duka, 1974; Tibenský, 1976). At first, he created a mineralogical map of Hungary and the neighboring countries (Transylvania, Wallachia, Serbia, Bosnia, Croatia, Slavonia). Mountain ranges (such as the Carpathians) are marked on the map in the form of small hills. In the mountains, the deposits of individual metals are marked by the old alchemist signs. The map distances are given in geometric miles. The direction of the ore vein is given in the hours according to the mining compass. The whole map actually represents the Upper Mountain mines, projected on the surface of the mining compass, divided into 24 horos. The location of the towns and mountains is distorted, and the more significant hills are marked by their names (Herčko, 2002).

Christian Goldbach, a Russian scientist of German origin, came from St. Petersburg via Bratislava for an almost two years long study visit of the Slovak mining towns in September 1722 (Tibensky, 1984). Besides geology and mineralogy, he had been carefully studying the underground, mining techniques, and attractions of the mining territories.

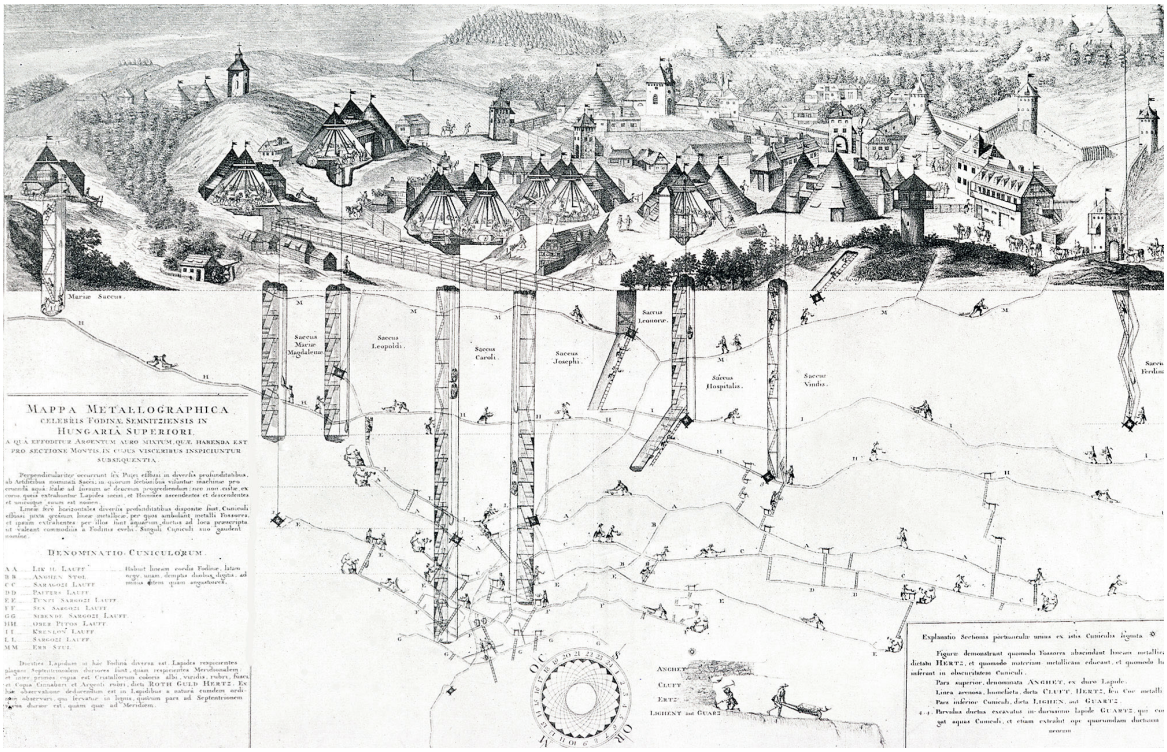

Fig. 29. Marsigli's map of Vindachta (Štiavnické Bane) dating from 1726, from private collection of I. Hercko

Fig. 30. The mining town of Smolnik in 1748, Slovak mining archive B. Štiavnica

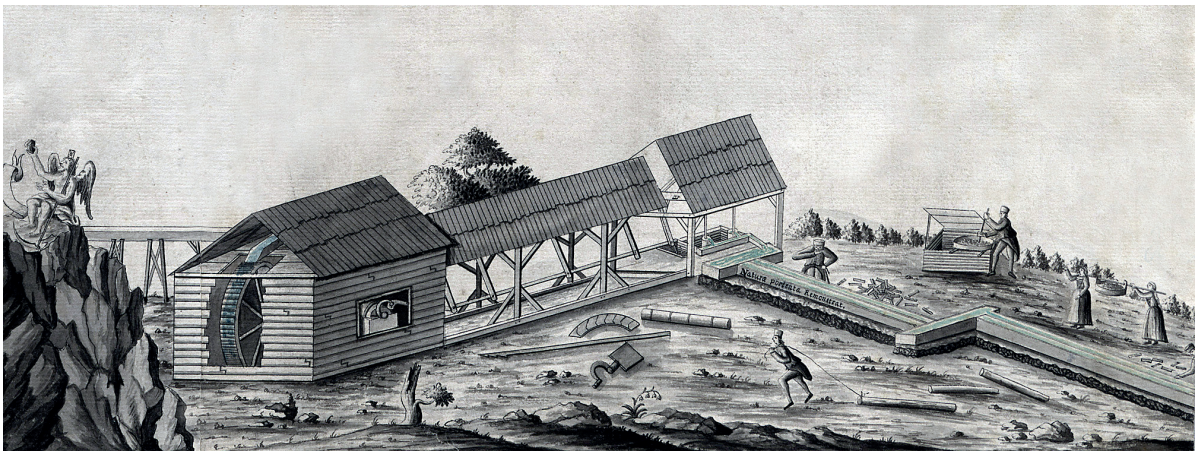

Fig. 31. Scheme of the production process of the copper cementation from 1748 in Smolník, Slovak mining archive B. Štiavnica

Fig. 32. Old heaps and galleries at Smolnik, used for the production of cementation water, photo P. Hronček

Fig. 33. Terezie water gallery at Smolnik, photo P. Hronček

The half-year long journey of the German polymath Franz Ernes Brückmann (1696–1754) the doctor in Wolffenbutell was the next step in the development of mining tourism in Upper Hungary at the beginning of the 18th century. A member of the Imperial Academy of Natural Traits and a member of the Royal Prussian Society of Sciences visited Slovakia in 1724 (Herčko, 2002). His reports were published in *Magnalia dei in locis subterraneis oder unterirdische Schatz-Kammer alter Königreiche und Länder*, published in Braunschweig in 1727 (Brückmann, 1727).

F. Brückmann (Fig. 34) arrived from Vienna to Bratislava on March 22, 1724, and from there started his tour of Slovakia. On his way, he was particularly interested in mining sites, mining, minerals, geology, minerals, deposit conditions, paleontology, caves, life and habits of local people. He traveled from Bratislava to Modra, Trnava, Hlohovec, Hronský Beňadik and Nová Baňa. Here he was very much interested in the work of a "fire" machine, which was built in 1722 by an English constructor Isaac Potter on the Althandel shaft. He watched the device in action when pumping water from the flooded shaft. He then continued to Banská Štiavnica, where he remained from 4 to 20 April 1724 (Herčko, 1975). He attended and met the surface mining-metallurgical facilities and devoted himself to studying minerals, ore veins, and depositconditions. He actively visited the mining underground, such as the shafts Windsacht, Hofer, Horná Bíberová, Mohr, and the mines in the Vyhnianska Dolina Valley and many others (Herčko, 2002). He made a brief overview of the occurring minerals and rocks (Herčko, Jedla, 1969). From Banská Štiavnica he continued through the mountains to Kremnica, where he also intensively studied mining, but also geology and minerals. He drove down into several mines in Kremnica and then continued to Banská Bystrica (Fig. 35), where he had a program similar to the previous stops, but he was the most interested in the cementation water in the underground of Špania Dolina mines. Mines in Špania Dolina Valley were the largest and most important in Europe according to Brückmann because one can go down a mine for a few miles underground and comes again to the surface elsewhere. After a thorough sightseeing of the mining attractions in Špania Dolina, he continued through the saddle of Šturec to Liptov via an old mining road. Besides the local mines, the caves in the Demänovská Dolina Valley were particularly interesting for him. On his journey he went further east through Liptovský Mikuláš to Kežmarok from where he made several excursions and study trips to the High and Belianske Tatras. In his mining route, he continued through Levoča to Dobšiná, where he stayed in the town for several days, to examine the mines for copper and iron around the town.

Next, he traveled to Smolník, where he arrived on June 12, 1724. He devoted an extensive part to his visit and observations in the Chapter XVII. *Bergwerkten in Unger und der Turckey*. Smolník is mentioned as *Schmölnitz, Smölnitz, Selmonicum, Szmolnokium, Szmolnok*. He calls it a mining town situated on the river Gelnica (*Goelnitz*) in the Spišský komitát

(*Zips. Comitat)* one mile away from Rožňava (*Rosenau*). The text says that the city has nice copper mines and cementation water (hat schöne Kupferbergwerkte und Caement-Wasser). As for the cementation itself, he states that the cementation water (*Caement-Wasser*), which local men call Ziment-Wasser, is pumped to the surface by pumps – called *kunsta*. The underground cemented water, but especially water on the surface, crossed through more than 300 cementation channels with iron (Brückmann, 1727).

From Smolnik, he continued to Prešov, where he stayed in Solivar. There, he became acquainted not only with the surface technology, but also with the underground of the mine (not yet flooded). He had to be delighted with the Solivar salt mines, because he noted: "In this mine, I was astonished to see in the hardest rock salt an intact chapel with artistically carved arches, pulpit, altar, sacristy, benches and all that is necessary for prayer service. In this underground church, where hundred people are comfortably greeted, a Mass takes place each year on the Sunday after the Three Kings (...)."

Afterward, F.E. Brückmann returned via Spiš and further down the river Váh to Bratislava and Vienna, where he arrived on August 1, 1724. Based on his correspondence, we can tell that he had visited some significant, as well as less essential mining sites throughout Slovakia as a "montane tourist." In separate letters, he described Banská Štiavnica, Kremnica, Banská Bystrica, Liptov, Vysoké Tatry, Dobšiná, Smolník, Solivar as well as other non-mining sites and towns.

Fig. 34. František Ernest Brückmann (1696–1754), archive P. Rybár, P. Hronček)

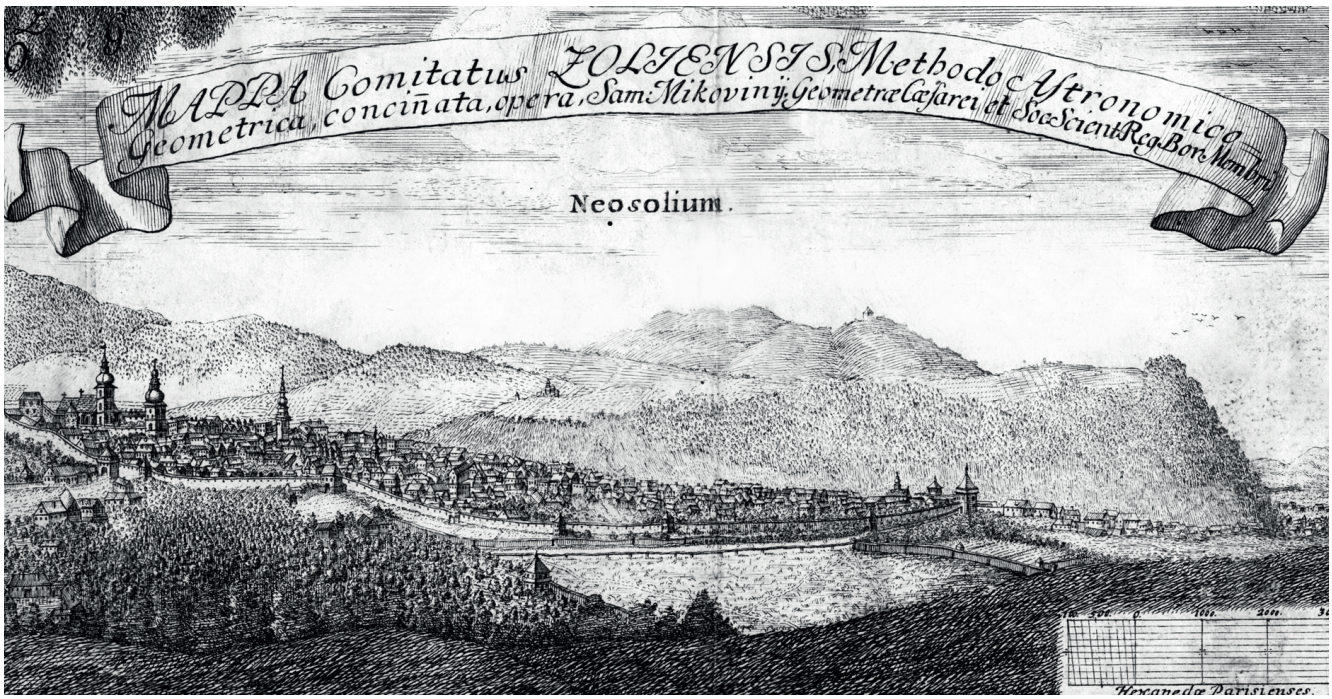

Fig. 35. The mining town Banská Bystrica on the map by S. Mikovini from 1736, archive P. Hronček

Another interesting person who traveled through the montane locations of Slovakia in the first half of the 18th century was the German polymath Johan Georg Keyssler (1689–1743). He traveled through a large part of Continental Europe and arrived in Vienna in June 1729 (Keyssler, 1758), from where he continued through Bratislava to Central and Eastern Slovakia. He had gradually visited Nová Baňa, Banská Štiavnica, Banská Belá, Pukanec, Kremnica, Banská Bystrica, Ľubietová, Nižná Slaná and other montane locations of Gemer and Spiš (Herčko, 2002).

According to the historical and historical-geographical research, Matej Bel (Fig. 36) can be regarded as the leading personality that began to form the "modern montane tourism" in the territory of Upper Hungary (present-day Slovakia) in the first half of the 18th century.

Fig. 36. Matej Bel (1684–1749), (Bel, 2017; private archive of P. Rybár, P. Hronček)

The polyhistor of a European significance was born on March 22, 1684, in Očová (district of Zvolen, Slovakia) and died on August 29, 1749, in Bratislava (Slovakia). He acquired his primary education at primary schools in Lučenec, Kalinov and Dolná Strehová. He attended the Gymnasiums in Banská Bystrica, Bratislava, Veszprém, and Pápa. After graduating from the Gymnasium in Banská Bystrica, he had acquired a university degree at the University of Halle, where he had been studying philosophy and theology during the years 1704–1707. He had been working as a teacher at the Gymnasiums in Banská Bystrica and Bratislava, where he uplifted the pedagogical level of both schools with his proficiency and by the introduction of new and progressive teaching methods. Both Gymnasiums had reached such a level that they had been sought after by talented students from the whole of Hungary. Teaching had created him an extensive network of scholars who later collaborated in the creation of his famous work *Notitia Hungariae Novae Historico-Geographica*. Matej Bel had already been respected within the professional circles during his life, and perhaps this was the reason his contemporaries called him the Great Ornament of Hungary (*Magnum decus Hungariae*). He was also recognized abroad and had been a member of several scientific societies, e.g., the London Royal Society, the Akademie of Wissenschaften in Berlin, the Societas Latina in Jena, and the Societas Incognitorum in Olomouc (Turóci, 2013).

Out of plenty of Matej Bel works (e.g. *The Old and the New Hungary, The Messenger of the Old and the New Hungary, The Preparation for the History of Hungary or The Historical-Geographical Knowledge of the New Hungary, Prodromus and others*) his detailed knowledge of the territory of the present-day Slovakia was summarized in his most important work Notitia (*Notitia Hungariae Novae Historico-Geographica*), which is the first very complex and systematic "homeland study" of the Kingdom of Hungary. Notitia contains descriptions of 48 Hungarian counties, including the Slovak ones. An important fact for our historiography is that the majority of the published counties is represented by Slovak counties. The writing starts with a historical description, followed by the description of the landscape and inhabitants of the individual counties and ends by the topography ordered according to towns and settlements. The descriptions also include information on the montane landscape, as well as details of mineral raw materials mining, whether subsurface or surface and their processing. Most of the space is devoted to mining in both the Hontianska and the Tekovská Counties, which is understandable because the towns of Banská Štiavnica (Fig. 37) and Kremnica had been located here.

Bel had also given a detailed description of the mining in the Liptovská County, in particular concentrating on the already extinct mining in the Západné Tatry Mts. These texts represent valuable sources of knowledge of historical mining in the territory of the current Tatra National Park. Interesting information for the present-day "montane" tourists heading to the most important Slovak National Park can also be obtained from a careful analysis of the old mines locations in the alpine areas of the Západné Tatry Mts. (Hronček, 2017).

Fig. 37. Banská Štiavnica with mining and metallurgical operations and with the course of ore veins on Zipser's map from 1747, from the archive of the Slovak Mining Museum

An authentic description of mines located at the highest altitude in Hungary (Slovakia), on the Kriváň Mt., at an altitude of up to 2,000 m above sea level, and their condition in the first half of the 18th century (Bel, 2014), Matej Bell wrote: "If there is a most famous hill, it is the Veľký Kriváň Mt., which leads to the west. It was named after its curved nose shape. The mountain lies to the north of Važec and neighbors with the highest ridges of the Spišské Carpathians... The peak is praised mainly because it is full of gold-bearing veins... the frost that rules over the whole region usually lasts longer and begins sooner than elsewhere, so the mining and metal processing has to be interrupted before any profit is obtained. This is also the reason why this "golden mountain" cannot be explored – but those who know how to process metals do not hesitate to call it like that."

Bel also carefully describes the mining in his native Zvolenská County, especially in the detailed description of the town of Banská Bystrica and its surroundings.

Matej Bel had also addressed the surface mining of mineral resources. He had a profound knowledge of the mining and processing of stone in the Oravská County and had given the following description (Bel, 2015): "It should be noted that the inhabitants of the Oravská County are successful in operating of stone quarries. We have learned that mainly four of them are heavily in use, namely in the following villages: Medzibrodie, Bziny, Pucov and Biely Potok... Millstones with excellent qualities are produced here as well, but I still do not know whether they are better than the millstones from Hliník... In addition to the Oravská County itself, these millstones are used in the Liptovská, Turčianska and Trenčianská counties... Moreover, they are also exported along the river Orava to the river Váh and from there not only to the neighboring but the more distant counties as well."

Only four original volumes of the writing had been printed. The Bratislavská County and the city of Bratislava were described in the first volume published in 1735, the second volume (1736) included the completion of the Bratislavská County and the descriptions of Turčianska, Zvolenská and Liptovská counties. The third volume (1737) is dealing with the Peštianska, Pilišská and Šoltská counties and the fourth volume (1742) describes Novohradská, Tekovská, Nitrianská, Hontianská and Malohonská counties (Tibenský, 1984).

Bel can be viewed as a personality of the "montane tourism" since the summer of 1708 when he returned as a young, educated 24-year-old teacher and an Evangelical priest from his studies in Halle to the native Zvolenská County and the town of Banská Bystrica. He started to apply the modern ideas as a teacher at the Evangelical Lyceum not only among his pupils, but he also developed the study of natural sciences connected with many trips to the surroundings of Banská Bystrica. He had gradually acquainted himself with the world-famous mines and technical facilities in Špania Dolina, Ľubietová, Poniky, Jarabá, Boca and other minor sites, which are described in detail in the description of the Zvolenská County in Notitia (Bel, 2017).

It is obvious that he had visited Špania Dolina several times. For example, he had visited the site to conduct a detailed examination of the cementation water in the early October 1716. He had done his "research" in the intentions of the then known scientific facts, due to his interest in chemistry, or rather in alchemy. In the work Notitia of the Zvolenská County, Bel mentions a special issue in this regard to refute G. Agricola's claims that birds or livestock are dying in it. He writes that he drunk the cementation water: "Birds, resp. Cattle do not suffocate because they soak up some malignant vapors. We have tasted the water from it not only by the tip of the tongue, but taking a proper gulp, and even after drinking it, it did not do us any harm."

We have to mention that at the time of Matej Bel, the worldwide glory of the Slovak Medieval copper ore mining in Banská Bystrica and the nearby Špania Dolina was fading after it reached its greatest prosperity in the 16th century during the Fugger period. Not only mines, but metallurgical

furnaces and other plants and technical facilities were still operating in the town's surroundings. Gradual development of iron ore mining in the area begins during this period. Matej Bel had evolved into a leading scientific personality of the then Hungary in this mining town.

Bel left Banská Bystrica in 1714 to teach at the Evangelical Gymnasium in Bratislava, where he then lived until his death. Since 1716, he started to travel from Bratislava for a several months' long trips throughout Upper Hungary (Slovakia) and Transylvania, which always took place in the summer season during the summer holidays. Objects of his studies were represented not only by the history, geography or folk customs but also the mining regions and towns. He had continued in these travels also during the following years.

The activities in the field of "montane tourism" had also increased in Bratislava besides his scientific research activities. His Europe-wide known personality had been a guarantee of the arrival of the most prominent personalities of the then European society, especially including his friends or acquaintances whom he had known personally or through his rich correspondence. His house and residence in Bratislava had become a sort of "tourist reception room" for many of these personalities.

Many important European scientists came only to learn and to study the mining areas of Upper Hungary (Slovakia) with their underground, geology, minerals, mining techniques and metallurgy. Their travels had been directed to various mining towns under the supervision of Matej Bel who recommended and mediated guides and accommodation by his friends, collaborators, and acquaintances throughout Upper Hungary. Every visit had to be signed in the "book of visits", which M. Bel led under the name *Album Matthea Belii, Doctissimi Viri, V.D., M. Posoniensi.* There are up to 189 written entries in various languages in this document (Latin, German, English, French, Russian, Polish, Hungarian, Danish, etc.) handwritten by the then "tourists." His services had also been used by the personalities mentioned above of Ch. Goldbach, F.E. Brückmann, J.G. Keyssler and many others (Tibenský, 1984).

The visit of the Austrian Emperor Francis (Fig. 38), the husband of Emperor Maria Theresa in the summer of 1751 was one of the most significant visits of the mining areas of Slovakia, respectively of the Central Slovakian Mining Towns. The main reason for the visit of Francis in Banská Štiavnica, Kremnica and their surroundings was the attempt of the rulers to gain more knowledge about the most crucial sector of the state economy and to solve the problem of how to become a successful and wealthy entrepreneur in the emerging industry. The monarch was also interested in natural sciences. The visit had been prepared very carefully. It had a precise program that evolved from the emperor`s interests, and its course had a pompous character in all aspects.

Fig. 38. Emperor František I. Lotrinský (1708-1765). archive P. Rybár, P. Hronček)

This happened especially because the re-emerging mining towns saw not only the prestigious importance of the emperor's visit in their territory but, they were above all expecting all kinds of support not only as from an emperor, but also as from an experienced entrepreneur. A substantial part of the Francis stay from 3 to 13 June was spent in the region of Banská Štiavnica, while he visited Kremnica on 8 June and had returned to Banská Štiavnica only on the following day.

The entire stay of the emperor had an accurate, preagreed and approved program followed by him and his escort. The ruler came to the Vindšachta shaft and Siglisberg above Banská Štiavnica on the morning of June 3, where a welcoming ceremony and a mining tour took place, including the examination of the Leopold shaft with a water-column pump installed. A welcoming ceremony in the center of Banská Štiavnica took place in the afternoon. The Emperor visited the Upper Bíber's shaft, and the finishing and metallurgical facilities on June 4. For the first time, he had a program outside the city on June 5, when he made his trip to Hodruša and Žarnovická Huta, and in the evening he attended the mining celebration. The next two days had a program in Banská Štiavnica, when he took part in the Saint-Trinity procession on the 6th of June and visited the calvary in Banská Štiavnica. On June 7, he entered the Glanzenberg adit and studied the precious metal test facility situated in the so-called Kammerhof. On the morning of the 8th of June, he set off with his companion to Kremnica, where he had seen the smelters, the town, the mint, and the mines, and in the evening he had seen a ceremonial mining procession. On the second day, the 9th of June, the Emperor examined the smelters and the spa in Sklenné Teplice on his way back to Banská

Štiavnica. After returning to the town, he spent the afternoon examining the administrative space of Kammerhof. The procession of the Body of God took place in the morning of the 10th of June, and in the afternoon the Emperor participated in a shooting race. The rich program on the 11th of June consisted of visiting the Ottergrundt tajch (mining water reservoir) and his technical appointments. He entered several adits and shafts and watched the military training of the Esterhazy Regiment in front of the Holy Trinity hereditary adit in the end. On the 12th of June, the last day of his stay, he attended mining officers Meeting in the Kammerhof, and later that day, he entered the Upper Bíber addition Vindšachta. A magnificent farewell to the Emperor took place after the Mass at the end of his stay in the early hours of the 13th of June, after which he began his journey back to Vienna (Čelko, 2001).

The stay of Emperor Francis I in the Central Slovakian Mining Towns had many elements of a modern form of montane tourism. According to the precise program, the Emperor was concerned not only with mining directly, but also with the related activities, technology, the secular and religious architecture of both towns, town life and habits of miners and ordinary citizens. Like a devout man, he had not left out attending of the Holy Masses. The Emperor was also interested in the economic operation of the Mining Chamber, as well as the individual factories and the mint in Kremnica. He had visited many smelting plants in the vicinity of both towns and had also been interested in spas and the spa industry.

The Holy Roman Emperor entered many mines, both in Banská Štiavnica and Kremnica. His entries into the underground carried many elements of the modern underground montane tourism. Before entering the mine, he received a unique garment or a festive mining uniform. The mining spaces he had visited were specially modified. Easy-to-access spaces had been selected where a safe passage could be ensured, and the technical equipment was adjusted – pathways, stair rails, ladders, reinforcements, etc. It is possible to reconstruct his mine entering in Kremnica on the basis of historical sources: "Next he walked alongside the vitriol production facility, alongside the Rudolf and Panna Mária adits to the so called *predný cech*, where he entered the mine in a red richly decorated damask garment, a green velvet miner`s hat and an *ošliador* – a small waisth-cloth, to the Plautzer (Plantzen) adit, which belonged to the affiliated town and Roth's mining business. The Emperor reached a depth of approximately 500 fathoms horizontally (approximately 900 m) and 50 fathoms vertically and dug offa nice the golden gravel piece that he had taken with him. Then he walked further to seethe stamping-mills" (Kianička, 2001).

Although we are talking about the head of an important monarchy and everything at that time had been adapted to it, the accompanying programs were strikingly similar to what today's participants in modern tourism require, of course, bearing in mind the interests and social rules of the 18th-century society. Welcoming and festive ceremonies had been practiced, and the decoration and customization of the town and individual streets corresponded to the events. Holy Masses, together with visits to church buildings and calvaries had been an integral part. Various ceremonial meetings of the dignitaries attended by the emperor were organized. As part of active rest, besides the mining and metallurgical sightseeing tours, multiple events like shooting competitions or spa visits had been organized. The whole town had been customized to the stay of the Emperor and his companion. It was a matter of accommodation, a special kitchen, a lot of specific gifts for the emperor, and so on.

Another crucial element of the contemporary mining tourism was the making of various "memorial"/ souvenir items. These items were adjusted to the importance of the visit and the time at when they were created. Three kinds of commemorative medals with three different image-text design were issued. They were cast in gold and silver in three sizes of 20, 25 and 29 mm in diameter. They have a great numismatic, cultural and historical value nowadays, and are stored in the Kremnica Museum of Medals and Coins (Fig. 39). The collection of stamps of the Vienna Mint (deposited in the Mint Cabinet of the Art-Historical Museum in Vienna) has still preserved stamps and punches for all three medals.

Fig. 39. Medals coined in the Kremnica mint, on the occasion of the visit of Emperor Franz I. Lotrinski, in the summer of 1751, The Museum of coins and medals Kremnica

The description of medals (Kamhalová, 2001) is following:

1. The crowned portraits of Emperor Francis I and his wife Maria Theresa and a circular inscription: FRANC. IMP. AUG.M. THERES. HUNG. REX is on the front side of the medal with the largest diameter (29 mm). The reverse side is the welcoming depiction of the ruler on horseback in the Central Slovakian Mining Region. He is welcomed by miners and town officials, in the background is a landscape with mining facilities. Above the picture is the circular text: ADVENTUS AUGUSTI, and in two bottom lines: IN FOD. HUNG. INFER./MDCCLI ADVENTUS AUGUSTI, the edge of the medal is raised.
2. The front side of the middle medal (25 mm) is the same as the previous one. The reverse side depicts the figure of the goddess Fortuna (or Hungaria) with a cornucopia of coins falling out. Fortuna is handing a piece of ore to Mercurius. Above the image is a circular text: FORTUNA REDUCI, and two bottom lines: ADV. AUG. IN FOD.H. I./MDCCLI, on the medal's perimeter, is an astragal.
3. The averse side of the smallest medal is again the same as in both previous medals. The reverse side depicts a crossed mining chisel and hammer with a six-line text above: ADVENTUS/AUGUSTI/IN FODINAS/HUNGARIAE/ INFERIORIS/MDCCLI, on the medal perimeter is an astragal.

As a demonstration of a perfectly prepared program of the visit of Emperor Francis I, which was conceived in various aspects in the intentions of today's economically successful modern mining tourism, we are presenting his stay in Kremnica from the 8th of June until the morning hours of the 9th of June, 1751 (Kianička, 2001): Emperor Francis I, together with his companion, have completed an "exploratory" journey from Banská Štiavnica to Kremnica on Tuesday the 8th of June 1751 at 6 AM in the morning. They had very likely used at that time a busy road through Sklenné Teplice and Stará Kremnička. The Emperor and his companion approached Kremnica approximately at 10 AM. The companion included the imperial-royal silver riders, the chief stableboy Duke von Auersperg, the president of the Court Chamber Count Königseeg Erps, general Marquess Spada, general O'Donnell, Count Chevallier Kinsky, Count von St. Julian, the Office Principal Baron von Toussain, the two councilors of the Court Chamber Count von Cherotin landlord von Ziegler, Chamber councilor from Braunschweig Baron von Imhoff, Baron von Heinitz, and other Court officials.

Just before entering Kremnica, the Emperor stepped out of the carriage and set off on his gray horse, while even the famous air which was undoubtedly a work of the smelters in Kremnica, did not spoil the whole act. From that moment on, the Emperor was accompanied by the principal Chamber Count, who explained to him everything he cared about and what he saw on the way to Kremnica. He visited a smelter south of the town. He had been welcomed by some town citizens, miners in uniforms, and military cavalry in front of the Lower Gate. Even the whole square was full of people who lined the road up to the triumphal gate and further to the mint, where the town nobility welcomed it, members of the Mining Chamber and clergy.

The Emperor entered the city around half past eleven and was given a formal reception in front of the mint where a symbolic key of the town was handed to him on a red velvet pillow, while the people in the square shouted "Vivat!" At the same time, there was a cannonade from the twelve cannons of the town's castle, and all the church bells had been ringing, together with the drumming of the town's infantry. Throughout the ceremony, the trumpets and drums played on both sides of the roadaccompanied by musicians standing on the first floor of the Triumphal Gate.

Then the Emperor continued on his horse to the Chamber Court where he should have been accommodated. In the end, after all the welcoming speeches, the miners were marching around him in glorious uniforms with burning mining lamps, mining hammers and chisels, troughs, rakes, forks and carpenter tools.

Without any rest, he continued his detailed examination of the mint. Next, the Emperor went to lodge on the first floor of the Chamber House where he briefly stayed and enjoyed a common lunch with other distinguished guests.

After lunch, around 5 PM, he continued on horses, with only a small companion to visit the mines lying north of the town. Here he examined shafts, adits, drainage machines, stamping-mills, smelters and all of the mining buildings. When entering into the Plautzer (Plantzen) adit, the Emperor reached a depth of approximately 500 fathoms horizontally and 50 fathoms vertically and dug off a nice the golden gravel piece that he had taken with him. He also visited the church of St. John at Kremnické Bane, which is currently considered to be the geometric center of Europe.

The Emperor returned from the tour around the mining district back to the city at eight o'clock in the evening, where a crowd shouting "Vivat Franciscus Imperator!" was waiting for him and at the same time he could hear a cannonade and a ringing of the church bells. The supper was served after a short rest filled up by a game. The day ended with a mining ceremony with burning mining lamps and an evening mining music. The evening celebrations lasted for about an hour, and then the Emperor headed for an evening rest.

The Emperor took part in Holy Mass in the parish church of Kremnica the next morning around 6 AM, and after the mass, he left the town with his companion. The departure was accompanied by the ceremonial ringing of bells, cannonades and by a large number of town commons, miners,

horse riders, and infantry. The procession of the town nobles accompanied the Emperor all the way to Banská Štiavnica. The escort passed through the Šášov Dominion and Ladomer and continued to Sklené Teplice. Here the Emperor examined the smelter, as well as other facilities. Emperor Francis I arrived at Banská Štiavnica with his escort in the afternoon and followed the official program.

The decoration of the town of Kremnica was costly and visually fascinating. A 12 fathoms high (approx. 24 m) and 8 fathoms wide (approx. 16 m) monumental triumphal gate, to which the procession had to be guided via a road lined from both sides with fir trees decorated with ribbons, was built near the Franciscan church and monastery. All of the welcoming people were dressed in uniforms according to their unions, and their horses were bluntly decorated. Throughout the night, from the 8th to the 9th June, lamps built on wooden green and white pillars burned in front of every house in the square. The lower part of the triumphal gate was illuminated, and the guards were dismantled in the city throughout the whole night.

The next step in the development of the beginnings of montane tourism in Slovakia was the sending of a Commission into the High Tatras and the surrounding area in July and August 1751. The aim of the Commission, approved by Emperor Francis I, was to assess the possibilities of extracting precious metals in the Tatras, and also speleological, geological and paleontological research. The Commission was made up of experts from Vienna, Anton Nagel and Jean Louis de Baillon, to which experts from Kremnica and Košice joined. The whole Commission was led by a self-taught mineralogist and a local expert Jakub Bucholtz from Kežmarok. The Commission set out from Kežmarok to the Tatra's area on the 29th of July, 1751. After Tatra's mining attractions, they visited old copper and precious metals mines in the Carpathian saddleback, in Zadné Meďodoly, in Velická Dolina valley, as well as the old gold mines on the Kriváň Mt. The Commission passed through Liptov, Veľká Fatra, Low Tatras, the surroundings of Brezno, Kráľova Hoľa, Spiš, the surrounding of Košice and had reached Miskolc slowly in the present territory of Hungary (Herčko, 2002).

The French montanist and metallurgist Gabriel Antoine Jars (1732–1769) was another traveler in the territory of Slovakia at the beginning of the second half of the 18th century. This scholar took a tour around Europe from Saxony, through Bohemia, Austria to Upper Hungary in the years 1757–1759, focusing primarily on the examination of mining sites. He was interested in mining, mining technology, mining underground (Fig. 40), mineralogy, deposit conditions and geology. He arrived in Banská Štiavnica in January 1758 and stayed in the town and its surroundings until June of the same year (Schmidt *et al.*, 1964).

A vital mining trip to the Central Slovakian Mining Towns was the visit of princes (throne successors) – Roman King Joseph and Archduke Leopold (Fig. 41), the sons of the Austrian Empress Maria Theresa and Emperor Francis I in the summer 1764. The education of princes was essential, and as for the throne successors they had to see the main sources of their country's wealth on their own. It is undisputed that the journey was also held on the recommendation of their father, whose was very impressed by the tour in 1751. From the preserved historical reports it is evident, that the visit of the princes in the mining towns was not just a trip, but it was primarily a logistically very thoroughly prepared and organizationally secured "study" journey, that could be called a sightseeing trip at present.

The itinerary of the journey was not accidental. His initiator was the Crown Prince Jozef, who wanted to get a detailed and plastic picture of the state of mining in Banská Štiavnica, Kremnica, and Špania Dolina near Banská Bystrica. The prince was interested in many specific issues – including the precise numbers of shafts and adits, how deep and long these spaces were, how many people worked there, where the ore is being excavated and where only a research and preparatory works were executed, what specific machines are there and how many devices are used, how to drain mining waters,

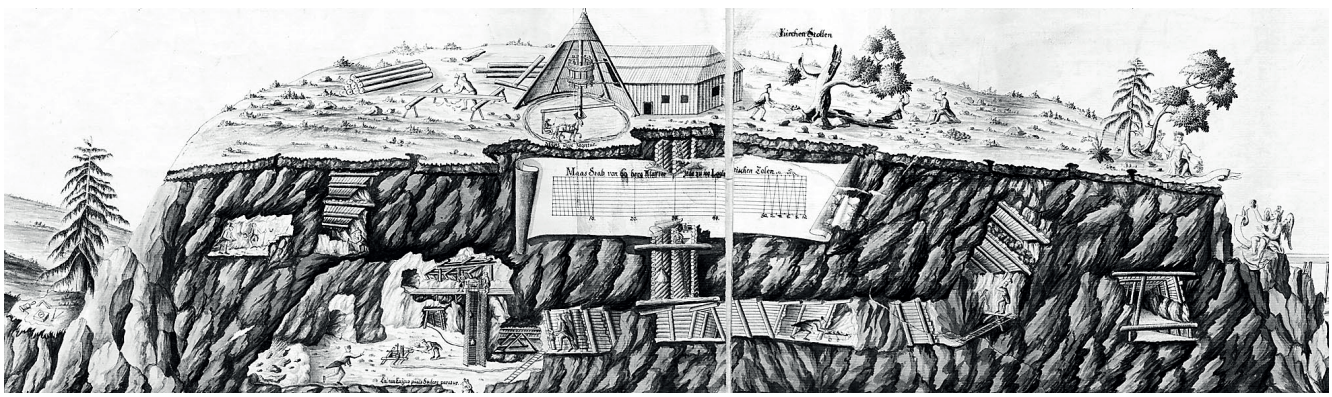

Fig. 40. Illustration of the underground mine from 1748, The Slovak mining archive Banská Štiavnica

how the whole drainage process is organized, how many water these machines drain in 24 hours, how many stamping-mills are there, how many blast furnaces and smelters, how the metallurgical process works, how many metric cents of ore and sludge are processed in the mines per month, how much gold and silver is gained, how many coins are produced, and so on (Vozár, 1983).

Fig. 41. Princes Leopold II and Jozef II Habsburg, Pompeo Batoni, 1769, Kunst Historisches Museum, Vienna, archive P. Rybár, P. Hronček

To handle a demanding program, they had to prepare detailed material. The reports that each mining town had written, served for the preparation of princes. Reporting has been demanding not only for the required number of maps, drawings, and texts, but also due to continuous adjustments and additions to their content. These reports were sent to Vienna, where they were used to write the "first mining tourist guide" (Baedeker) of Central Slovakian Mining Towns of Banská Štavnica, Banská Bystrica, Špania Dolina and Kremnica, known as *Das Goldene Bergbuch* (The Golden Book of Mining). The golden book of mining has been preserved in three manuscript specimens, which differ slightly from each other. Two are deposited in the archives in Vienna and one in the Slovak Mining Archives in Banská Štiavnica.

The professional readiness and interest of princes for the mining towns and mining -metallurgical equipment and facilities on the surface and in the underground are documented by a diary written by Prince Leopold. His diary is also filled with personal entries, which are complemented by some technical drawings of facilities and buildings (Vozár, 2014).

The journey of princes to Central Slovakia (Fig. 42) took place from the 19th to the 31st of July 1764 (Vozár, 1983). They left Bratislava on the 19th of July, about one o'clock in the afternoon, and continued through Nitra to Vráble, where they had spent the night. The princes entered the Central Slovakian mining area at around 10 AM on the day they came to the Richnavský tajch (water reservoir). They had further continued to Vindšachta (Štiavnické Bane) after short welcoming procedures and an inspection of the water reservoir, and they had arrived in Banská Štiavnica in the evening of that day. They entered into the mines of Banská Štiavnica and examined some of the mining facilities. They had visited Hodruša on Monday the 23rd of July. On the second day, they had a morning visitation to mining facilities in the surroundings of Banská Štiavnica, and in the afternoon they had examined the economic affairs of the Mining Chamber. They had continued in this activity also on the next day. After the lunch, they drove to Kremnica through Sklenné Teplice. Here they had a rich program until the 28th of July 28, when they set off to Banská Bystrica in the morning. Until the 30th of July, they saw not only the town of Bystrica and its smelting facilities but also the mines in Špania Dolina and the smelter at Staré Hory. On Monday morning they went back to Banská Štiavnica through Banská Belá, where they had spent the night. They set off on a return journey in the morning (about 3 o'clock) on Tuesday, the 31st of July 1764 and they had arrived in Vienna at about twenty o'clock in the evening.

The stay of the two princes in Banská Bystrica lasted three days from the 28th to 30th of July 1764 (Vozár, 1983). On Saturday the 28th of July they made a journey from Kremnica to Banská Bystrica. They had crossed the Kremnické vrchy Mts. via an old mining road. They were welcomed by the chair, chamber and town officials first in front of the town gate and then in front of the arch of triumph in the square. They were accommodated in the Chamber court, which had been adapted and renewed. After lunch, they visited a smelter in Tajov, a new smelter in Banská Bystrica, the Lower wood rakes used for catching wood transported upon the river Hron and the wood coal manufacture next to them. On Sunday morning, the princes participated on a military exercise of the miners from Špania Dolina, which had been presented at Mlynská lúka near Hron. In the afternoon, they examined the Medený Hámorfacility in detail, where the laborers showed them all the working processes, and later they also visited the Upper wood rakes on Hron and the wood coal manufacture next to them.

On the last day of stay in Banská Bystrica, i.e., on a Monday morning, they visited Špania Dolina (Figs 43, 44, 45).

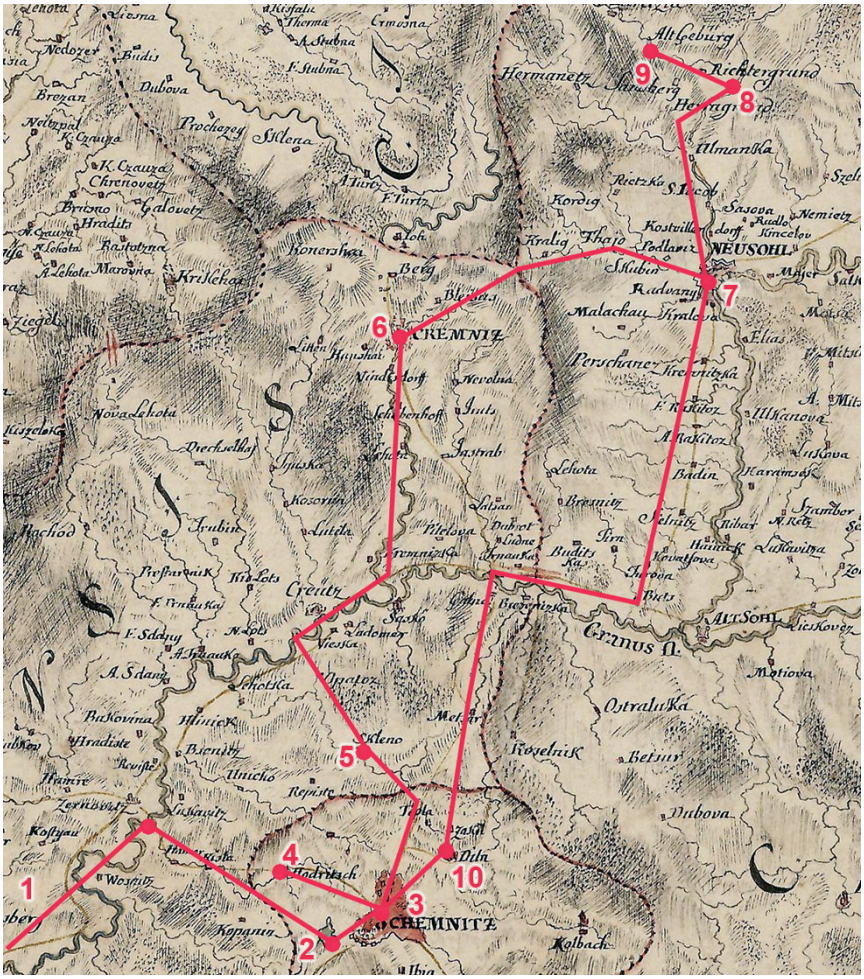

Fig. 42. Route of princes Leopold II. and Jozef II. Habsburg on the Central Slovakia mining towns in summer 1764. Legend: 1 – arrival from Bratislava, 2 – Vindšachta (today Štiavnické Bane), 3 – Banská Štiavnica, 4 – Hodruša, 5 – Sklenné Teplica, 6 – Kremnica, 7 – Banská Bystrica, 8 – Špania Dolina, 9 – Staré Hory, 10 – Banská Belá, and departure to Bratislava, compiled by authors on the map by S. Mikovini from 1725. archive P. Rybár, P. Hronček

Fig. 43. The "Denná gallery" at Špania dolina, near Banská Bystrica, where Princes Leopold II and Jozef II stepped in to the underground in July 1764, photo P. Hronček

Fig. 44. Table near "Denná gallery" at Špania Dolina, photo P. Hronček

Fig. 45. The heap of Maximilian Shaft at Špania Dolina, photo P. Hronček

Here, they had a detailed examination of not only surface facilities and buildings, but also enter the underground through the Daily adit (the adit is a tourist attraction until present). They focused mainly on the process of obtaining the green color from the mining waters, production of copper from iron using the so-called cementation waters, and extensive ore treatment facilities, as well as slag-heap washing. Then they passed from Špania Dolina to Staré Hory using the Nová (New) adit (this connection still exists today). The journey of princes and their escort lasted three-quarters of an hour. They examined a copper smelter built by the former Thurzo-Fugger company at Staré Hory. They returned to Banská Bystrica with their escort after the visit to the smelter, stopped in the town shortly and continued on their way to Banská Štiavnica.

The whole journey to the Central Slovak Mining Towns was accompanied by extensive preparations made not only by the Mining Towns, but also by the Mining Chamber and Chairs. The roads and buildings had been repaired, as well as many adjustments and reparations were carried out in mining, smelting and other facilities. Miners and other workers were preparing new uniforms, mining and military troops had been preparing and practicing. Food, accommodation, and quantities of unique and precious gifts for princes had been prepared. Triumphal arches were built for ceremonial greetings at Vindšachta near Banská Štiavnica and also at the squares in Banská Štiavnica, Kremnica, and Banská Bystrica. The town squares were ceremonially decorated, but the biggest impression was made by the square of Banská Bystrica, which reminded them of a "beautiful garden".

Princes received many gifts – memorial items. E.g., the representatives of the town of Banská Bystrica gave them ceremonial golden keys that symbolically unlocked the town gate. Their originals are still deposited at the Central Slovakian Museum in Banská Bystrica. The keys from the town gate were donated to them in Kremnica as well, and they were also given a mining model made of precious metals. Upon arriving in Banská Štiavnica, they received gold-plated brancards with golden ore and silver-plated brancards with silver ore. On each of them lied a purse woven made of golden, respectively, of silver threads in which were gold, respectively silver coins minted in the Kremnica mint only for this occasion. They also received silver and gold-plated mining insignias – a crossed hammer and chisel and a festive mining dress with a protective apron (Vozár, 1983).

The princes had enjoyed their stay rather actively, for example, they had tried to break the ore with chisels and hammers in Banská Štiavnica on the Jan horizon of the Špitaler vein. They had also tried manual disintegration of rock in Hodruša at the bank of the hereditary adit František, which

was named after their father, and even in Kremnica in the adit St. Catherine. They had also manually minted silver coins in a value of one thaler in the Kremnica mint and had taken part in shooting competitions at Banská Štiavnica during the relaxation day (on the 25th of July). Also, they were actively interested in all the processes that were shown to them in the technical facilities.

Until the end of the 18th century, several important European scholars whose priority was to study mining and related fields, which of course included visits to the mining underground and mining sites, came to Upper Hungary after the prince's visit.

One of the most important of them was Ignac Anton Edler von Born (born on the 26th of December 1742 in Alba Iulia in Sedmohradsko in present-day Romania – died on the 24th of July 1791 in Vienna), who made a journey to the Upper Hungary and Transylvania at the end of the 1860s (Fig. 46). This famous European geologist, mineralogist, and montanist focused his research mainly on the surroundings of Banská Štiavnica, but he also personally visited East Bohemian Mining Towns (Herčko, Weis, 2014). Based on his work we can assume that besides Banská Štiavnica and its surroundings, he had visited Smolník, Štós, Švedlár, Mníšek nad Hnilcom, Krompachy, Slovinky, Dobšiná and its environs and Rožňava and its surroundings (Teich, 1966).

Obr. 10. Ignác von Born. Reprodukcia starej rytiny J. Privitzera.

Fig. 46. Ignác Anton von Born (1742–1791). archive P. Rybár, P. Hronček

Anton Edler von Born' findings of the journey around Hungary are described in an extensive correspondence with the Swedish montanist J.J. Ferber, who had published them in 1774 in Frankfurt and Leipzig under the title *Brief über Mineralogische Gegenstände, auf seiner Reise durch das Temeswarer Banat, Siebenbürgen, Ober – und Nieder – Hungarn* (Ferber, 1774). It was the first "scientific" work in the history of Slovak mineralogy, which was later published in 1777 in English, in 1778 in Italian and finally in 1789 in French as well.

In his correspondence with J.J. Ferber from Sweden, he wrote mainly about mineral deposits in Banát, Transylvania and Upper Hungary. The four letters from Slovakia (No. 19–22), dated September 1770 dealing with the territory of today's Slovakia, contain many I. Born data on the minerals, rocks and ore veins, as well as the mining works in Slovak mines, especially in those located in Banská Štiavnica. For example, the twenty-first letter contains a relatively detailed description of Kremnica, Tajov, Špania Dolina, Ľubietová (Fig. 47, 48) and Nová Bana (Herčko 1977, 1978).

A world-class montanist Johann Jakob Ferber visited the surroundings of Banská Štiavnica in January 1770 during the stay of I. Born. He had also visited Kremnica, Vyhne and Sklenné Teplice during his stay in Banská Štiavnica. J.J. Ferber is the author of the most extensive and complete work on geological and montanistic conditions in mining and metallurgy in Slovakia until the end of the 18thcentury, which was written by a foreigner. He summarized his observations from his stay in Banská Štiavnica in his extensive work, which was published under the title *Physikalisch – Metallurgische Abhandlung über die Gebirge und Bergwerke in Ungarn* (Ferber 1780). In addition to the mineralogy, the work focuses mainly on the mineralogical and deposit conditions of the Banská Štiavnica orefield (Schmidt *et al.*, 1964; Herčko, Weis, 2014).

The professor of Natural Sciences of Lvov University Baltazar Hacquet made a study journey to Banská Štiavnica, in 1772, and later in the summer months of 1793 (Tibenský, 1966). Dominik Teleki, a university lecturer at Pest, who was five years later appointed as the first president of the Mineralogical Society in Jena (Szinnyei, 1909), had also visited Banská Štiavnica at the beginning of the 1790s.

Montane tourism can be associated with the arrival of a young Scottish traveler, physician, naturalist, and member of the Royal Society of Edinburgh Robert Townson in 1793. He had also visited Špania Dolina, Staré Hory, Banská Bystrica and probably Ľubietová on his way from Liptov to the mining towns of Central Slovakia. Then he continued to Banská Štiavnica, where he stayed the longest. From Banská Štiavnica he made his way to Kremnica stopping for a day in the thermal baths in Sklenné Teplice (Tibenský, 1966; Herčko, Weis, 2014). The findings of his journey were summed up in the work entitled *Travels in Hungary with a short account of Vienne in the year 1793*, published in London in 1797 (Townson, 1797).

Fig. 47. Heaps in Zelená dolina (Green Valley) at Ľubietová – Podlipa, photo P. Hronček

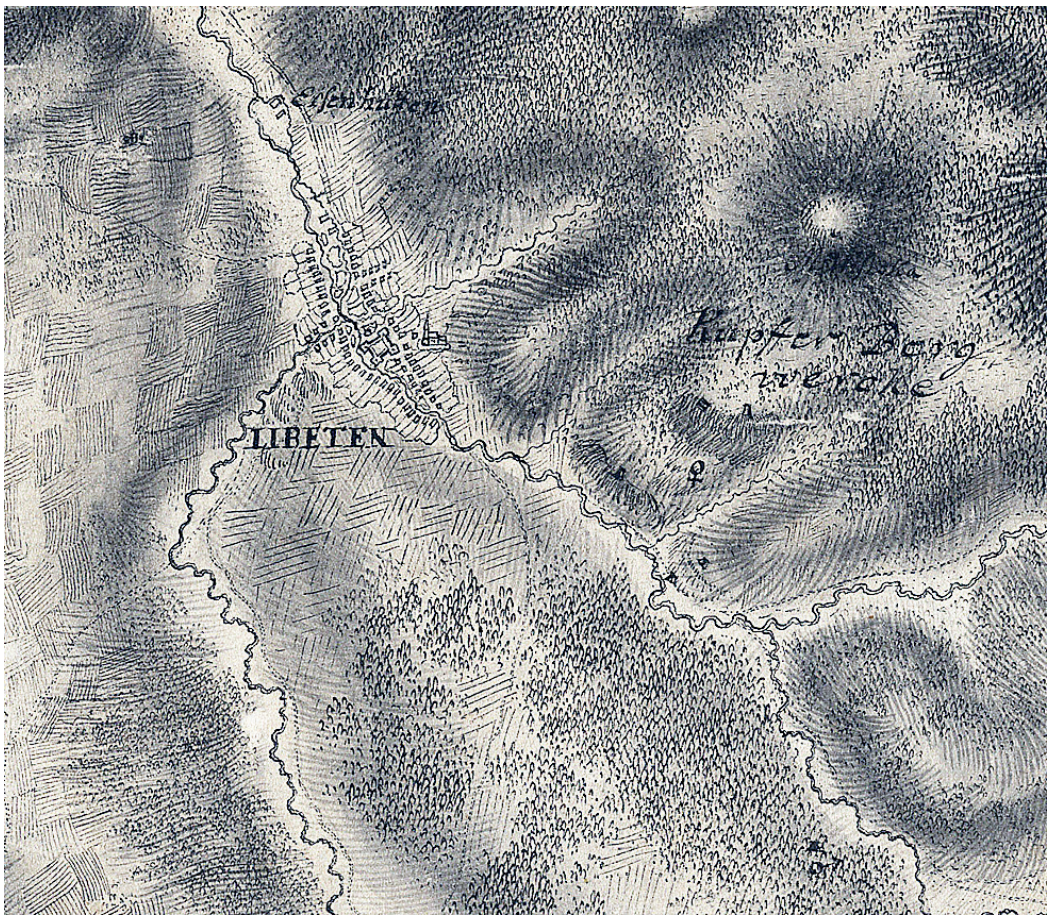

Fig. 48. Mining town Ľubietová on the map by S. Mikovini from 1725, archive P. Hronček

He further remarked that the copper mines were in operation with a loss and that copper was produced by cementation. This process was considered very lengthy, although very simple, and he never heard of it being used elsewhere. The mining and mill water was allowed to flow through the heaps, which formed a massive accumulation, almost in size of the surrounding hills. The water was captured in wooden tanks, connected to each other, in which blue-green sediment settled on the iron. Thirty tonnes of pure copper were obtained per year this way. At the time of Townson's visit, there were beautiful stalactites made of pink color sulfates, containing a few drops of free unstable water. Dripstones of pink to a blue color with a length of more than one foot (about 2 m) were collected and taken away by him (Herčko, 2003).

One of the last scientists from abroad who visited Upper Hungary (Slovakia) at the end of the 18thcentury, which we can be associated with montane tourism, was the Norwegian mining engineer and mineralogist Jens Esmark. He has been staying in the Carpathian Mountains from Central Slovakia to Transylvania (present-day Romania) for several months since the end of July 1794.

With regard to the development of the Hungarian, as well as the European society, we can conclude that the first stage of the beginnings and the development of mobility (visits or traveling) comes to an end at the end of the 18th century. This period can be identified as the beginnings of montane tourism in Upper Hungary and, thus, also the territory of present-day Slovakia.

Conclusion

It is clear that people have traveled since the very beginnings of human society. A more specific form of travel appears during the Ancient times. Travelling in the Middle Ages and at the beginning of the Modern times included not only the nobility, dukes, kings, emperors, or popes, but also soldiers, merchants, pilgrims, messengers, knights, businessmen, students, and even paupers. However, it must be remembered, that the motivation was always different for those aforementioned. It followed higher, usually more important, goals than traveling for fun, relaxation, joy or to spend leisure time. We cannot describe any of them as tourists (according to the present perception of this term), even though the first passengers, who were partly motivated by relaxation as an intention that led them to move from place to place, appeared in Upper Hungary in the 17th and 18th century.

Following the beginnings of mining tourism by the end of the 18thcentury, we must state that it relied almost exclusively on the study or scientific journeys of a narrow group of domestic and European scholars, who were attracted by the possibilities of field studies in the most crucial mining sites of the world at that time. We can therefore say that traveling not only in general, but also in montane tourism had only a little to do with relaxation and pleasure and had to be necessarily legitimized by some more serious, useful, practical or more meaningful goals preferred in that historical period.

Towards the end of the 18thcentury, traveling (even in "mining") cases which was usually related solely to education or work, began to embrace embrac a new romantic content, which was also focused on the beauty of nature and the landscape with which romantic traveling was linked mainly (Chard, 2002). In our territory, this was mainly due to an increased interest in the Tatras, which was later fully developed in the 19thcentury also in the other mountain ranges on the Slovak territory (Chorvát, 2006).

At the end of the 18th century, the word "tourist" – no longer a traveler – appeared in the contemporary writings when it was used in 1780 in a guidebook for the Lake District in Northern England. Later in 1800, it appeared in a book on the use of new English words, where the following was written: "A traveler is now called a tourist" (Chorvát, 2006). The term tourism was definitely acknowledged in 1811 when it was included in the new Oxford English Dictionary (Berghoff, Korte, 2002).

The whole insight on travel and tourism of the 18thcentury is gradually changing, especially under the influence of the ideas of the French philosopher Jean Jacques Rousseau. In his romantic approach, he begins to look at nature not just as something abstract, but as something concrete that surrounds us, that is beautiful, and without it, we would not exist. This insight is reflected in his thought when writing the following: "I understand. The inhabitants of cities, who see only walls, streets and crimes, have so little faith." (Stibral, 2005). The thinking of the society that developed in the "romantic" 19th century (Holec, 2014) originates from his ideas, in which he depicts nature as a place and symbol of freedom, good and beauty. On the other hand, civilization is described as responsible for all the evil in the life of human society (Chorvát, 2006). The changing view of the community on the landscapes and the human values of human beings are gradually reflected in travelling. Leisure time becomes the main motive of traveling in the course of the 19th century. Travelling is increasingly focused on aesthetic chracteristics and on the perception of the uniqueness of nature and the landscape. Education or science as the main motive is disappearing from montanistic journeys as well.

By the end of the 18th century, travelers who were experts in mining and related sciences, were expected to publish scientific, objective works based upon findings from their journeys, often including new scientific findings. These reports would only occasionally have side features of travel books, but everything was subjugated to the nature and its endless romantic admiration in the 19thcentury.

During the 19thcentury, traveling has become more popular with the participation of wider and poorer population, especially in the places of industrial development. Industrial workers and urban residents began to have free time and financial resources for traveling.

The experience, as a "modern" and nowadays a very widespread element of tourism, was a typical feature of the first stage of the development of montane tourism in Upper Hungary, in addition to the basic and conditional elements like education or situ research. Experiential tourism is currently purposely set up by the organizers of montane tourism and tourism itself as an element that attracts tourists. Nowadays, it includes staged activities, production processes in open-air museums, annual fairs, celebrations, etc. Tourism in the functioning industrial and mining facilities is currently a new trend, where elements of adrenaline tourism (blasts, machine roar, etc.) are also coming to the fore.

At the end of the 18th century, experiential tourism was implemented directly in the production facilities, which were modified, secured, cleaned or upgraded for these events. These events were usually arranged for one important visit of the top members of the reigning family, the nobility or the Mining Chamber. The various activities were performed by experienced masters, who have been working for many years (this is different from the current practice because these performers are often actors). These specialists were dressed in new dresses, usually in uniforms of their guilds. The entire operation had been commented and explained by the supervisor, who managed the running operation of the entire facility. Many activities were prepared so that the visitor could also try out given forms with authentic and specially made tools. This was usually a mining chisel and a hammer, which was used only once for significant visits. They also took part in safer and technically less-than-easy activities, making some object, which was later given to the visitor. For example, it could be an excavation of a rich sample of precious metal ore that had been pre-selected and prepared for the great visits so that its excavation using chisel and hammer was as simple as possible. A frequently used and also interesting process was the manual minting of memorial coins in the Kremnica mint.

The production of souvenirs was an important element. Since these were important visits, donations had to match their status. That is why these were not only original, but also rare objects. For example, memorial golden and silver coins and medals, mining insignia, or symbolic keys from the city have been preserved until now.

Another important element was the decoration of towns, for which important artists and architects were hired, who were supposed to create the elements and especially the triumphal arches. These had not only to attract, but also to overwhelm the visitors and drew attention to the wealth of the mining towns. Large escorts had to be provided with accommodation, food and security.

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   - tables **as separate *.doc files**, (for details see par. 14),
   - list of figure captions and table legends **in separate *.doc file**, (see par. 3).
6. The Authors are requested to submit supplementary documents:
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   - introduction explaining the aim of the paper and presenting the research problem,
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   - presentation of the results,
   - interpretation of the results and discussion,
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8. **The main text body** must be prepared exclusively in Microsoft Word *.doc or *.rtf formats, A4 page size, left-margin justification. Please, use normal, plain Times New Roman 12 point font, 1.5 spacing and 2.5 cm all margins. For indents, please, use tab stops instead of space bar. Please, avoid boldface and italics for emphasis as well as field functions, spreadsheets and footnotes. Please, use automatic pagination and only two ranks of headings: major headings flush left, Times New Roman 14 point bold font and secondary headings flush left, Times New Roman 12 point font. Please, do not embed figures and tables in the text body and do not mark their intended positions. Abbreviations should be defined at first mention and used consistently in the text. Please, use SI (metric) units. English geological terminology and spelling should be consistent with the *Glossary of Geology* edited by the American Geological Institute.
9. Sizes of figures and tables **must not** exceed the maximum printed area of the "Geotourism" page, which is 175 mm × 247 mm. Please, submit 1:1 scale drawings.
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    Reynard E., Coratza P. & Regolini-Bissig G. (eds), 2009. *Geomorphosites*. Verlag Dr. Friedrich Pfeil, München.
    The Oxford English Dictionary, 1989. Clarendon Press, Oxford.
    Chapters in books:
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    Cedro B., Mianowicz K. & Zawadzki D., 2009. Ocena walorów geoturystycznych stanowisk pochodzenia wulkanicznego Gór i Pogórza Kaczawskiego. In: Dudkowski M. (ed.), *Problemy turystyki i rekreacji,* 2. Oficyna IN PLUS, Szczecin: 25–35.
    Hose T.A., 2006. Geotourism and interpretation. In: Dowling R.K. & Newsome D. (eds), *Geotourism*, Elsevier Butterworth – Heinemann, Oxford: 221–241.

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Jasionowski M., 1995. Kredowa powierzchnia niedepozycji w okolicach Krakowa (Mydlniki, Zabierzów): rycia, drążenia, stromatolity. *Annales Societatis Geologorum Poloniae*, 65: 63–78.

Migoń P., 2011. Development of karst phenomena for geotourism in the Moravian Karst (Czech Republic). *Geotourism*, 26–27: 3–24.

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Krobicki M. & Golonka J., 2007. Early Jurassic distribution and migration routes of "Lithiotis" facies bivalves. *1st International Paleobiogeography Symposium, Abstracts, Paris 10–13 July 2007*, Université Pierre et Marie Curie, Museum national d'Historie naturelle, Paris CNRS, Paris, 59.

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Krobicki M. & Golonka J., 2007. Early Jurassic distribution and migration routes of "Lithiotis" facies bivalves. *1st International Paleobiogeography Symposium, Abstracts, Paris 10–13 July 2007*, Université Pierre et Marie Curie, Museum national d'Historie naturelle, Paris CNRS, Paris, 59.

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