

1. History of Mining at the Territory of Slovakia

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Abstract: The paper is devoted to the history of the mining sector in Slovakia in the timeline from ancient times to the present. The use of stone tools in the Stone Age is discussed, their production for daily necessities up to the beginning of the use of metals. In the Bronze and Iron Ages it documents the origins of the use and improvement of metallurgy and metal ore mining in our territory. The use of precious metal ore resulted in the first coinage in our territory that was introduced by the Celts. In the Middle Ages, at the times when our territory experienced a huge development of mining, which is already documented by written sources, the first bearers of mining were our Slavic ancestors. During the Hungarian state in particular the ore mining continued to develop, the execution of which was for the then society very important. After more than 1000 years in this territory the coins were minted again, based on the production in Banská Štiavnica and later in Kremnica. An important area, however, were also the Central and Eastern Slovakia copper deposits. At the turn of the Middle Ages the Hungary copper ore mining industry was the largest copper producer in the former world. From the beginning the iron-ore mining was purpose-directed as support for precious metals and copper ore mining. The salt mining significantly contributed to the history of mining and later antimony and nickel-cobalt ore exploitation. In the modern history among the non-metallic raw materials a prominent position has occupied magnesite. And we should not forget the extraction of precious opal, which has been historically our only mined precious stone. The paper is devoted to the history and creation of registers of exploration areas, deposits, old mining works and deposits exploration. It describes the Internet applications of deposits registers and their functionality and shows possibilities of development of Internet applications in the future. The assessment of the importance of deposits applications for different user groups is presented.

Key words: Precious metal mining, copper ore mining, iron-ore mining, antimony, magnesite, precious opal eposits, exploration areas, deposits applications, old mining works, deposits exploration level

1.1. Introduction

Mining can be characterized as a set of activities related to the acquisition of mineral raw materials (ores, non-metallic and energy) either by surface mining (quarries) or underground method (pits, galleries). Under the term mining we understand a comprehensive summary of the work necessary for search, extraction and treatment of industrial minerals. In a broader sense it comprises extraction of any mining non-renewable resources.

In our territory the exploitation of mineral resources has had a very long and strong tradition. The first direct written mentions of ores from Slovakia are bound to Kievan Nestor's Annals, which dates back to the 10th century.

Of course mining and quarrying took place much earlier, only there have not been preserved written sources to those activities.

The paper maps the extraction of minerals from prehistoric times to the present with an increased emphasis on mining of ore resources and briefly presents the selected extraction of non-metallic minerals.

1.2 The history of mining in prehistoric times and antiquity

1.2.1. Stone Age

The Slovak territory was inhabited since the Stone Age, in Paleolithic. From this period there are known settlements from our territory (Nové Mesto nad Váhom, Vyšné Ružbachy, Seňa, Poľov), where *Homo erectus* had lived and produced chopping-tool industry. The best-known tool of that time is hand axe used for hunting. The raw material originated from the vicinity of dwellings.

From the mid-Paleolithic (from 250 ky to 38 ky BC) on our territory much more numerous settlement of Neanderthal man and later the modern human (*Homo sapiens*) is already documented (most important Gánovce, Hôrka, Beharovce, Radošiná, Bojnice, Banka; Zámora et al., 2003). The Neanderthal man and later modern human had made great skill in stone working. He already produced stone tools which serve him for working hides, meat, antlers, bones and wood.

Of Young and Late Paleolithic (38 ky to 8,000 years BC) a large number of settlements is known in our territory; in eastern Slovakia there are known about 100 settlements (Barca, Seňa, Košice, Veľký Šariš, Tibava and others). In this period there was a great development in the production of stone tools. They were found evidence of the production of stone tools in specialized workshops where some selected specialized professionals in stone processing had worked.

In the Middle Stone Age – Mesolithic (8 ky to 5,000 years BC), and especially in the younger, Neolithic Age (5,000-2,900 years BC) and the Late Stone Age, Eneolithic (2,900-1,900 years BC) great changes occurred in human development. In the Middle Stone Age period the predatory economy started to be replaced by the manufacturing economy. Human began to cultivate the land and raise cattle. These facts required the production of new, specialized instruments (Zámora et al., 2003). The territory of Slovakia provided for the production of stone tools

several suitable raw materials. They were mainly SiO_2 materials (quartz, chert, radiolarite, volcanic glass – obsidian, less jasper, agate and chalcedony). Firstly, these raw materials were collected from streams, then from the natural outcrops at the Earth's surface, and, finally, the man began to exploit them in excavation pits and tunnels (flint Neolithic site in Zemplínske vrchy Mts., Tóhegy in Hungary).

According to some authors Eneolithic (Chalcolithic) already belongs to the Bronze Age which was a significant



Fig. 1.1 26,5 mm Copper axe blade cross-type Nógrádmárcal (4th millennium BC). The finding from the village of Podkonice 5 km southeast of Špania Dolina, weight: 1049 g, length: 236.5 mm, width of hoe blade 51.2 mm, height of the axe blade: 35.1 mm, hole diameter for shaft: 26.5 mm.

turning point in history, when the mankind began to use metals, mainly copper, silver and less gold for the production of tools of daily use, decorative and cult objects. Metals started to be collected from the outcrops of their deposits on the surface, or from streams and rivers and their sediments, later using panning (gold). The first copper tools were forged from the cold copper. Later the prehistoric man began to crush the ore in the stone mortars and to melt on charcoal. There were produced wedges, hammers (Fig. 1.1), at the beginning similar to stone originals, later, as unique tools which could not be produced from the stone. The copper started to be traded, which is documented by the so-called copper grzywna or “copper cake” found in various places of our territory (Stupava, Handlová, Kočovce; Zámora et al., 2003). In the processing of the ore to metal specialization started to be applied in the Eneolithic, with specific categories of artisans – prospectors, founders, jewellers and traders who provide the distribution of finished products or semi-finished product, in the form of so-called copper cake (Struhár, 2015).

1.2.2. Bronze and Iron Ages

In the Bronze Age (1900-700 BC), around 1600 BC, bronze industry started to prevail in our territory. Bronze is an alloy of copper and tin. Based on the analysis of findings from the Bronze Age tin was added to the alloy at a ratio of 1:10 to 1:20. The copper ore was already treated before smelting. Below the old mining works at the site Piesky – Špania Dolina stone tools (stone crushers) have been found (Fig. 1.2), by which the copper ore was beaten and mulled into flour. It is reported that in the saddle

Piesky there were found about 300 stone crushers of different sizes during surveys (Kvietok et al., 2015). At the same site there were also found remains of roasting place for ore. The tools and fireplace are dated back probably in the Early Bronze Age (Zámora et al., 2003). Production of bronze and bronze instruments was not focused only in places of their primary sites, but mainly took place in the major fortified settlements that were at the same time market centres (Veselé near Piešťany, Nitriansky Hrádok near Nové Zámky and Barca near Košice). From these settlements there has been preserved quite a large collection of objects from the Bronze Age, as well as stone and bronze pig moulds used for bronze objects casting. Under the influence of increased production of bronze tools gradually receded into the background the production of stone tools.

Among major metallurgical discoveries occurring roughly in the middle of the second millennium BC belong smelting and production of iron from iron ore. In our area iron smelting began in Hallstatt period (Iron Age) around the 7th to 5th century BC. In our territory we assume oxidized iron ores to be treated as the first ones (limonite, hematite, goethite) from the superficial parts of the iron ore deposits. An important testimony to the processing of iron ore in our territory is Molpír hill-fort near Smolenice, which dates back to the 6th century BC. Here there were found the objects where the ore was processed (forge) with iron slag as well as and semi-products of knives and iron rods. But the massive development of iron production in our territory occurred in the La Tene period. Evidence of extraction of the iron ores are also visible in the Massif of Slepý vrch Hill at Horné Orešany, an important Early La Tene hill-fort (about 5th century BC, Pieta, 2008). The most significant evidence of the extraction and processing of iron ore bind to a written report in the work of Tacitus Tusculi elegia which mentions a Celtic tribe Cotini that pay tribute Quadi and Sarmatians “to their great shame” in iron. The Cotini tribe lived probably in Gemer and Hron area and used local resources and ore. Evidence of the mining and processing of iron ore in particular, are also known from the Upper Váh settlement inhabited by Púchov culture. Especially around Strečno narrows there

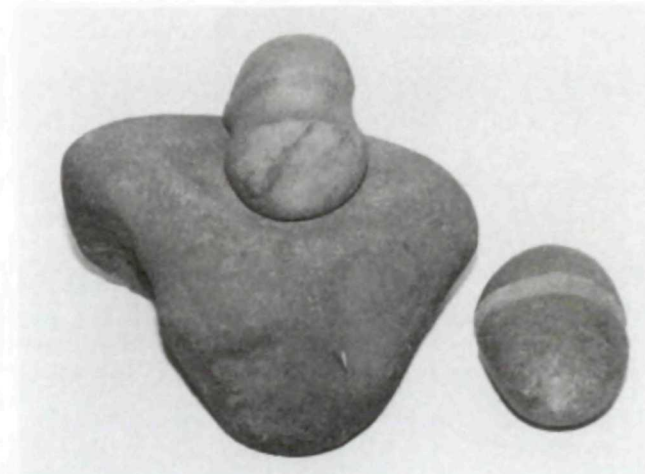


Fig. 1.2 Stone crusher and base for ore crushing. Basic tools of prehistoric miners.

is evidenced a mining centre with hematite ore mining and initial metallurgical processing. These are sites Varín and Nezbudská Lúčka with several fields of metallurgical slag heaps (Pieta, 2008).

Celts as first ethnicity in our territory also began minting coins mainly from precious metals gold and silver, less copper. In the beginning these were silver coins tetradrachms and obols dated to the second half of the 3rd century BC (Apolonia types with a lyre, Bátovce type and Ptičie type). Later they began the production of coins in Púchov culture region in northern Slovakia. There were minted coins of the types Veľký Bysterec, Spiš, Hrabušice, Liptovská Mara and Folkušová. In eastern Slovakia again we know the type of small coins of the Zemplín type from Celtic – Dacian environment. These were adjoined by gold coins staters and their parts minted in the Middle Váh valley (staters with ring and blade staters), coins of the types Nimnica, Divinka, Pohanská and Čachtice. The highlights of Celtic coinage in our territory undoubtedly include silver and gold coins from an important centre situated in the territory of present day Bratislava. There were minted coins from gold and silver – stater and tetradrachm of the type Biatac and lower monetary units (Kolníková, 2012). Issues of origin and possible extraction of precious metals from domestic sources by the Celts have not been sufficiently solved yet. It is envisaged, based on metallographic analysis, that the sources of precious metals and thus the extraction were in our territory. The mint from Bratislava oppidum could exploit the gold from the deposits in the Malé Karpaty Mts. or from Danube placers. The coin workshops in the Middle Váh valley were close to the Zlatníky placers in the Považský Inovec Mts. (Fig. 1.3). In the case of silver it is assumed that deposits of silver from



Fig. 1.3 Footprints in the form of mining pits for precious metal ore using panning on site Zlatníky.

the Nízke Tatry valleys, from Štiavnické and Strážovské vrchy Mts. and the Slovenské rudohorie Mts. were utilized (Kolníková, 2012).

1.2.3. Roman period and Migrations

In Roman times it is assumed already quite intensive mining in most well-known mining regions. Our area was settled in that period by Germanic tribes namely Quads. It

is important to mention that coinage system in our territory used adjacent Roman Empire currency and the Germans didn't mint their own coins. Based on the finds (Roman coins, terra sigillata and Roman glass) from Banská Štiavnica, site Staré Mesto (Fig. 1.4), which assumes the very



Fig. 1.4 Banská Štiavnica, location Staré Mesto, surface mining on Glanzenberg.

beginning of underground mining in the mining region, we can assume that in Roman times there was operated here quite extensive precious metal ore mining. In terms of German jewellery design and forge it is very important discovery of jewellery making workshop in simple earthing at Stupava (location Urbárske Sedliská). Here they were found several fragments of pots with traces of melting ferrous metals, copper, silver and gold (Varsík, 2011). The Germans were craftsmen in making ostentatious jewellery that symbolized differentiation of power in society, which is evidenced by the relatively numerous findings of several settlements mainly in southwestern Slovakia (Zohor, Stupava, Cífer-Pác, Očkov-Pobedim and others). For the manufacture of agricultural machinery and equipment they used primarily iron, which was supplied as tribute subjugation by Cotini tribe. The Germans were very combative ethnic and neighbouring and they led constant wars with Roman Empire known as Marcomanni wars. In early fifth century our area was attacked by nomadic Huns, which triggered a massive relocation of Germanic tribes, which historians call Migrations.

1.3. The history of mining in the Middle Ages

1.3.1. Early Middle Ages

Expansion of Slavs into our territory took place in the 5th century. Upon arrival in a new homeland the Slavs found at that time already used deposits. The Slavs brought knowledge about the exploitation of metals from their homeland already. After their arrival in our territory they began to improve technologies. This concerned mainly mining and iron ore metallurgy. Like the Germans the Slavs didn't develop their own coinage system. As medium of payment iron grzywnas served them (findings in Pobedim, Hrádok, Nitra, Bošany, and elsewhere). The ores were processed probably near the ore deposits. Particularly high levels reached Slavic blacksmithing. Knives and other tools were quenched in order to become harder. They recognized the hardening of tools using water and heat. In a workshop, various types of iron were processed, made of various ores and deposits (Zámora et al., 2003). We have no direct reports regarding the Slavic extraction and processing of precious metal ores and copper. But given the popularity of these metals by Slavs and proves of processing and manufacturing of jewellery (Bojná, Nitra, Bojnica, Pobedim) we assume that ore deposits were mined in Kremnica, Banská Štiavnica etc.

1.3.2. High Middle Ages

Exploiting of the ore deposits continued even after the demise of the Great Moravian Empire, when Slovakia became part of Early Hungarian state. Demand for iron and particularly for precious metals increased further. It seems that the ore district produced many precious metals which not only were able to cover the domestic consumption, but they were also exported. This is evidenced by the above-mentioned Primary Chronicle of Saint Nestor, which refers to the import of Hungarian silver in Kievan Rus around AD 969. The greatest importance had undoubtedly precious metal ore mining in Banská Štiavnica mining district. It is assumed that 50% of mined silver came from Banská Štiavnica ore district. This silver served as the basis for Hungarian silver coins minting. In the trade, however, not only coins were used for payment, but also so-called chopped silver. During the 10th century in Banská Štiavnica already significant mining of precious metal ore took place. There has been preserved record of AD 963 of the arrival of the Czech miners in Banská Štiavnica (Lichner, 2002). The document from AD 1156 called this territory "terra Banensium" – the land of miners. Later in 1217 it is referred to as "Bana". But the seal at the charter from 1275 already mentioned Štiavnica (Schemnitz). The historians explain that the name Bana refers to the Staré Mesto – Glanzenberg and Štiavnica was a settlement in the valley, which coincides with today's centre of Banská Štiavnica. Production of gold and silver in the 11th century can be considered as very interesting due to the high content of metals in surface part of the deposit and easy accessibility of the ores. Large pits were in rich surface outcrops of the veins Baumgartner and Goldfahrtner in Banská Belá, the

Terézia vein (Fig. 1.5), Špitáľer, Bieber and Grüner Lode. Reports on rich deposits in the area of Baňa attracted first German settlers, who gradually took over leadership not only of mining, but thanks to extensive privileges over municipalities administration. The Germans improved the work with picker and hammer and introduced a profession of worker. The mines boom brought turn of settlements to city, which in the year 1238 received from King Béla IV. town privileges and mining law. Mining importance is also underlined in the city seal from 1275, where the coat of arms comprises in addition to the city walls also mining tools picker and hammer (Lichner, 2002).



Fig. 1.5 Banská Štiavnica, traces of medieval mining on the vein Terézia.

The first written records proving the existence of Kremnica are from the 14th century. In 1328, King Charles Robert of Anjou granted "guests" – coiners from Kutná Hora in the village of Cremnych Bana special privileges to support its intensive development. The settlement thus obtained privileges of a free royal town and mining and minting rights according to Kutná Hora Law. At that time however, there developed in Kremnica mining business with a total annual output estimated at 130 kg of gold per annum (Beránek, 1977). Shortly after arriving of the coiners started minting of the first coins – Hungarian groschen in the year 1329. Eight years later the Mint increased production by gold florins minting. They later became known as Kremnica ducats. It is assumed that the mining history in Kremnica began much earlier. However, there is no written evidence, attributable to the start of mining at this deposit. The only direct evidence, however, was found in the detailed geological survey at the Šturec site. It was the rest of the wooden pillar of the old workings in Šturec, which was dated to AD 1050 by the method ¹⁴C. According to other authors beginnings of mining activity date back to the 8th or 9th century, or to the beginning of the 11th century, when in the years 1004-1008 miners came from the Harz region. Most likely the beginning of the Kremnica mining is the end of the 9th to the beginning of the 10th century. In the charter from 1385 the hereditary gallery is mentioned, for example, which had a length of 4 km. This shows the long-term use of the deposit.

Mining of deposits in the vicinity of Banská Bystrica dates back to Eneolithic. However, the privileges of free royal mining town were granted Banská Bystrica in 1255

during the reign of Béla IV. Mine owners, so-called Wald-burgers and their mining rights – to search and mine gold, silver and other metals on the whole territory of Zvolen county – were declared by charter of Béla IV already in 1242. The privileges included also the exemption of all taxes and the only duty was so-called royal compulsory metal delivery (urbura) 01/10 of the mined gold and 01/08 of the mined silver or other metals (derived from Banská Bystrica privileges from 1255).

Oldest codified mining law from Slovakia dates back to the 30s of the 13th century. It was probably Štiavnica mining law, which was in the form of privileges granted by the king Béla IV, but its wording or a charter was probably destroyed during the Tartar invasion in the years 1241-1242. To this day there have been preserved only copies in German from 1466. All mining towns in what is now Slovakia have taken it over either as a whole or at least some parts. Most decisions regarding mining were given to the free mining towns. But already King Stephen I. (997-1038), founder of the Árpád dynasty, introduced a royal mining authority, which was the predecessor of mining chambers.

The second half of the 13th century witnessed a significant development in Slovakia mining. All mined ore deposits in Štiavnické vrchy Mts. Banská Belá, Hodruša, Štiavnické Bane, but also Pukanec and Nová Baňa were exploited. There were mined also occurrences in the Nízke Tatry Mts. Vyšná Boca, Partizánska Ľupča and Hybe. The gold mines from around Rimavská Baňa were also mentioned. In the Spiš region silver was mined mainly in Gelnica, Smolník and Spišská Nová Ves, in the Gemer region in Jasov and Zlatá Idka (Zámora et al., 2003).

1.3.3. Late Middle Ages

Since the 14th century, mining in our territory witnessed a great boom, but with a deepening of mines and tracking of ore lodes in the depth the most mining districts experienced water problems. This resulted in most districts in driving of drainage tunnels and construction of installations for water pumping from mines so-called “gápel”. At the same time the deepening of mines the quality of ores reduced and quarrying was more complex and involved the participation of a large number of miners, and thus the costs of ores extraction increased. The mines were developed manually using picker (Fig. 1.6) and hammer, eventually using fire in mining operations, provided good ventilation of a mine was possible.

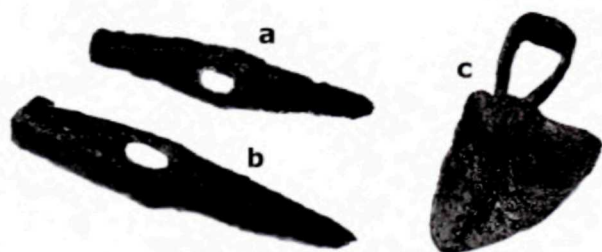


Fig. 1.6 Mining pickers and mining hoe so-called “graca”. a – Vyšná Boca, b – Banská Hodruša, c – Vyšná Boca.

In Banská Štiavnica, in the 14th century the great enemy of miners – mining water – occurred. Despite the prosperity of mining the groundwater began to decide on the progress of work. Some mines were flooded and the water could not be withdrawn out of them, so many miners had to close the mine. In each mining town based on the Regulation by King Charles Robert, a royal house was built – Kammerhof – which was a seat of Count of the Chamber. Miners were required to deliver gold and silver in Kammerhof and Count of the Chamber was solely entitled to determine purity of metals. On April 7, 1388, there was held in Banská Štiavnica constitutive meeting of the Association of Central Slovakian mining towns, with the task of joint solving of the mining towns issues.

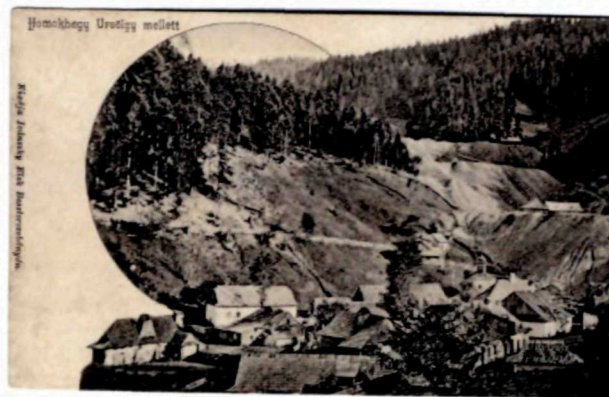


Fig. 1.7 Contemporary postcard of the mining settlement Piesky at Špania Dolina, 19th century.

15th century brought Banská Štiavnica busy times of fires and power battles for the Hungarian throne, destruction of the old city of Bana (Glanzenberg) completed by the large-scale earthquake in the year 1443. Banská Belá became a separate mining town in the year 1453, but its fame after several floodings of the main mine in the years 1383 and 1474 had never returned despite many efforts and raised funds that were spent on its restoration. Hodruša also sought for the autonomy. The mining was profitable, landscape enabled easy drainage and fast development downwards, therefore in 1494 a new heritage gallery was founded, today the Hodruša heritage gallery. In Banská Štiavnica in the late 15th century the miners began to build water reservoirs to collect surface water that served to drive water wheels.

In the 14th and 15th centuries precious metal ore exploitation in Kremnica reached its maximum and the annual gold production exceeded 400 kg, representing a third of total production in Hungary and tenth in the then world (Beránek et al., 1977). The city's prosperity in the 14th century is documented by its rapid expansion. In Kremnica water aqueducts were built to supply a propulsion for water pumping. The oldest of them, the Turček pipeline, began to be built in the 15th century.

In the 14th and 15th centuries, precious metal ore were exploited in the Malé Karpaty Mts., especially in Pezinok, then around Nitrianske Pravno, Zlaté Moravce and Zlatníky. Precious metal ore production in Smolník in this period had to be at its high when King Charles Robert of

Anjou ordered to establish in Smolník in 1328 one of the two mint chambers in our territory (the other one was in Kremnica). Many precious metals had to be exploited at the deposit in Nová Baňa, where in 1345 24 ore mills were registered.

In the Banská Štiavnica region deposits produced a lot of silver, which was extracted from tetrahedrite ore. Mining in the local mines situated in Špania Dolina, Piesky (Fig. 1.7), Richtárova and Lubietová was primarily focused on copper ores containing silver (so-called black copper). In the 14th century most of the production of black copper was exported to Venice, where at that time knew how to separate silver. The technology of copper production from the ore with its lower content was introduced at the late 15th century by Cracow burgher Ján Thurzo. Along with the Fugger traders they created in 1494 at then time a grandiose trade and commerce company "Ungarische Handel". During the first half of the 16th century the company dominated all markets with copper. The period of maximum development of copper ore mining with high content of Ag was in the period 1496-1546. In the 16th century Banská Bystrica copper enterprise (Thurzo-Fugger company) was the largest copper producer in the world.

In the Lubietová settlement, which became in the year 1379 free mining town with confirmed privileges of 1382, the copper ore mining was profitable. Only in the first half of the 15th century, when Lubietová was looted and burned by the Hussite army, Lubietová mining declined until the above mentioned Thurzo-Fugger company took control of local mining (Fig. 1.8).



Fig. 1.8 Pottery opened tallow burner from the turn of the 14th to 15th centuries from Lubietová mining field Svätodušná.

Copper ore mining was also developed in what is now eastern Slovakia. Significant mining factories were in Gelnica, Smolník and Spišská Nová Ves. Notable was mainly production of cementation copper in Smolník.

Iron-ore mining in written reports began to emerge from the 13th century. However, a major iron ore mining development occurred in the 14th century. This was also due to the development of precious metal and copper mining and metallurgy, since they needed iron for the produc-

tion of manufacturing tooling, for different pumping and conveying equipment. The iron ores were located on the territory of Slovakia in large quantities and in numerous places. In the 14th century iron ore mining was especially prevalent in the Gemer region, but also in Spiš, Abov and Hron regions. In the first half of the 14th century large change occurred in the steel production. There was introduced the water wheel to kilns and trip hammers. Extensive mining of the iron ore was established in the mid-15th century on deposit Železný vrch at Dobšiná. Significant ironworks area was formed around iron ore deposits Železník, Rákoš and Hrádok (Zámora et al., 2003). An important factor in the development of iron ore mining was the fact that royal urbura had not to be paid for the iron ore extracted or produced iron.

Written records from 13th century document salt springs in Prešov. In 1348 there were mentioned three salt springs. Brine of salt springs was exploited by Šoš family, which owned the land with salt springs.

From the 14th century on deposit in Malachov near Banská Bystrica mercury was exploited. Written reports document also cinnabar mining at sites Dubník in Prešov, Gelnica and Dobšiná. Antimony ores were mined in Čučma.

1.4. The mining in modern history to the present day

1.4.1. Early Modern Period

The beginning of modern history and thus the end of the Middle Ages in our area, according to historians was associated with Battle of Mohács (August 29, 1526) in which the Hungarian troops of Vladislav II. Jagiello were defeated by the Turkish troops led by Sultan Suleiman I. The whole period was marked by struggles against the Turks, who were also linked with Anti-Habsburg uprisings and the struggle for power in Hungary. Early 18th century our territory was befallen by pandemic plague that left significant traces in the mining regions.

The mining in the first half of the 16th century was highly influenced by the bad political situation in Hungary. After entering the Habsburg dynasty to the throne Hungary was chaotic with poor economic, but above all internal political situation. A large part of the Hungarian nobility did not support Ferdinand I as king, but his opponent, national Transylvanian Duke King Ján Zápoľský, which was supported by the Turkish Empire. Hungary collapsed and disintegrated in three separate states. Our territory remained under the influence of the Habsburgs and Bratislava became the capital and coronation city of Hungary for a long period. The flow of low-quality silver money in the country also affected emerging social dissatisfaction of miners and the struggle for their rights. The first riots started around 1525-1526 in the copper ores area with the centre of Banská Bystrica. These riots later spread to Štiavnica areas (especially Hodruša) as well as in Kremnica area. The riots were suppressed by Palatine István Werbőczy. The miners struggle for better social conditions, however, continued and the period of 16th-17th centuries was an epoch of numerous mining uprisings.

At the beginning of the 16th century there were 426 separate mining works around Banská Štiavnica. The work technology was being changed by improving transportation in the mines. Rock was initially transported in bags on backs, then pulled on sledges, then in the boxes on wheels. Finally Tyrol cars were introduced, being adapted to the conditions of Štiavnica mines, so-called Štiavnica pit cars also called Hungarian pit cars. Vertical transport was ensured by using a simple winch, later the treadmill, horse power or water wheel were used. Hydropower was needed and so the miners started to improve artificial water reservoirs. In the period 1500-1638 there were only four water reservoirs /Veľká Vodárenská, Malá Vodárenská, Brennerštôlnianska, Evička/. The water was drawn in tanks on the rope, ventilation was natural, or supported with blowers. Lighting passed from primitive rays and torches to oil burners. The development of mining requested some specialty workers – breakers /disassociating rock/, disposers /disposing rock into transport containers/ and transporters /rock transported to the place of destination/. Special squads provide water pumping. Specialized personnel were engaged in ore treatment and smelting. Individual craftsmen prepared tools, machinery and buildings for operation. Mining foreman and his assistants provided control and operation of mines, smelting and purification plant. The state gradually took over more and more mines from small miners who were unable to keep the mining operation financially.

In the 17th century, an independent mining authority, for state mines, so-called Mining Administration, was established in Vindšachta (Fig. 1.9).



Fig. 1.9 Contemporary postcard of Vindšachta, today Štiavnické Bane, with Leopold shaft building, from the 19th century.

Although in the 17th and early 18th centuries Banská Štiavnica was severely tested – Turkish raids, revolts against Habsburgs, plague epidemic in 1709-1710 to which some 6,000 people fell victim, yet still Banská Štiavnica mining progressed. Cheap labour and state as the largest mining entrepreneur who could invest in mining greater financial resources, contributed to positive development. Year 1690 was the richest year of the Banská Štiavnica mining area when the smelters produced 29,000 kg of silver and 605 kg of gold, the largest production in Banská Štiavnica throughout the life of the mines. Metal mining proceeded deeper, mining work became technically more demanding. Rock

disintegration was still manual (using pickers and hammer, exceptionally, a fire). On February 8, 1627, Gaspar Weindl from Tyrol made the first underground mining blasting in the world with black gunpowder in Bieber Upper Gallery. The blasting work quickly extended to other mining districts. The miners also started using a hand drill. Mine water was drawn from the level of heritage galleries to the surface in drainage buckets, leather bags and piston pumps. The first mention of piston pumps is from 1604 in Brenner mine. A horse power was used in 1619 to drive piston pumps. Human and horsepower was not sufficient to accommodate increasing demands for deeper mining in the mines. More emphasis was put on improving the structure of horse-powered pumps and the use of water power.

In early 18th century, in 1700-1701 the propulsion foreman Adam Unger constructed a pumping machine powered by a water wheel. Flooding of galleries became an increasing problem and threatened mines operation. To their recovery contributed mechanical master Matej Kornel Hell. He constructed a water pump in the shaft Magdaléna at Vindšachta and Upper Bieber Gallery. The development required enhanced ore processing. It began to be applied the method of treatment in stamp mills, which was one of the most important finishing processes at Štiavnica ores. The growing need for more driving water led to extension of the network of artificial water reservoirs – reservoirs that provide the energy to drive the mining machinery, water-drawing, hauling and dressing plants and smelters. This sophisticated water management system of artificial water reservoirs, powered and interconnected by collecting, connecting and conducting ditches not only saved Banská Štiavnica mining, but on its energy base there evolved mining pumping equipment, which was a model for other mining districts in the world. To its creation contributed two important figures, mechanical master M.K. Hell and Samuel Mikovíni, who was appointed in 1735 as imperial and royal geometer and the first professor of Mining School based in Štiavnické Bane.

In the nearby Nová Baňa, after a brief flowering era (14th-15th cent.), the city experienced internal turmoil in Hungarian Kingdom and anti-Turkish wars one blow after another – the destruction of the city by the Turks in 1664, Anti-Habsburg Uprising and plague epidemic. In the 17th century the town almost disappeared. Problems of groundwater in the mines hampered further mining development. The flooded workings had to be saved by fire-atmospheric engine, constructed in 1722 by English constructor Isaac Potter (machine model is in Pohronské Museum in Nová Baňa). It was the first steam engine on the European continent.

In Pukanec precious metal ore mining in this period was relatively well developed, but the periods of richer ore mining alternated with periods when the mining was non-economic. In these periods the heritage galleries were maintained thanks to the contribution of the Mining Chamber. The region was also negatively affected by Turkish wars.

In the area of Boca mining business seemed to be very promising in the second half of the 16th century, but in the 17th century, the mines were struggling along.

The Ľubietová mining for silver ore completely ceased and the mine continued to operate only for copper ore.

In the Eastern Slovakia region, the silver ores were exploited in Smolník, Spišská Nová Ves, Švedlár and partly in Rožňava.

The copper ore mining in the 17th century was mainly focused in Ľubietová and Banská Bystrica districts. But it gradually shifted to the Eastern Slovakia mining areas. The rich copper ore mines were in Smolník, Gelnica, Štós Švedlár and Spišská Nová Ves. Thurzo-Fugger Company terminated its activities in 1545 and the mines were taken over by treasury. After Bocskay and Bethlen uprisings the copper company was in a desperate state. The mines were mostly flooded and the miners had gone. The situation was partly improved as treasury signed a contract with leasers W. Paller and L. Henckel, who provided capital for the operation of the mines. Production began to rise slowly. However, the copper businesses began to be challenged by the production in Sweden first, then in Japan. In 1642 the treasury rented the mine Viennese merchant brothers Joaneli. But they rather plundered the mines and exploited the mining staff which led to dissatisfaction. After the George Rákóczi uprising in 1645 came the plague epidemic, famine and miners who did not receive wages on time had gone. In the second half of the 17th century the operation was relaunched, and the treasury introduced measures to streamline the mining and production of copper rose again. The exhaustion of ore reserves was more and more perceptible. The shafts were over 350 m deep, the costs soared, and the production declined. Specific monument of this period are typical “mining signs”, tokens, the coins that were minted for the payment of the mining by the working class. They were made of copper and possibly minted initially by miners themselves (mine owners), later by treasury in mining areas of Banská Štiavnica (Fig. 1.10), Špania Dolina (Fig. 1.11) Ľubietová, Smolník and others.



Fig. 1.10 Typical token of Banská Štiavnica in 1696 from the reign of Emperor Leopold I, diameter 22 mm, weight 2 g, probable monetary value – 1 poltura.

Iron-ore mining during this period concentrated in particular in known iron ore deposits in Spiš-Gemer Ore Mountains. However, of great practical importance was the mining in the Hron Valley, around Hronec, Poniky, Ľubietová, Breznica, Vyhne and Horné and Dolné Hámre. Production in this district was primarily streamlined in supplying precious metal copper ore and mining. There were created also new ironworks, e.g. in the late 17th century in Tisovec and Ružomberok. The ores were still large-

ly extracted from surface deposits – gossans. In general, the ores from the Hron Valley had lower metal content than those from Spiš-Gemer district. At the end of the 17th century the first blast furnaces were built; in 1692 in Ľubietová in 1710 in Hnilec.



Fig. 1.11 Typical token from Špania Dolina with inscription Herrn Grund – Špania Dolina from 1739 from the reign of Emperor Charles VI., Diameter 21 mm, weight 2.35 g, probable monetary value – 1 poltura.

The underground salt mining took place from 1572, as the treasury took in their hands the mining from the family Šoóš. Later (in 1586) the plant was leased and during Bocskay uprising completely destroyed. In 1616 the plant was leased to Prešov City. At the end of the 17th century the deposit was accessible by three shafts and developed by several galleries. The production of rock salt was constantly increasing. At the end of the Francis II. Rákóczi Uprising the plant began to decline. In the mid-18th century the salt was still retrieved in two ways; from brine and by extraction of rock salt. However, in 1752 the Solivar mines were flooded by salt water and rock salt mining terminated. The brine extraction continued (Fig. 1.12) in the Leopold shaft (Zámora et al., 2003).



Fig. 1.12 Contemporary postcard of brine processing by cooking in Solivar in the late 19th century.

For other minerals there is mentioned minute extraction of mercury, sulphur and antimony. The first mention about possible extraction of precious opal on Dubník is in the Admissions list for Stephen Kecera by Emperor Rudolf II dated 1603) (Semrád, Kováč, 2003). Upon the arrival of the Habsburgs to the throne the mining legislation big changes arrived. Already Emperor Ferdinand I was trying to impose these changes, but his successor, Emperor Maximilian II managed to enforce amendments. The change

is mainly related to decision-making power, which was transferred from the mining towns to newly-formed authorities of the Mining Judge (Bergrichter) and the Royal Office (Mining Court – Berggericht).

1.4.2. Mid Modern Period

In this period the most active mines were in the hands of the feudal state (treasury), which made great efforts to get maximum profit from the extraction. There were implemented new technologies in mining and treatment of metal ores, there were raised the mining experts who implemented new sophisticated mechanisms and thus the ore production of precious metals, copper, iron, salt, and other industrial minerals grew.

In Banská Štiavnica at the late 18th century the construction of additional reservoirs was strongly contributed by Jozef Karol Hell, who in the year 1738 built the first beam pumping machines. J.K. Hell in 1755 put into operation his invention – Hell's air pump machine which used for drive, besides water, a completely new element – compressed air. The machine was a revolutionary design ahead of its time. Nevertheless, the wide use of atmospheric steam /fire/ pumping equipment continued. In the mining region of Banská Štiavnica the most of them were built. At the end of the 18th century more economical Hell's water-column machine started to be used (Lichner, 2002).

A major breakthrough in mining of precious metal ores in Banská Štiavnica was the completion of Heritage Gallery of Joseph II. (Voznica), which started to be developed in 1782 and was completed in 1878. This drainage tunnel that drains the deposit to the level of 12th horizon has a length of 16,210 meters and in then time it was unique mining project on a European scale. This adit was very helpful in mining in the region, as it already drew water below mining level and the cost of extraction were no longer so high.

In early 19th century the Hell's water-column machines were perfected by Jozef Schitko, professor of the Mining Academy in Banská Štiavnica. The mineral processing of ores during the 18th and 19th centuries reached in Banská Štiavnica high technical level. Empress Maria Theresa adopted the proposal of John Thaddaeus Peithner and by Decision of December 13, 1762, ordered to establish a Mining Academy in Banská Štiavnica. It was the first college of affiliate programmes in the world and Banská Štiavnica became the centre of development of mining science and technology in Europe. The first lecture at the Mining Academy was delivered on October 1, 1764. With the names of professors (Jacquin, Poda, Delius, Scopoli) of this school there were associated many European, even world leaderships in science and technology. The Mining Academy later merged with the Forestry Institute to become Mining and Forestry Academy in Banská Štiavnica. The Academy raised number of mining specialists, who participated in the introduction of new methods and procedures for ore extracting virtually worldwide.

In Kremnica in the second half of the 18th century, due to the mine drainage (Deep /Hlboká/ Heritage Adit) and exposure of deeper ore units, the precious metal ore production began to increase. In the years 1748-1800 it yielded

an average of 635 grzywnas of gold and 809 grzywnas of silver (Zámora et al., 2003). However, in the early 19th century Kremnica mines already struggled with great difficulty and were unprofitable. The mines got into deeper parts that could not be drained by Deep Heritage Adit and they needed to be drawn, ventilated and transporting of mined ore was also very expensive. In 1841 the work started on the excavation of the Main Drainage Heritage Gallery which was completed in 1899. It reached a length of 15,481 m.

Precious metal ore production from other regions was negligible. The Banská Bystrica area and some Eastern Slovakia locations delivered silver to the mint in the form of so-called black copper, used for the alloying of silver, i.e., the production of alloys suitable for minting coins.

The extraction from the mines in Nová Baňa, Pukanec, Boca, Magurka, Pezinok was minimal, about 200 talents of silver and some gold. The rapid development experienced only the mines near Zlatá Idka that produced at that time about 8,000 talents of silver.

Copper ore mining in Banská Bystrica region /Špania Dolina, Lúbietová/ still survived, but the focus of mining in this period shifted to Spiš-Gemer region. The main mining towns were Gelnica, Smolník and Spišská Nová Ves, but they were gradually joined by other sites of Slovinky, Rejdová, Krompachy, Medzev, Folkmar, Helcmanovce, Poráč, Rožňava, Vondrišiel (Nálepkovo), Švedlár. On the Slovak localities it was manufactured in this period about 80% of copper, of the total amount of copper produced in Hungary and 64% throughout the Austro-Hungarian monarchy.

The iron-ore mining experienced a setback in the late 18th century. Mining treasury tried to enforce a change to make the iron minerals the reserved mineral so the State could collect urbura payment. This change, however, was finally implemented by the early 19th century. Treasury at that time was also active in mining of iron ore and owned ironworks in Tisovec, Hronec and partly in Sirk (Železník). But the private miners had still a decisive position within the mining industry. The largest miners of the period include noble families of Andrassy and Coburg. The greatest concentration of iron furnaces and forges were in Spiš and Gemer near abundant deposits. By the late 18th century about 70% of the nationwide production of iron was produced in Gemer (Zámora et al., 2003). Significant deposits of iron ore in Spiš and Gemer at this time were Železník, Rákoš (Fig. 1.13) Hrádok, Dobšiná,



Fig. 1.13 Contemporary postcard with deposit Rákošská Baňa in the late 19th century, at the forefront a mine train transporting mined ore to the treatment plant.

Slovinky, Žakarovce, Gelnica and Medzev. A major drawback of iron ore production was that it focused only on the production of pig iron (lack of manufacturing). Most of the production was exported to western countries of the monarchy, from where different ferrous products were imported (from Austria and Bohemia).

It continued mining of brine by “gápel” – brine pumping facility driven by horses – in the shaft Leopold in Solivar. At the end of the 18th century there were constructed two cookers with salt settling tanks. The production increased gradually and profits were high enough. About 80% of production was sold on the domestic market, the rest was exported. But the mining couldn't cover market demands and the salt had to be imported from Poland and Transylvania.

Lead ore was extracted mainly in Banská Štiavnica. The lead ores mining in Čavoj, Poniky and Ardovo was of local importance.

Mercury was extracted on a smaller scale on deposits in Nižná Slaná, Zlatá Idka and Gelnica.

The antimony ores began to be exploited in the late 18th century at the deposits Pernek and Pezinok. Around 1840 mining at the deposits Liptovská Dúbrava and Magurka started. In Spiš and Gemer regions the plants Spišská Baňa, Čučma and Poproč were operated.

Cobalt-nickel ores were mined from 1780 in Dobšiná. Initially, the problem was with the usage of the ore (used exclusively in the manufacture of dyes). Early 19th century the ore began to be exported to England, German States and Belgium. Extraction of the cobalt-nickel ore from the deposit Dobšiná accounted for 75% of its mining across the Austro-Hungarian monarchy.

The surface mining of manganese ores in the deposit Kišovce began around the turn of 19th-20th centuries; it supplied the local ironworks. Later, in 1908, Vítkovice ironworks began underground exploitation. But only during the World War I (1916) the mining developed on a large scale, as the import of the manganese ores was interrupted.

The beginnings of mining of magnesite in our territory date back to the end of the 19th century. Its mining was conditioned by the necessity of obtaining fireproof materials for blast furnaces lining. The magnesite deposits were discovered by workers that built the railway line Jesenské – Tisovec in 1871 between the villages Hnúšťa and Hačava. This was followed by a targeted search for the mineral, which resulted in the discovery of deposits of magnesite near Ratkovo, Jelšava, Lubeník, Ochtná, Bankov near Košice, Ružiná and Cinobaňa. In 1900, the factories of the Company Magnesit Industrie Aktien-Gesellschaft (MIAG) were built in Hačava and Jelšava. So-called Horný Hačavský plant exploited magnesite mined at the deposits Ratkovská Suchá and Burda. The raw material was transported by horse-drawn vehicles and later the cable car was built from Burda to Hačava. In 1909 the Danish company Schmidt installed rotary kiln for sintering of magnesite, which was the first of its kind in the world. The plant Jelšava was supplied from the deposit Dúbrava; the magnesite was burnt only and assorted and dispatched to the brick factory in Kőbánya (Budapest). Later other

companies and factories began to mine and process the magnesite and new plants were opened in Hačava, so-called Dolný závod, Chyžná Voda – Lubeník and Bankov near Košice.

The industrial mining of the single Slovak precious stone – precious opal from Dubník is documented in the second half of the 18th century (reign of Empress Maria Theresa). Between 1750-60 Earl Vecsey secretary Szukovicz made trial pits at the site. In 1787 the treasury expressed interest in opal mines, but in the early 19th century the state leased the mines. Gradually during the 19th century it had several leaseholders, the Viennese business family Goldschmidt operated the opal mines the longest. The most famous opal found at Dubník was so-called Harlequin, or Vienna Imperial Opal, which was found in 1775 and weighs 2,970 carats or 594 g and is now exhibited in the Natural History Museum Vienna (Semrád, Kováč, 2003).

In 1854 so-called General Mining Act came into force in the mining legislation, which replaced the former Maximilian's Mining Code. It stipulates the procedure for acquiring licenses of deposits and industrial minerals during their extraction. It was the most advanced mining regulation in Europe. The mining administration was also updated. The mining courts were replaced by mining capitanates in Banská Štiavnica and Smolník. After the year 1859 the capitanate of Banská Štiavnica moved to Banská Bystrica and the capitanate in Smolník to Košice and later to Spišská Nová Ves. Mine commissariats located in Kremnica, Nová Baňa, Malužiná and Pezinok were subjected to the capitanate in Banská Bystrica and commissariats in Gelnica, Rožňava and Spišská Nová Ves to the Smolník capitanate.

1.4.3. Contemporary Period

1.4.3.1 Period of 1918 – 1945

The results of the World War I largely marked the mining in our territory. The establishment of Czechoslovakia distorted historical continuity of essential linkages to Vienna and Budapest from the previous period. The government of Czechoslovakia was interested in a weakening of Austro-Hungarian capital, which was established within the territory of Slovakia and in domination, monopolising of industries by own (Czech) concerns. For this purpose, so-called “nostrification laws” were put in force, which obliged the non-resident companies with plants in Czechoslovakia, to translate the residence and management in CSR and to ask the State for accreditation (Zámora et al., 2003). The economic crises of the periods 1921-1923 and 1929-1933 were another factor that affected the mining in our territory. The mining development was impacted also by other circumstances. With the exception of the state blast furnace in Tisovec and in Podbrezová the ironworks disappeared and this fact affected the operation of the iron ore mines. In 1919, the College of Forestry and Mining moved to Hungary and with it most of the teachers had gone. Slovak technical terminology was only just emerging and most of the plants used German or Hungarian language and in the state mines the Czech language. The new management organization and turn in north-south

transport to Hungary to the east-west Czechoslovak route brought great difficulties. The last but not least, the beginning of the period was marked by invasion of the Hungarian troops in 1919. At the end of this period, again, the Second World War, the establishment of the Slovak State and the annexation of southern Slovakia to Hungary resulted in losing a lot of mining operations mainly antimony, iron ore and magnesite (Grecula et al., 2002).

Precious metal ore deposits were mined mainly in Kremnica, Banská Štiavnica and Hodruša. Magurka and Zlatá Idka mining deposits were abandoned in 1923 for low precious metal content. Exploratory works on deposits Nová Baňa and Harmanec were unsuccessful. All these operations were in state hands. The operation of Aurea Company in the panning of Danube placers was also terminated.

The plants in Banská Štiavnica and Hodruša were suspended in 1923-1931 due to the reconstruction and rehabilitation of mining and smelting facilities. From the original number of 1,500 miners only 600 of them remained employed. There were launched preparatory works for the opening of the richest veins of ore columns Špitáľer and Grüner, and deepened the shafts František, Emil and Mária for ventilation. Later the work began on Maximilán shaft and Svätotrojičná (Saint Trinity) and Pacher galleries (Fig. 1.14). The system of stamp mills and treatment plants was also redesigned. At the František shaft a modern flotation plant was built in the year 1930, which alternately processed the precious metal and polymetallic ores. Around 1930, a full mining operation with extraction was launched on the precious metal ore vein Grüner and polymetallic Špitáľer vein. In the observed period there were extracted a total of 405,000 tonnes of ore, of which 187,000 t were precious metals ores and 13,920 t of lead concentrate was produced. The water reservoirs mostly lost their original purpose, ceased to provide energy and water began to serve fishermen and tourists.



Fig. 1.14 Contemporary postcard of Pacher Štôľňa plant in the early 20th century.

The plants in Hodruša implemented an exploration programme focused in Schöpfer vein (Dolný závod – the Lower plant) and Finsterort and Východná veins (Horný závod – Upper plant). The work was carried out also in Vyhne in the veins Pod Šivárňou. As the quality of ores did not reach the expected parameters, in 1939 began the prospection of the Rozália vein for copper ore.

In the year 1922 the plant in Kremnica was taken over by Ing. Aurel Lehotzký, who was a native of Kremnica and a graduate of Mining Academy in Banská Štiavnica. He elaborated a plan of the plant reconstruction, which focused on more promising veins in the mines Ferdinand, Ludovika (Fig. 1.15) and Anna. The ore was treated by amalgamation associated with flotation followed by leaching in the cyanidation facilities. In the period discussed 495,000 t of precious metal ores were extracted, and from the concentrate approximately 2 tons of gold and 4 tons of silver were produced. Thanks to utilizing of the Turček pipeline the mine was self-sufficient in electricity production. The reconstructed hydroelectric system (Ferdinand shaft, Anna shaft and shaft no. IV) allowed to supply electricity even to the public grid.



Fig. 1.15 Contemporary postcard of the Ludovika shaft in Kremnica with the heaps and Šturec undermined area in the early 20th century.

The gold and silver were also produced in the metallurgical process from antimony concentrates and polymetallic ores with factories in Čučma and Medzibrod.

The copper ore mining in this period developed at the deposit in Slovinky. This was originally a plant focused on complex siderite ore with a relatively high copper content of 4 %. Following the liquidation of the Krompachy Ironworks it was decided that the iron component of the deposit will be mined. After installation of the copper smelters in Krompachy the mining was again put into operation in 1938 and it continued only with the extraction of copper ores. In the period 1919-1944 the deposit produced 1,043,000 t of the copper ore which represented 97.7% of the Slovak production.

The iron ore mining experienced problems with finding mined ores markets. For example, in 1929 the mining of iron ores reached 999,000 tonnes, representing 55% of the entire mining in Czechoslovakia, but only 32% of its needs. From 300,000 t of pig iron at the beginning of the reported period, in 1929 the production decreased to one tenth. The abandoned ironworks were replaced by the new steel capacities in Bohemia (Třinec and Vítkovice) and Hungary (Ózd, Diósgyőr). Mining continued at the deposits Koterbachy (Rudňany), Máriahuta, Roztoky, Grétla, Bindt, Mlynky, Dobšiná, Nižná Slaná – Vlachovo, Železník Rákoš, Sirk, Rožňava, Nadabula and Luciabaňa. In the reported period a total of about 20 million t of iron ores were extracted.

Mining of manganese ores decreased compared to war years, the original level was achieved during the WWII

and even doubled in 1943. Most of the production was supplied by deposit Kišovce – Švábovce, during the the WWII Michalová and Čučma deposits were mined.

Antimony mining made a significant progress in the period. Exploration and mining activities were conducted on deposits Čučma, Banisko in Bystrý potok stream, Spišská Baňa, Tinnesgrund, Poproč, Zlatá Idka, Pezinok, Magurka, Dúbrava, Medzibrod, Lom, Dve Vody, Chyžné and Zlatá Baňa. Antimony production was rising rapidly, saturated domestic market and exported the surplus. In 1930 the smelter was reconstructed in Vajsková, and it was capable to produce all the required metallurgical products on the market (regulus crudum, oxide) and Au-Ag bullion from concentrates. In the years 1933-1935, Slovakia participated in world 5-7% of antimony production (Zámora et al., 2003). Overall, for the period 428,400 t of the antimony ores at all deposits were extracted (Grecula et al., 2002).

The extraction of mercury ores was carried out in the deposit of complex ores in Koterbachy (Rudňany; Fig. 1.16), where it was a by-product of the extraction of siderite. There were also mined deposits Gelnica-Zenderling and Merník. Of the total production in Rudňany were mined 91.2%, and in Merník 8.4% and in Gelnica-Zenderling 0.4% (Zámora et al., 2003). During the reported period 1,698 t of mercury were extracted on deposits (Grecula et al., 2002).



Fig. 1.16 Contemporary postcard from Rudňany (Koterbachy), mining and processing of mercury ore in the early 20th century.

Magnesite mining was impacted negatively by the recognition of nostrification law, since all the magnesite works were in private hands. At the same time the development of the magnesite industry had an impact on liquidation of the Slovak iron industry in the period after the First World War. Sales to the market represented only 2-3% of total sales. Czech companies were mainly supplied by fireproof materials from Austria. On this market Slovak magnesite works supplied only 7-8% of total sales. The Austrian magnesite industry gained worldwide dominance thanks cartel among the main suppliers of fire-proof materials, which set disadvantaged quotas for the producers from Czechoslovakia. The overseas export of our production had to compete with the magnesite production from Greece and Yugoslavia, thanks to low-cost shipping. In the reported period there were mined deposits Hnúšťa - Dolná magnezitka, Ružiná, Košice – Bankov, Lubeník, Studená, Hačava, Hnúšťa – Horná magnezitka, Ratkovská

Suchá, Burda, Ploské, Sirk, Jelšava (Fig. 1.17) and Ochtiná. The products were exported practically to the whole of Europe. Of the total amount 8.5% were sold of the raw magnesite, 76% as clinker and only 15.5% magnesite as a final product. This also reduced the use of such prosperity of this scarce raw material (Zámora et al., 2003). For the reported period there were extracted in all plants around 2.6 million t of raw magnesite.



Fig. 1.17 Contemporary postcard of the magnesite factory in Jelšava the early 20th century.

Brine mining continued in the plant in Solivar that was named in 1925 after President Masaryk. The plant was completely rebuilt and salt was treated on the principle of vacuum cooking. Since the flooding of the mine in 1752 just salt in the form of brine was exploited without direct contact with the deposit, a survey proceeded, which should clarify the structure of the deposit. Four exploration wells completed in 1922 didn't sufficiently clarified the deposit geometry.

The Dubník deposit of precious opal was allocated to Soľné Bane Company. The directorate of the company did not manage the Dubník mining and it was the beginning of the end of the opal mines. Then Czechoslovakia rented opal mines for 10 years French enterprise Bittner – Belángenay in 1922. However, the company was unable to continue in mining of opals and so in the same year its activity ceased.

First systematic geological – deposit studies in our territory were carried out by State Geological Survey of Czechoslovakia in the territory between Vrútky and Žiar nad Hronom. The Czechoslovakia government's effort was not to create better conditions for the development of geology and mining in Slovakia, creating a geological or mining research organizations or technically oriented university. Prospective students had to study mining engineering at Příbram or Austrian Leoben. In the field of mining science and education in the period reported the first State Mining Museum in Banská Štiavnica was founded in the year 1927. Dr. F. Fiala was commissioned its management and the organization had research character. After his retirement in the year. 1939 the activity of the Museum stagnated. Only after the creation of an independent Slovak state the efforts to establish a professional base for deposit research emerged and paved the way for the emergence of Geological Institute of Slovakia.

1.4.3.2 Period of 1945 – Today

The end of the Second World War was the beginning of division of the European countries in two different socio-economic groupings. On April 5, 1945 the Košice Government Programme ratified the complete subordination of Czechoslovakia to the Union of Soviet Socialist Republics (USSR). It was the beginning of the “popular democracy” and the building of the social set up under the leadership of the Communist Party of Czechoslovakia. Of particular importance for the development of mining was a government decree on the nationalisation of mines and the key industries undersigned by Dr. Eduard Beneš on October 24, 1945. All plants and related properties passed into state property, which commissioned the newly established national management companies. In Slovakia, based on the reported deposits, the following companies incurred in 1946: *Železorudné bane* (Iron Works), national enterprise (n.p.) *Spišská Nová Ves*, *Rudné bane* (Ore Works), n.p., *Banská Bystrica* and *Slovenské magnezitové závody* (Slovak Magnesite Works), n.p., Bratislava, later Košice.

In the first years after the WWII there was still in force General Mining Act of 1854, building on the private business. In order to ensure intensive and economical use of mineral deposits the National Assembly of Czechoslovakia adopted on July 5, 1957, Act. 41/1957 Coll. on the exploitation of mineral wealth – the Mining Act. The law defined and introduced new concepts such as reserved and non-reserved minerals, exclusive deposit and mining area and it contained provisions ensuring planned and comprehensive prospecting and exploration. Stewardship over compliance with mining regulations was entrusted with State Mining Authority. The subjected district mining offices (OBÚ) were based in Banská Bystrica and Spišská Nová Ves, later amended on OBÚ in Košice (1945), Bratislava (1954) and Prievidza (1959). The OBÚ were directly subordinated to State Mining Office Inspection in Bratislava (till 1954) and later to Central Mining Office in Prague

Železorudné bane, (n.p.) Spišská Nová Ves comprised several factories. In *Rudňany* mining of siderite ore and mercury was carried out. The total quantity of mined siderite ore during the reported period that covers the years 1945-1990, was 30,615,000 t. Despite a rich tradition and extensive ore field, *Plant Dobšiná* had a problem to ensure more high-quality ores and after the 1958 the Plant was cancelled and production stopped in 1969. For the period 1,363,000 tonnes of iron ore were mined. *Plant Luciabaňa* as a standalone plant ended mining in 1962 and total mining was stopped in 1969. In the reporting period 1,964,000 tonnes of iron ore were extracted. Prior to nationalisation *Plant Železník* was formed by two or even four mining enterprises. The industry nationalisation joined together all of the deposits. In 1946, the plant *Rákošská Baňa* associated the *Železník* plant. In 1957, exploration work managed to clarify the geological structure of the hill *Železník* with deposits *Železník* in the north and *Rákoš* in the south. Extensive exploration work didn't identify such reserves of metallic ores that would ensure the prosperity of the

plant. This resulted in the completion of mining of iron ore in 1965. The deposit produced in the period reported 3,450,000 t of iron ore. In the period 1975-1987 there were mined at the deposit *Rákoš* mercury ores, but the operation was unprofitable. *Plant Rožňava* with the sections *Drnava*, *Malý Vrch*, *Dolný* and *Horný Hrádok* formed one of the largest iron ore plants in Slovakia. In all known deposits intense mineral exploration took place in post-war times, which ensured workable reserves of iron ores in the veins in *Rožňavské Bystré*, *Rudník*, in the central part of the ore field in the deposits *Bernard*, *Sadlovský*, *Štefan* and *Mária baňa*. In *Mária baňa* the vein *Mária* was reviewed and in 1981 vein structure of *Strieborná* was discovered, with high content of silver in tetrahedrite (150 to 400 g/t). The vein was investigated in detail in the years 1985-1991 and verified a great hopefulness of the mineralisation. The mining works on iron ores were completed in the entire mining district in 1993. In total, in the reported period the production in this mining district equalled to 9,988,340 t of siderite ores and 2,422,700 tonnes of siderite-tetrahedrite ores. *Plant in Nižná Slaná* thanks to intensive geological exploration at the deposit *Manó*, which resulted in the reserves calculation in the year 1966, ensured the annual extraction of 700,000 t. for 45-50 years. Another geological survey verified the depth continuation of the deposit as well as perspective eastern part *Kobeliarovo*. The positive results of the survey ranked the district *Nižná Slaná* as the biggest iron-ore region in *Spiš-Gemer Ore Mountains*. In the period reported there were mined in this ore district 16,471,800 tonnes of iron ores. The operation was stopped in 2008. *Plant Smolník* extracted pyrite copper ore, which were already the subject of mining in pre-war years. The pyrite ore was processed to a coarse concentrate that was suitable for burning in furnaces for the production of sulfuric acid in all Slovak pulp and paper mills. The granular pyrite rash, containing more than 50% Fe was sold to *Vítkovice ironworks*, which extracted the copper and silver from it. Mining of these ores ran until 1989. During the period the deposit produced 4,980,700 tonnes of copper pyrite ores. *Plant Slovinky* in the post-war period appeared to be a non-profitable and this plant didn't get any support. Only in 1948, a report evaluating the efficiency of the mining and metallurgical processing of metals (Cu, Au and Ag), was elaborated. This report launched a series of situations that led to the re-establishment of the plant and the start of extensive exploratory programme. From 1950 to 1990, there were extracted in this plant 8,437,000 tonnes of copper ores. *Plant Švábovce* comprised two deposits of manganese ores in *Švábovce* and *Kišovce*. The end of mining at these deposits was influenced mainly by cheap ore shipped by USSR – the world's largest producer of manganese ore. For the period reported there were extracted a total of 3,430,000 tonnes manganese ores (Zámora et al., 2004).

Rudné bane, n.p., Banská Bystrica comprised plants in *Banská Štiavnica*, which even in the post-war years exploited precious metal ores, particularly on the vein *Grüner* and base metal ores were mined on *Špitáler* vein. Exploration works till 1952 were not systematic, they just met momentary needs. Intensive geological survey started in

1952, but not to a sufficient scale even up to 1965, so irregular development long-term affected the economy of these deposits. After the construction of a Nová (New) shaft in 1973 new conceptual solution of the Štiavnica ore field was developed. It was decided to carry out extensive geological exploration in depth along the entire length of the ore field, including part Piarg in Štiavnické Bane and around the Hodruša ore field. Potential of the ore deposits was estimated to 5 million tonnes of geological reserves. The driving of shaft Roveň in the southern part of the deposit was launched, which should make accessible the ore complexes in the southern part of the ore field. Important event was the New Heritage Gallery excavation (NOS), which should help the Old Voznica Gallery that did not allow draining the entire ore district. Its development started in 1978 and was completed in the year 1989 in a circular profile of 3.4 m. The Plant Banská Štiavnica was the largest factory of Rudné bane, n.p. In the years 1946-1947 there were produced 17,500 tonnes of precious metal ores. After the transition to exploitation of polymetallic ores in the period 1946-1990, 4,078,400 tonnes of ores were exploited equalling to 44,736 t of lead, 5,064 t of copper, 787 kg of gold and 39,460 kg of silver. The zinc concentrate was treated separately from which it was produced 56,470 t of zinc, and 10,871 kg of silver (Zámora et al., 2004). At the high of the plant development 1,500-1,600 workers worked in mining enterprise. After 1989 dissenting voices intensified against the high cost of ore mining and based on the Government Resolution of 1991 on the Concept of exploitation of selected mineral resources in the Slovak Republic, by 1995 the mines in Banská Štiavnica should decrease the extraction and carry out liquidation of redundant mining areas and facilities. In 1992 the mine passed into private hands and Company Hell, s.r.o. continued the extraction till 1993. In 1994, without any detailed analysis the liquidation of the company started, and thus a promising programme for the mine and the town ended and terminated the industry that gave rise to the city and ensured its development (Lichner, 2002). *Plant Hodruša-Hámre* mined the precious metal ore till 1950. In the period 1946-1950 47,000 t of ore were mined. Then the plant switched to the extraction of copper ore at the mine Rozália (Fig. 1.18). For the period reported there were excavated in the plant 1,857,000 tonnes of copper ores. The copper concentrate was supplied to Krompachy metallurgic enterprise. At the beginning of 90s after the end of the exploitation of polymetallic ores there were discovered in the northern part of the deposit precious metals, which have been exploited since 1992. *Plant Kremnica* mined precious metal ores during this period on ore pillars of the Anna shaft. The mining ended here in 1959, in the shaft Ludovika in 1966. The richer veins of the shaft Ferdinand were mined till 1970, when the operation was suspended by the decision of the then Ministry of Mines. Between the years 1959-1965 the precious metal ore was excavated at the deposit Šturec. In early 80-ies the price of gold on the market increased rapidly. This has prompted the interest in exploration activity and the possible resumption of precious metal ores mining by superficial way in Šturec. In

the period 1946-1970 there were mined at the deposit a total of 922.300 tonnes of precious metal ores. In the years 1983-1986 there was built a pilot plant line and machinery facility, treatment plant and leaching facility for cyanidation process were reconstructed. The plant developed the proposal to increase the capacity to extract 30,000 tonnes of ore per year, but the implementation didn't occur. On a pilot line in the years 1987-1990 the total of 34,710 tonnes of ore were processed equalled to 46.5 kg of gold and 328 kg of silver. At starting of its operation in 1946 *Plant Poproč* with antimony ores had very little reserves and its closure was proposed in 1948. During the revision of abandoned upper horizons there were found relatively large amounts of ores suitable for flotation treatment. These were mined until 1964, when it was decided to stop mining at the factory and in 1965 the plant was closed. At the closure of the plant residual reserves of 5,200 tonnes of antimony ores were written off. For the period 1946-1958 the plant along with Helcmanovce section mined out about 211,000 t of antimony ores with low Au and Ag components content. *Plant Dúbrava* was almost destroyed after the War and resume operation required the construction of a flotation treatment plant (1946-1948). Exploratory work was carried out intensively in all sections of the known ore district. The survey was able to clarify a complicated system of vein mineralisation impaired by tectonics and the actual status of the ores reserves under steadily increasing mining at the deposit. During the reporting period, the de-



Fig. 1.18 Portal of the Rozália mine around 2000 operated in 1950-1990 for the extraction of copper ores and since 1992 – to present for the extraction of precious metal ores.

posit mined a total of 1,268,400 tonnes of antimony ores equalling to 27,869 tonnes of antimony. After 1946 the *Plant Pezinok* was closed due to low reserves and it concentrated solely on geological survey to verify the concentrations of interesting antimony ores. In 1951 ore mining started, which ran until the 90s. In the reported period at the deposit a total of 1,080,000 tonnes of antimony ores was mined out and the amount of antimony in the concentrate was 43,029 tonnes. Since 1946 the *Plant Špania Dolina* developed substantial exploration work and activities. The hereditary adit on Polkanová was developed and it opened up horizons of the blind shaft Ludvika and the Fer-

dinand shaft in Špania Dolina. At the same time a survey of old dumps and their metal content in Piesky, Richtárová and Špania Dolina started. Economic reserves of copper – silver ore were detected only in the Piesky deposit. Because of these reserves there was developed a gallery with a length of 1,600 m in order to secure an access to ore complexes in the Piesky deposit. In Špania Dolina a treatment plant was built, which in addition to the ore obtained on plant processed in a certain period ore from slag heaps from Banská Štiavnica, ores from Dúbrava, and particularly 252,000 tonnes of mercury ores from the deposit Malachov in the years 1982-1990 equalling to 293 t of mercury. In total, for the period 730,000 t of copper ores were extracted equalling to 1,844 t of copper production. The last plant was a *Plant Prešov*, which extracted the brine. During the reporting period, the salt of the brine was extracted in two ways. The first was a classic old way of the brines withdrawn in Leopold shaft and evaporated in cookers. This method was functional until 1970, when the building of the shaft and cooking facilities were handed over to the Technical Museum. The second method was the use of leaching from the surface wells that were drilled in the scope of extensive exploration activities since the survey in 1939. Of a total of 15 wells drilled, 11 wells were used for the leaching method. From 1947 to 1990 1,870,000 tonnes of salt were extracted. In 2009, the company Solivar Prešov terminated the brine mining after the centuries long tradition of salt mining in the region. The next deposit, which was discovered in the scope of the oil exploration in 1959, was Zbudza with reserves of 1.5 billion tonnes of salt. At the deposit a 192.6 m deep shaft was excavated along with over 2 km of mining tunnels. The implementation of production by the enterprise Chemko Strážske did not happen, so in 1970 the Zbudza mine objects started to be liquidated (Zámora et al., 2004).

After the WWII Slovenské magnezitové závody, n.p., Košice (Slovak Magnesite Works, n.e., Košice) started to resume mining in the plant destructed by retreating German troops, mainly the surface objects (generator, furnaces for magnesite burning, electricity sources and others. In previous years geological survey was neglected, the data on possible reserves of magnesite were missing, while magnesite was not among the reserved minerals. SNR Regulation No. 46/1947 of the Slovak Parliament declared magnesite a reserved mineral. In the years 1953-1965 geological exploration was carried out on all deposits of magnesite. Most reserves were confirmed at the deposits Jelšava – Dúbrava, Burda – Poproč, Košice – Bankov, Podrečany and Lubeník – Studená. The magnesite international cartel ceased to function during the war and after the war, in 1947, it was legally dissolved. The new situation enabled the development of the magnesite industry in Slovakia. In 1963, the Government of Czechoslovakia decided on the development of magnesite industry in Slovakia. The plant Jelšava should produce sinters and Lubeník plant should produce bricks. Unfortunately the trends that have been taken to improve the quality and efficiency of the extraction and production, were not maintained, which had a negative impact on the development of the magnesite

industry after 1990. In the reporting period, since 1959, the surface mining has been replaced by underground mining of magnesite. The Slovak magnesites are of inferior quality, their processing and post-processing after firing is not easy and the Slovak magnesite industry could hardly withstand the concurrence of natural quality Chinese and North Korean magnesite. Overall, during the period reported, 86.6 million t of raw magnesite were extracted at factories in Hačava, Jelšava, Košice, Lovinobaňa and Lubeník (Zámora et al., 2004).

The function of the geological survey was provided by the State Geological Institute of D. Štúr. The Institute was subordinated to the Chairman of the Central Geological Institute in Prague, but under federal arrangement of Czechoslovakia from 1969 it was subjected to the Slovak Geological Office. The exploration sector of the state geological service component was delegated to Geological Survey, n.p. which was created by merging of several organizations in 1958 with the seat in Turčianske Teplice, later in Žilina, and since 1965 in Spišská Nová Ves.

1.5. Conclusions

As mentioned at the outset, Slovakia has a rich history of mining and quarrying. In prehistoric times human ancestors used different types of suitable raw materials for primitive tools that were improved over time. A major technological breakthrough was the discovery of metals. The large number of stone threshers at the site Piesky evidences prehistoric copper mining on this site. Tacitus documents the mining of iron ore by Cotini tribe who lived in our area. It is very likely that they mined precious metal ore as a commodity for coin production. It is possible that the Slavs were the first miners of precious metal ores in Šturec in Kremnica; this idea is supported by the finding of a wooden pillar in old mine. During the reign of the Árpád dynasty Banská Štiavnica was the source of silver for the coinage of silver coins in Hungarian Kingdom. Several centuries later, under the reign of Anjou dynasty, Kremnica was of the same importance, and thanks to gold mining the city was granted mining rights. In troubled times that followed after the Mohács defeat, Thurzo-Fugger Company, as the largest producer of copper ore deposits extracted near Banská Bystrica, was prosperous. Large mining development and technological advances in mining of metal ores documents the first use in the world of gunpowder for rock disintegration in Banská Štiavnica, but also the use of water from reservoirs and constructing of ingenious machines for pumping water from mines, driving the mining machinery and stamp mills. In the nearby Nová Baňa it was atmospheric fire-engine, which was the first steam engine on the European continent. Based on these important pre-eminences, it is not surprising that the first Mining Academy was established in Banská Štiavnica. Equally important demonstration of technical prowess of mining in our territory was the development of the 16 km long drainage gallery of Joseph II (Voznica Old Heritage Gallery). After the First World War and the establishment of Czechoslovakia, Mining Academy moved to Hungarian

territory, and this time the glorious phase of our mining was interrupted. In terms of the common state with Czechs a new generation of mining professionals had to be raised in order to restore the former glory. After World War II unprecedented development of mining occurred due to political changes in Czechoslovakia. Totalitarian systems called for increasing mining production and so the government provided for the exploration and mining operations large subsidies. A change occurred with the fall of the totalitarian system and the onset of the democratization period, when most mining operations were halted and the work in them gradually attenuated.

Currently, the only underground mine on precious metal ore in Banská Hodruša is operated reminding the faded glory of the mining region. To conclude we just say goodbye using typical mining greeting “Zdar Boh” “May God give you success!”.

Acknowledgements

The author thanks for providing photographic documentation from the book *Gold in Slovakia* Mgr. František Bakos, PhD., (Fig. 1.2, 1.3, 1.5), Richard Čillík (Fig. 1.10, 1.11), Dušan Mesároš (Fig. 1.6, 1.8), Ing. Peter Baláž, PhD. (Fig. 1.18), JUDr. Mgr. Martin Kvietok (Fig. 1.1), RNDr. Peter Paudits PhD., EMED Slovakia (Fig. 1.4). Contemporary postcards with the mining theme are from the private collection of the author (Fig. 1.7, 1.9, 1.12 to 1.17).

The author also expresses his gratitude to peer reviewer for his valuable notes and propositions.

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