2. Mineralogical Heritage of Slovakia – A Significant Contribution to Knowledge of Minerals in the World

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Abstract: Up to date, 21 new minerals have been described from 14 Slovak deposits. Another 39 minerals have provided invaluable information on the scientific knowledge and diversity of individual minerals on Earth. On the territory of Slovakia, the world's most famous locality of occurrence is mainly euchroite, scainiite, hodrušite, kobellite, mrázekite, schafarzikite, vihorlatite, skinnerite, telluronevskite and brandholzite. On a European scale, examples are precious opal from Dubník, sernarmontite from Pernek and kermesite from Pezinok. While preserving the mineral heritage, it is important to preserve, in particular, the type and rare minerals, especially in large national museums and collections, and to deposit other cotype material into other (and private) collections in order to preserve them for future generations in unforeseen circumstances.

Key words: mineral heritage, type specimens, extraordinary minerals

2.1 Introduction

Due to the large number of hydrothermal veins and their varied mineral composition, Slovakia was one of the centres of mining in Europe and in the world. Mineralogical sciences, thanks to professors at the Banská Štiavnica Mining Academy, who did not always focus in the knowledge and prognosis of mineral wealth, developed much more slowly than the technical sciences related to mining. As a result, there was a low level of mineral knowledge in Slovakia as well as a small number of new minerals first described from our territory. This was despite the fact that in the Central Slovakia in the wider area of Banská Štiavnica and Banská Bystrica, as well as in the eastern part of the Spiš-Gemer Ore Mts., there are very large concentrations of ore veins. These lodes have provided for many centuries many wonderful samples of minerals that are the adornment of many world museums as well as university or private collections. Evidence that mineralogy was not a leading scientific discipline at the famous Mining Academy in Banská Štiavnica is also the fact that no new mineral was described from this one of the largest silver deposits in Europe. For example, 7 new minerals were defined from similar deposits in Příbram, 48 from Jáchymov (both Czech Republic), and 13 from the vicinity of Freiberg (Germany), where silver was extracted. There was only one new mineral found in the vicinity of Banská Štiavnica – Hodruša-Hámre in 1972 (Koděra et al., 1970).

There are several minerals that have made Slovakia famous for heir history, some important physical properties, the size or the morphology of crystals. Many minerals are important only from a scientific point of view, occurring in microscopic form and their size does not exceed a few dozen microns. Among them are, for instance, huanzalaite from Ochtiná (Ferenc & Uher, 2007), nuffieldite, kirkiite and eclarite from Vyšná Boca and Brezno vicinity (Ozdín, 2015, Pršek & Ozdín, 2004, Pršek et al., 2008), povondraite from Bratislava (Bačík et al., 2008), pellouxite from Chyžné (Bálintová et al., 2006) and Kľačianka (Topa et al., 2012), rouxellite from Kľačianka (Topa et al., 2012), etc.). They are interesting, for example, by their rare occurrences, their exceptional chemical composition, and the like. Many of them have the second or third occurrence in Slovakia when compared with the rest of the world. This contribution, however, deals only with the macroscopically significant mineral of Slovakia, which are divided into two categories: 1. Type minerals (minerals first described from our territory); 2. Significant minerals in the world or in the European scale. A special group consists of sporadically identified minerals. This includes minerals that have been described but were probably incorrectly or doubtfully identified (e.g. camerolaite $Cu^{2+}{}_4Al_2(HSbO_4,SO_4)(CO_3)(OH)_{10}\cdot 2H_2O$ from Špania Dolina, launayite $CuPb_{10}(Sb,As)_{13}S_{20}$. from Dúbrava, qitianlingite $Fe^{2+}{}_2Nb_2WO_{10}$ from Gemerská Poloma) or they are of vague origin (e.g. poitevinite $(Cu^{2+},Fe^{2+},Zn)SO_4\cdot H_2O$) from Ponická Huta).

2.2 Type minerals (minerals first described from Slovak area)

CHOVANITE $Pb_{15-2x}Sb_{14+2x}S_{36}O_x$, where x = ~0.2 (Topa et al., 2012; Fig. 2.1) – is a very rare Pb-Sb sulphosalt with oxygen and was described in 2012 especially from the deposit Dúbrava in the Nízke Tatry Mts. It also occurs on two other smaller occurrences (Malé Železné and Kľačianka in the Nízke Tatry Mts.). The mineral chovanite was named in honour of Prof. Martin Chovan (1946-), Emeritus Professor of the Department of Mineralogy and Petrology at the Faculty of Natural Sciences of Comenius University, Bratislava, Slovakia.

COHENITE $(Fe,Ni,Co)_3C$ (Weinschenk, 1889; Fig. 2.2) and **SCHREIBERSITE $(Fe,Ni)_3P$** (Haidinger, 1847b) – were first described from the world-famous meteorite Magura, which probably fell sometime between 1830-1840 near a village of Slanica in Orava, nowadays already flooded by the Orava dam reservoir. The meteorite became famous for the fact that besides 2 new minerals in the world, a third, later discredited mineral cliftonite was

Fig. 2.1 Aggregate of the holotype specimen of chovanite (Inv. No 7277). Cutting size 3.5 x 4 mm. Photo: D. Ozdín

Fig. 2.2 Up to 2 cm long longitudinal lobular aggregates of the cohenite in the Magura meteorite. Photo: D. Ozdín

Fig. 2.3 A qualitatively exceptional sample (10 x 6 cm) of the emerald-green euchroite from the Ľubietová – Svätodušná deposit. The size of the euchroite crystals is up to 2 cm. Finding of 2003. Photo: T. Bancík

described, and especially because it was the most precious iron meteorite in the world in the 19th Century. Cohenite was named in honour of the professor of mineralogy at the University of Greifswald in Germany and an important meteorite expert Emil Wilhelm Cohen (1842-1905). Schreibersite got its name by Haidinger, to commemorate a prominent naturalist of the 19th Century, Carl Franz Anton Ritter von Schreibers, who was born in 1775 in Bratislava.

EUCHROITE $Cu^{2+}_2(AsO_4)(OH)\cdot 3H_2O$ (Breithaupt, 1823) is the most beautiful Slovak type mineral, which was described in 1823 by F. A. Breithaupt from the Svätodušná Deposit near Ľubietová. It was named after its beautiful emerald-green colour. To date, the crystals and the intergrowths of euchroite from this site are the largest and most beautiful in the world (Kúšik, 2007a; Fig. 2.3). Another known locality of euchroite crystals is the occurrence of Poniky – Farbište (Števko et al., 2011), from where come very aesthetic aggregates of up to 10 mm large euchroite crystals, which are also the most beautiful in the world.

FLUORARROJADITE-(BaNa) (Števko et al., 2017a) (IMA 2016-075) is the latest new mineral in the world that has been described from the territory of Slovakia. It creates max. 2 cm large green-yellow to yellowish aggregates in quartz at Gemerská Poloma site, Adit Elisabeth. These aggregates consist of fluorarrojadite (BaNa) and "fluorodicksonite-(BaNa)" and sometimes contain the inclusion of viitaniemiite. Localities are intergrown with rodochrosite (Števko et al., 2015).

HAUERITE MnS_2 (Haidinger, 1847a; Fig. 2.4) was described in the year 1847 from Vígľašská Huta – Kalinka and named after the Austrian geologists J. R. Hauer (1778 – 1863) and F. R. Hauer (1822 – 1899). The hauerites in Kalinka, along with the Italian site of Radusa, are still the largest crystals of this mineral in the world.

HODRUŠITE $Cu_8Bi_{12}S_{22}$ (Koděra et al., 1970) was described in the year 1971 as a new mineral from Hodruša-Hámre from the Mine Rozália, where it creates mostly small-scale aggregates, rarely several mm needles in association with quartz, hematite, chalcopyrite, sphalerite and galenite. More recently, there were also found the world's largest crystals at this site. The length of the needles reaches up to 1.5 cm (Sejkora et al., 2015).

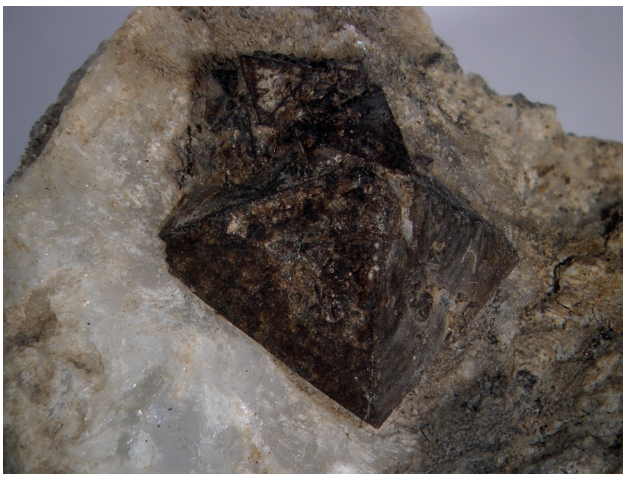

Fig. 2.4 Idiomorphic crystal of hauerite from Vígľašská Huta-Kalinka. Crystal size 0.8 cm. Photo: D. Ozdín

JAVORIEITE $KFeCl_3$ (Koděra et al., 2017b) creates max. 15 μm large green-coloured crystals in inclusions of salt melts in the quartz on the Au-deposit Biely vrch at Detva. When it gets in contact with the air, it degrades immediately. This mineral was found in 3 other localities in Slovakia (Slatinské Lazy, Kráľová (near Zvolen) and Beluj; Koděra et al., 2017a), even before the approval process of this mineral came to an end.

KORNELITE $Fe^{3+}_2(SO_4)_3 \cdot 7H_2O$ (Krenner, 1888)**, RHOMBOCLASE $(H_5O_2)^{1+}Fe^{3+}(SO_4)_2 \cdot 2H_2O$** (Krenner, 1891) and **SZOMOLNOKITE $Fe^{2+}SO_4 \cdot H_2O$** (Krenner, 1891) – the type location of these 3 secondary hydrated iron sulphates is Smolník. The szomolnokite received its name according to the Hungarian name of Smolník (Szomolnok). The kornelite was named after the mining engineer Kornel Hlavacsek from Smolník, and the rhomboclase was named after the rhombic shape of the crystals and the distinct cleavage (from the Greek *rhombos* – rhombic, and *klao* – cleave).

LIBETHENITE $Cu^{2+}_2(PO_4)(OH)$ (Breithaupt, 1823; Fig. 2.5) is the best-known Slovak type mineral. Like euchroite the libethenite was described in 1823 by F. A. Breithaupt, however from the Podlipa deposit and named after the German name of Ľubietová (Libethen).

Fig. 2.5 Superb crystal (6 mm) of libethenite in the quartz cavity from Ľubietová – Podlipa deposit. Photo: D. Ozdín

MRÁZEKITE $Bi_2Cu^{2+}_3(PO_4)_2O_2(OH)_2 \cdot 2H_2O$ (Řídkošil et al., 1992; Fig. 2.6) – was described in 1992 from the Podlipa deposit, from the Rainer minefield in Ľubietová. At places it forms very aesthetic prismatic transparent blue crystals in the quartz or limonite cavities. Up to several millimetres large crystals are grouped into gorgeous roses. It was named after the Czech mineralogist Zdeněk Mrázek (1952-1984) who found the mineral and made its first analyzes.

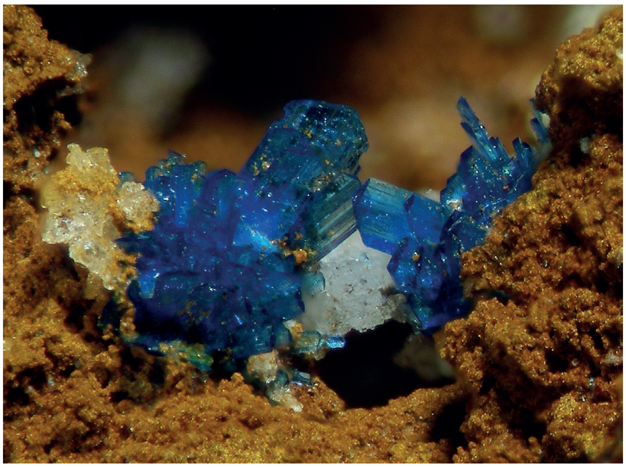

Fig. 2.6 Mrázekite aggregate in quartz-limonite vug. Ľubietová – Podlipa deposit, mining filed Rainer, field of view 1 mm. Photo: D. Ozdín

OXY-SCHORL $Na(Fe^{2+}_2Al)Al_6Si_6O_{18}(BO_3)_3(OH)_3O$ (Bačík et al., 2013) was commissioned by the Commission for New Minerals at International Mineralogical Association in 2011 under the number 2011-011. Typical locations are Zlatá Idka along with the Czech site of Pří- byslavice. The name reflects the recommendation of the International Mineralogical Association for designating the minerals of the tourmaline group. The title refers to the oxygen content in one of the anionic positions (oxy-prefix) and to the affinity for the tourmaline – schorl.

RUTILE TiO_2 (Ludwig, 1803) is the first type mineral described in our territory. It was described from Revúca by Ignác Born in 1772 under the title "basalt ruby", but the name of rutile was introduced by Werner in the year 1803. Its name is derived from the Latin "rutilus" – reddish. For the first time in the world, the titanium element was isolated from the rutile of Revúca (Klaproth, 1795).

SCHAFARZIKITE $Fe^{2+}Sb^{3+}_2O_4$ (Krenner, 1921) is the only type mineral from western Slovakia. Its typical location is Pernek, where it is associated with kermesite, antimonite, valentinite and sénarmontite. Its name was given after the Hungarian geologist Ferenc Xaver Schafarzik (1854 – 1927). However, samples of schafarzikite in most of the museums in the world and in private collections come from collections that were made after its re-discovery in 2002 (Sejkora et al., 2004, 2007).

TELLURONEVSKITE Bi_3TeSe_2 (Řídkošil et al., 2001) and **VIHORLATITE $Bi_{24}Te_4Se_{17}$** (Skála et al., 2007) – both bismuth selenotellurides were described only after 2000 and are our youngest types of sulphides. They are grey to black in colour and can not be macroscopically distinguished from each other, or from other selenotellurides of bismuth, at the type locality, which is Poruba pod Vihorlatom. The name of telluronevskite is derived from the chemical prefix of tellurium (according to Te content) and similarity with nevskite. The vihorlatite has got the name according to the mountain range of its location.

TETRADYMITE Bi_2Te_2S (Haidinger, 1831) was described in the year 1831 from a small adit at Župkov. It is a historic site where tetradymite is the main sulphide mineral. Its name comes from the Greek *tetradymos* – fourfold.

VASHEGYITE $Al_{11}(PO_4)_9(OH)_6 \cdot 38H_2O$ (Zimányi, 1909a,b) and **EVANSITE $Al_3(PO_4)(OH)_6 \cdot 6H_2O$** (Forbes, 1864) are hydrated aluminium phosphates, which were first described from Železník at Sirk. The vashegyite was named after the locality Vashegy, the Hungarian name of Železník and the evansite after the English metallurgist and mineralogist Brooke Evans (1797-1862), who collected the first samples and brought them to London for determination. In recent years, there has been a tendency to abolish evansite as a mineral because it is an amorphous mineral with a problematic chemical composition.

In addition to the above-mentioned new minerals recognized by the International Mineralogical Association, other new minerals have been published, the description of which has not yet been completed. They include, for example, the new minerals from the group of roméite from Pernek (Sejkora et al., 2012), "fluorodicksonite" (BaNa) from Gemerská Poloma" (Števko et al., 2015), As-analogue of cyanotrichite from Ľubietová (Ozdín, unpublished) or vacant mantienneite (Vavrová et al., 2006) and others.

2.3 Significant minerals of the world or the European significance

Among the other minerals which have made Slovakia world-famous are the so-called "Historical classics", i.e. minerals that were not first described in our territory but were known in the past in particular from our sites. These minerals include:

ARAGONITE $CaCO_3$ is one of the most common minerals in the world. There are two exceptional locations in Slovakia, with the most beautiful aragonites in the world (Tóth, 1882). The historical site is Špania Dolina, where hexagonal and more than 10 cm large, prismatic, white or yellow crystals have been grouped in cavities into magnificent aggregates. One of the most beautiful samples is still exhibited at the Natural History Museum in Vienna. In 1840 there was found a 6.4 m long cavity with the most beautiful aragonites in the world of that-world (Ozdín, 2012a, 2013).

The second location is Podrečany, where were more than 20 cm large white crystals have been grouped into very aesthetic and more than half a meter large aggregates. Approximately 10 cm large crystals of aragonite were rarely grouped into gorgeous rosettes. The most beautiful cavity was found in 1985, from which comes a unique sample exhibited in the museum in Banská Štiavnica. Aragonite samples from Podrečany are adorned by several major museums in the world (e.g. Smithsonian in the US and others).

AZURITE $Cu_3(CO_3)_2(OH)_2$ was long-term in Slovakia only a common mineral occurring in surface parts of ore deposits. In 2016, at the Piesky deposit at Špania Dolina a very rich unique azurite find was unearthed, partly with malachite (Fig. 2.7), from which most of the samples are deposited in museums and private collections. Several hundreds of qualitatively exceptional samples (in Slovakian terms) were found during the period of 2016 and 2017, the best of which are the prominent azurites found in the Central European region for at least 250 years. The azurite itself is characterized by great morphological variability, unprecedented quantity, as well as the size of aggregates that crystallized within the cavities and fissures of Permian sedimentary rocks (Ozdín et al., 2016).

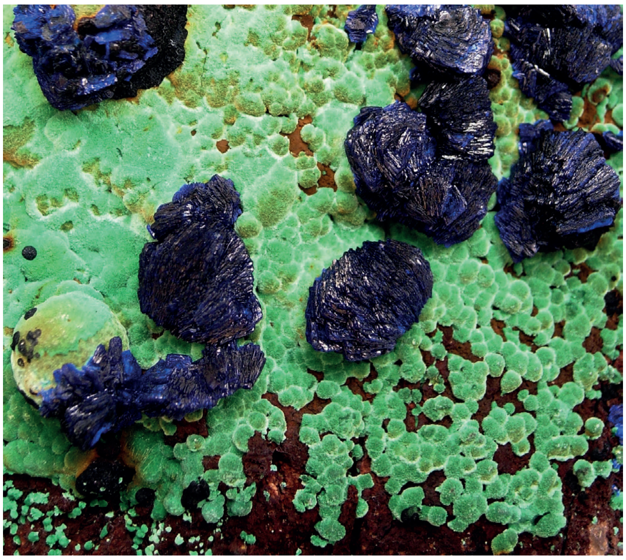

Fig. 2.7 Aggregates of azurite composed of dark blue, glossy, table-shaped crystals grown on malachite. The slit width is 2.9 cm. The size of the largest aggregate of azure at the centre of the image is 8 mm. Photo: D. Ozdín

BARYTE $BaSO_4$ has in Slovakia 2 significant locations of its occurrence. The first one is Banská Štiavnica, from which up to 15 cm large leaf-shaped crystals are known (Ozdín & Krejsek, 2016), grouped into several tens of centimetres large aggregates, which are the pride of the Carpathian polymetallic veins, especially in European museums. The second location is the broader area of Rožňava, where, under the name of Betlér (Betliar), there occur very aesthetic maximum 5 cm large crystals of secondary baryte in the quartz-limonite veinstone – **wolnyne** variety (Jonas, 1820). This variety, in addition to genesis, is also characterized by great morphological variability and often glass shine. Recently, the rich druses of wolnyne were found on the Lode Mária in Rožňava, the size of which was up to 5 cm (Števko et al., 2017b).

BOULANGERITE $Pb_5Sb_4S_{11}$ – the largest and most beautiful aggregates composed of up to 5 cm long crystals are formed on a deposit in Nižná Slaná (Uher & Ozdín, 2004). The length of the needles belongs to the largest and its aggregates belong to the most beautiful samples of this mineral in Europe.

BRANDHOLZITE $Mg[Sb(OH)_6]_2 \cdot 6H_2O$ (Fig. 2.8) was found in Pernek as the second type location in the world where it forms up to 4 mm large colourless, white to grey crystals (Sejkora et al., 2004, Števko, 2012a). This was an extraordinary, world-wide finding of this mineral that has been subjected to several reference analyzes for this mineral (Frost et al., 2009, Sejkora et al., 2010). Thanks to this finding, the Pernek's brandholzite began to expand into collections of museums and private collections around the world, as there were only a small number of samples from the original type site of this mineral in Germany, unlike Pernek. At the same time, the largest crystals from Pernek have so far been the largest samples of brandholzite crystals in the world. The scientific, museum and collectible upheaval around the Pernek finding was not enough to die away, and much more significant occurrence was found in Pezinok, on the Kolársky vrch deposit. At this site, very rich macroscopic aggregates of brandholzite were found on several hundred cm^2 areas with tabular crystals up to 1 cm in size (Števko et al., 2012a, b). The finds in Pezinok are so rich that they consist at least 85% of all the brand-name on earth found so far. The brandholzite here originates recently on the walls of the mining corridors and is able to crystallize within a few weeks. Therefore, at the Pezinok deposit the conditions for the formation of this mineral were determined for the first time in the world (Majzlan et al., 2016). Due to the size of the crystals and the richness of the samples, the Pezinok deposit is today the dominant locality of this mineral in the world, and from a scientific and museum point of view, it is a practically uncompromising locality.

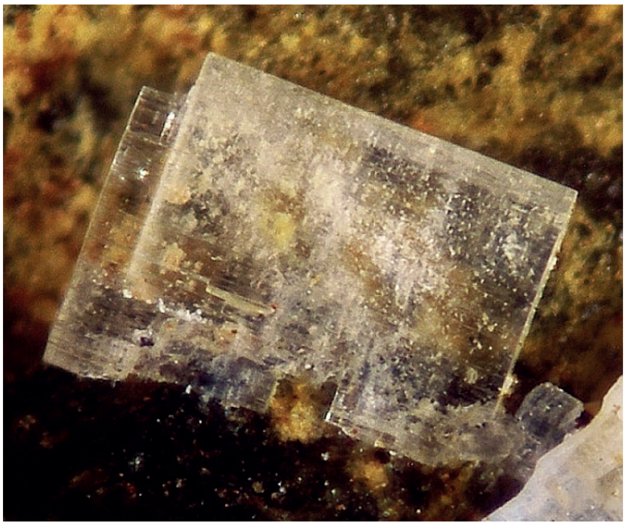

Fig. 2.8 Euhedral brandholzite crystal from Pernek. Size of crystal is 1 mm. Photo: Daniel Ozdín

CALCITE $CaCO_3$ is one of the most abundant minerals in the world. From Slovakia, the calcites are most well-known from Banská Štiavnica. They are probably exhibited in all major museums in the world. Likely, the Gemerská Ves findings could make Slovakia even more famous thanks the last few years discovered phantoms of calcite (Bálintová et al., 2006). In the translucent to several centimetres large calcite there are brick-red phantoms. The phantom is a variety of any transparent or translucent mineral in which another crystal of the same mineral is seen morphologically.

CELESTINE $SrSO_4$ was found in Špania Dolina in the calcite cavities, where it is mostly heaven-blue to blue-grey, off-white to colourless crystals. It is characterized by very strong morphological variability of the crystals (Zepharovich, 1873, Goldschmidt, 1913 – 1923), whereas the most characteristic being tabular, lanceolate, prismatic and loop-like crystals. Especially in the 19th Century they were considered the most beautiful in the world (Tóth, 1882).

CHRYSOTILE $Mg_3Si_2O_5(OH)_4$, which is the basic raw material of asbestos, has probably the historically most significant site in the world in the serpentinite quarry in Dobšiná, where it was mined already in 1705 (Rozložník ed., 2008). The chrysotile forms fibrous aggregates with a fibre length of up to 6 cm (Zlocha, 1978).

COBALTITE CoAsS has an important locality in Hnúšťa, where at the Mútnik deposit (Koděra et al., 1986-1990; Števko & Volejník, 2016) up to 1.3 cm large perfectly morphologically crystallized crystals of cobalt in magnesite, talc and chalcopyrite, were found. The size of cobaltite is unique here, and there are likely to be the largest crystals of this mineral in Europe, with the only exception of locations in Sweden.

CORUNDUM Al_2O_3 var. sapphire (Fig. 2.9) has an important European occurrence around the village of Hajnáčka. There is historically, quantitatively and qualitatively the most significant occurrence of corundum var. sapphire not only in Slovakia but also in the whole Carpathians (Ozdín, 2017). The sapphire's location has been known since the 1970s, but Szádeczky (1899) made a first description of sapphire from a sample of basalt from Kostná dolina Valley (Valley of Bones) near Hajnáčka. Subsequently, the corundum of blue, violet-grey to grey colour was found almost 100 years later when the sediments from Kostná dolina Valley were panned (Uher et al., 1999, 2012). In the years 2015 – 2017 local enthusiast Ladislav Oravec of Šurice after long searching found several dozen samples of sapphires directly in the basalt near Hajnáčka in the stone quarry above the village of Gemerský Jablonec. The largest piece of jewellery made out of Hajnáčka's sapphire had a weight of 0.265 carats.

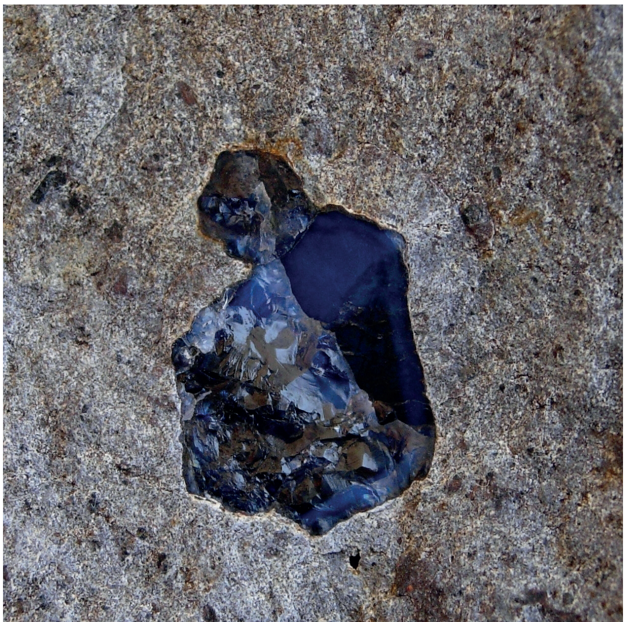

Fig. 2.9 To date, the largest Slovak corundum var. sapphire from the quarry at Gemerský Jablonec. Its size is 1.43 cm. Photo: Daniel Ozdín

DEVILLINE $CaCu^{2+}{}_4(SO_4)_2(OH)_6·3H_2O$ (Fig. 2.10) is one of the most valuable minerals in Slovakia, which makes wonderful table crystals grouped into more than 1 cm large globular dark green aggregates. It was first described under the name herrengrundite (Brezina, 1897) as the new mineral in the world from Špania Dolina (German Herrengrund). Later, Meixner (1940) found that it was identical to the previously described devilline, but for many decades this mineral was known as herrengrundite. In addition, Sabelli & Zanazzi (1972) solved the crystalline structure of the devilline, based on samples from Špania Dolina and not from the UK type location. Up to now Špania Dolina and Staré Hory – Richtárová are the most important localities of this mineral in the world, with the largest and most beautiful aggregates of this mineral in the world. More detailed information on the history of the description of the devilline and herrengrundite is given by Papp (2004) and Števko (2013).

Fig. 2.10 Devilline from Špania Dolina from the collection of National Museum in Prague. Photo: D. Ozdín

DIASPORE AlO(OH) is the pink aluminium oxide found in Banská Štiavnica near Banská Belá. In the 19th Century, the diaspores of Banská Belá were probably the most beautiful in the world and certainly the most famous in Europe. It was also probably the second place in the world where the diaspore was known. The diaspore was found in 1823 at the Prince Ferdinand Adit, but it was first published by world-renowned mineralogist Haidinger (1844). The largest idiomorphic diaspore crystals with lot of different crystal shapes were up to 1.5 cm in size (Szakáll et al., 2002), but individual buck-like diaspore crystals in radial aggregates were up to 4.5 cm in size (Ozdín, 2009 – 2017).

GERSDORFFITE NiAsS has a classic location in Dobšiná from where it was described as *wodankies* by Lampadius (1819). Later it was described corresponding to the German name of the site dobschauite (Dana, 1868). Although it is common mostly in solid and grainy dark grey aggregates, there are exceptionally large crystals up to 1 cm (Hintze, 1904), which is the maximum size of gersdorffite crystals in Europe and with the exception of one site in Morocco also in the world.

GLADITE $PbCuBi_5S_9$ as well as KRUPKAITE $PbCuBi_3S_6$ represent Cu-Pb-Bi sulphosalts. They were discovered by the end of the 20th Century at the site of Vyšná Boca – Paurovská, where they form needles grouped into 4.5 cm large aggregates in quartz. In a short time they have been delivered to many museums in Europe, Asia and America (Ozdín, 2015).

GOLDMANITE $Ca_3V^{3+}{}_2(SiO_4)_3$ is a green vanadium garnet. It has a unique chemical composition with a pronounced Cr participation in structure (goldmanite-Cr variety). So far, the Pezinok locality is the only site in the world with a chemical composition ranging from goldmanite to uvarovite (Cr-garnet). It is located in the vicinity of Pezinok, especially at the site of Rybníček. It is one of the most attractive science-collector minerals from the Western Slovakia (Uher et al., 1994, 2008).

GUDMUNDITE FeSbS. The crystallized gudmundite was found in 1999 in the calcite vein in front of the Sirková Adit near Pezinok. The crystals exceeded 3 mm (Ozdín et al., 2008) and are still ones of the largest in the world. Recently it was found in situ in the Sirková Adit (Ozdín et al., 2017). Due to its size and simple paragenesis, where gudmundite occurs virtually as the only white-calcite sulphide, the gudmundite from Pezinok has been exhibited by dozens of museum and private collections.

INESITE $Ca_2Mn^{2+}{}_7Si_{10}O_{28}(OH)_2·5H_2O$ (Fig. 2.11) was described as a new mineral in the world under the name of agnolith from Hodruša-Hámre (Breusing, 1900). Later it was identified with the previously described inesite (Ulrich, 1922). It is a relatively rare manganese silicate, whose aggregates at least until the first half of the 20th Century belonged to the most beautiful in the world. Also, at that time, it was probably only the second finding of this mineral in the world.

Fig. 2.11 Agreggate of the pink prismatic crystals of inesite. Size of specimen is 3.7 x 3.4 cm. Photo: D. Ozdín

KERMESITE Sb_2S_2O (Fig. 2.12) is one of the most beautiful Slovak minerals that make up wonderful red-wine coloured needles, grouped in particular into fan-shaped or radial aggregates. Up to now, kermesites from Pezinok are the most beautiful and largest in the world. Born (1790) described it from Krížnica near Pernek, which was the site where, along with the German Bräunsdorf, the most beautiful and most significant samples of this mineral in the world were found in the 19th Century. Later in the 20th Century, especially in the second half of the 20th Century, the most famous locality of kermesite in the world was Pezinok, where very aesthetic dark red needles reached a length of up to 8 cm (Koděra et al., 1986 – 1990) and radial kermesite aggregates were here present covering area of several hundred cm^2. The newer findings from the Pezinok deposit from the 20th-21st centuries were characterized by the presence of very aesthetic wine-red needle-like kermesite aggregates on the colour contrasting white colour of calcite (Kúšik, 2007 b). To date, kermesite samples, especially from Pezinok, are the adornment of most of the world's leading museum collections (Ozdín, 2012c).

Fig. 2.12 Cavity (7 x 5 cm) with radial needles aggregates of kermesite from Pezinok (Nová Alexander Adit 2001). Photo: D. Kúšik

KLEBELSBERGITE $Sb^{3+}_4O_4(SO_4)(OH)_2$ is a rare Sb sulphate. In 2009, at the Au-Ag deposit in Kremnica there was found a very rich accumulation of this mineral (Števko et al., 2009). Ball-shaped and radial aggregates form maximum 4 mm large white to yellow-orange aggregates on planes up to 30 cm^2. Qualitatively, these samples are ones of the best in the world (Števko, 2012b) and practically the only available for museum expositions. The newer conditions of this mineral origin, for the first time in the world, have been determined from the Kremnica deposit by Majzlan et al. (2016).

KOBELLITE $Pb_{22}Cu_4(Bi,Sb)_{30}S_{69}$ is one of the most important Slovak sulphosalts. Although this sulphosalt may be well known, little is known about the fact that has more than 35 locations in Slovakia (Ďuďa & Ozdín, 2012), which is more than all other locations around the world. The largest needles and aggregates of this sulphosalt in the world come from the Spiš-Gemer Ore Mts. deposits. On the Smolnícka Huta – Fichtenhübel deposit it formed up to 5 cm long needles (Trdlička et al., 1962), at the heap of the Pater-Noster pit at Hencl it formed up to 4 cm long needles, and at Rožňava have been rarely found up to 7 cm large aggregates of this mineral (Ďuďa & Ozdín, 2012).

KONINCKITE $Fe^{3+}PO_4·3H_2O$ is present at the Kociha site (Novák et al., 2003) in a larger proportion in association with vashegyite, evansite, allophane and volborthite. In Kociha's small gallery is probably the largest accumulation in the world, and its samples with whitewash aggregates are the top quality and the best in the world.

LANGITE $Cu^{2+}_4(SO_4)(OH)_6·2H_2O$ is a blue to light bluish- green secondary mineral, which is quite common on Cu deposits. There is one gallery (Jakub) in Ľubietová, where a large amount of this mineral is recently produced. The langite forms rich, very nice coloured crystalline coatings on the rocks (Řídkošil & Povondra, 1982). Samples from Ľubietová, especially at the end of the 20th Century and the beginning of the 21st Century have been exhibited in many world museums and collections.

LUDJIBAITE $Cu^{2+}_5(PO_4)_2(OH)_4$ (Fig. 2.13) **and REICHENBACHITE $Cu^{2+}_5(PO_4)_2(OH)_4$** – are polymorphic modifications of the conventional pseudomalachite mineral. They were described from Ľubietová, from the deposit Podlipa (Hyršl, 1991), where they form macroscopic coating and radial aggregates, or crystalline individuals, especially grown on pseudomalachite. In the 1990s, these were the second occurrences of these minerals in the world. Both minerals emerge in hardly macroscopically identifiable but up to several centimeters large aggregates.

Fig. 2.13 Two aggregates of ludjibaite from the site Ľubietová – Podlipa. The larger one has a size of 9.7 x 5.4 mm Photo: D. Ozdín

MARRUCCIITE $Hg_3Pb_{16}Sb_{18}S_{46}$ is a sulphosalt of Pb, Hg and Sb. It has long been known under the unapproved name of "gelnicite or gelnicaite". It was described in 1971 on Zenderling deposit at Gelnica (Háber & Babčan, 1971, Háber, 1980), but there was not enough material to solve its structure needed to complete its characteristics (Ozdín, 2012d). Finally, in 2007, the French-Italian team from the Buca della Vena site in Tuscany, Italy completed the description (Orlandi et al., 2007). The marrucciite of Gelnica was one of the most rewarding candidates for new mineral from our territory (1971 – 1992). It forms up to several mm large needles in association with Pb-Sb sulphosalts, antimony, cinnabar and other minerals (Sejkora et al., 2011). "Gelnicite", although not officially recognized by the International Mineralogical Association as a new mineral, has just been known for several decades from Gelnica, which is one of two sites of this mineral in the world (Ozdín, 2012d).

NICKELSKUTTERUDITE (Ni,Co,Fe)As_3 has one of the classic European sites in Dobšiná, where it has been known since the 19th Century. In Dobšiná there were found ones of the largest nickelskutterudite crystals in the world, which reached 3.8 cm (Cotta & Fellenberg, 1862) or 5 cm (Koděra et al., 1986-1990).

PRECIOUS OPAL $SiO_2{\cdot}nH_2O$ (Fig. 2.14) is the only Slovak historically known gem, which was probably known in Roman times. For almost 1900 years, the precious opal was known in the world only from Dubník site in Slanské vrchy Mts. The most beautiful and largest sample of the opal from the Dubník site is exposed in the prominent part of the mineralogical exposition in the Natural History Museum in Vienna. Among the largest diamonds, ruby and sapphires it belongs to the historically best-known gems. All historically significant pieces of precious opal have been found at Dubník. Several publications, especially from the 21st Century, point to the great importance of the precious opal from the Slanské vrchy Mts. and its everlasting glory (Constantini, 2005, Semrád, 2011, 2015, 2017, Butkovič, 1970).

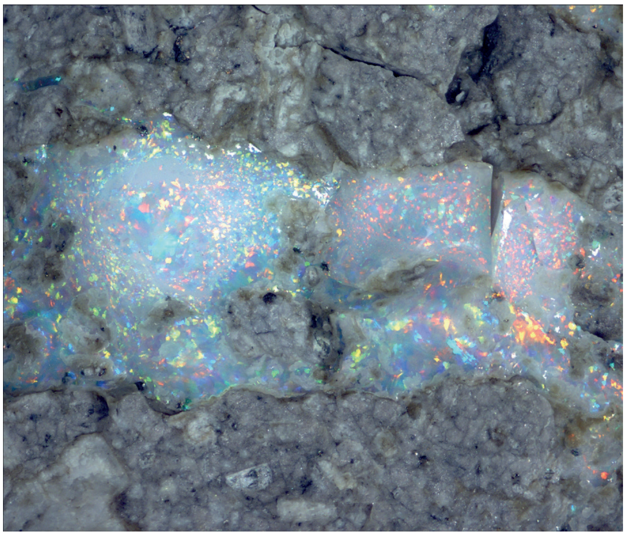

Fig. 2.14 Vein of mosaic precious opal in andesite matrix from Červenica – Dubník deposit. Field of view 5.3 cm. Photo: D. Ozdín

WOOD OPAL $SiO_2{\cdot}nH_2O$ (Fig. 2.15) belongs to comparatively widespread minerals and we encounter it in volcanic areas. In the case of Slovakia, there are young mountainous areas with the prevalence of intermediate andesite volcanism, which was accompanied by hydrothermal activity, whose product was also silicic acid. When effused on the Earth's surface, colloidal silicic acid incrusted mainly in tree trunks and wood opal was formed. The wood opals are mostly white, light brown to black. In the vicinity of Poľana, especially, there are specific, very aesthetic orange to red-brown wood opals with a preserved wood texture, especially in Ľubietová, Povrazník, Strelníky, Detva and Ponická Huta. The trunks of these trees reached up to 4 m in length and are locally used for grinding in gemmology (Koděra et al., 1986 – 1990, Ďuďa & Ozdín, 2012). These opals have been known at least in the 19th Century and, as they were characteristic, they have gotten to almost all of the most important European museums and collections. Even today, there have been still found new opalised tree trunks, which are valued also abroad. Wider area of Poľana is a classic wood opal site in Europe.

Fig. 2.15 A characteristic red-brown wood opal (8.5 x 9.2 cm) from Strelníky near Ľubietová. Photo: D. Ozdín

PALYGORSKITE $(Mg,Al)_2Si_4O_{10}(OH){\cdot}4H_2O$ belongs to the visually of the least attractive minerals, but in Slovakia, especially in Jelšava, there are up to 1 m^2 large white aggregates grown on carbonates (Ďuda & Ozdín, 2012). It does not create characteristic crystals, but dewier skin similar to aggregates of predominantly white colour. Its aggregates are probably the largest in the world.

PARNAUITE $Cu_9(AsO_4)_2(SO_4)(OH)_{10}{\cdot}7H_2O$ rarely forms rich crystalline aggregates on Svätodušná deposit near Ľubietová (Sejkora, 1993, Sejkora & Kouřimský, 2005). Its aggregates forming pseudomorphoses after euchroite on areas over 7 cm^2 are probably the largest in the world.

PHARMACOSIDERITE $KFe^{3+}_4(AsO_4)_3(OH)_4{\cdot}6\text{-}7H_2O$ (Fig. 2.16) was described from Nová Baňa, where this mineral formed up to 4 mm large emerald-green crystals in the cavities of limonitized altered rocks. The first finding was published by J. Krenner (1874) and one year later by Berwerth (1875) first in Hungary and after Schwarzenberg in Saxony, Cornwall in England and New York it was the fourth location in the world. At the time of their discovery, pharmacosiderites from Nová Baňa belonged to the most beautiful in the world and are exhibited in most important museum and private collections.

Fig. 2.16 Pharmacosiderite from Nová Baňa deposit. Field of view ~ 15 mm. Photo: D. Ozdín

PSEUDOMALACHITE $Cu^{2+}_5(PO_4)_2(OH)_4$ (Fig. 2.17) is a relatively common mineral in the world, but Ľubietová belongs to historically known and classical localities of this mineral in the world. Especially in the 19th Century, Ľubietová and the localities of the Urals Mts. were probably the most famous pseudomalachite sites. Under various names, it was known in 1817 (Zipser, 1917). It creates beautiful, dark-green aggregates on the cracks and in the cavities of the quartz or sedimentary rocks (Hyršl, 1991). It is the adornment of almost all the historical collections of museums.

Fig. 2.17 Pseudomalachite from Ľubietová (7 x 5 cm). Photo: D. Kúšik

QUARTZ var. AMETHYST and var. SCEPTRE SiO_2 (Fig. 2.18) is in long-term one of the most famous and most characteristic minerals of Slovakia. The sceptre quartz is a variety, where on a thinner and a longer prismatic crystal grow on a shorter and usually thicker quartz crystal on its top. The sceptre-like skeletal crystals of quartz (especially amethyst) from Banská Štiavnica still belong to the largest historical "classics" from the former Hungarian Kingdom and Europe. Their size was up to 20 cm (Uher & Ozdín, 2004). The quartz variety amethyst (Ozdín et al., 2011) was particularly rich in hydrothermal veins in Banská Štiavnica from 18th till the half of the 20th centuries. Banská Štiavnica is historically the most significant European locality for amethyst, and every world museum with specimens dated before the end of the 19th century contains its amethyst specimens (Ozdín & Krejsek, 2016). Some older, especially European museums even have tens of pieces.

Fig. 2.18 Amethyst sceptre 5.5 cm in size from Štiavnické Bane, Göllner Adit. Photo: P. Škácha

ROBINSONITE $Pb_4Sb_6S_{13}$ has the most important locality in the world in a small locality called Malé Železné near Magurka in the Nízke Tatry Mts. Because it occurs in the form of macroscopic grey, fibre aggregates, often together with zinkenite (Majzlan et al., 1998) and at places it forms the dominant fill of some smaller veins (Ozdín, 2012d), it has got gradually in almost all collections around the world. If there is a robinsonite represented in some museum in the world, it is mostly robinsonite from Malé Železné. Overall, Slovakia is rich in the presence of this sulphosalt, almost 1/3 of all occurrences in the world are found in Slovakia.

SCAINIITE $Pb_{14}Sb_{30}S_{54}O_5$ forms at Sb deposit Dúbrava the largest aggregates of this mineral across the world (Fig. 2.19), which reach up to 1 dm (Sejkora & Kouřimský, 2005). The scainiite is a grey Pb-Sb sulphosalt, found in Malé Železné (Topa et al., 2012) and in Gelnica (Sejkora et al., 2011) in addition to the type locality in the Apuan Alps (Chovan et al., 1998). In the last years, the wealthiest and most beautiful aggregates of this mineral in the world, consisting of up to 4 cm large needles (Ozdín, 2012d), have been found in Dúbrava.

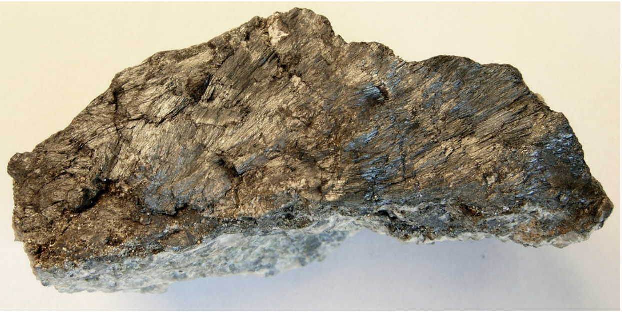

Fig. 2.19 Exceptional sample of scainiite aggregate from Dúbrava. Size of specimen is 8.8 x 3.7 cm. Photo: D. Ozdín

SÉNARMONTITE Sb_2O_3 has a classic location in the entire Carpathians and therefore also in Slovakia in Pernek (Fig. 2.20), from where Kenngott (1852) described it as probably the second occurrence in the world and the first one in Europe termed as *Oktaedrischer Antimon-Baryt*. In Pernek, it forms the max. 3 mm large, idiomorphic, cubic, transparent, colourless crystals (Bernard & Hyršl, 2004; Koděra et al., 1986 – 1990) in association with antimony, valentinitite, kermesite, schafarzikite and Fe-carbonates.

The most significant occurrence of the sénarmontite is on the stilbnite deposit of Dúbrava, where the lenses of primary sénarmontite up to 2 m (Sejkora & Kouřimský, 2005) are present in sections Predpekelná, Dechtárka and Ľubelská (Michalenko, 1967). The sénarmontite is predominantly found a piece, of dark to light-brownish colour. In Dúbrava, the largest accumulations of the massive sénarmontite in the world are likely to occur (Ozdín, 2012b).

Fig. 2.20 Nearly transparent, 1 mm large crystal of sénarmontite from Pernek with closed needles of stibnite on siderite. Photo: D. Ozdín

SKINNERITE Cu_3SbS_3 (Fig. 2.21) is a relatively rare Cu-Sb sulphosalt occurring mostly in microscopic proportions. On the magnesite deposit of Košice-Bankov in the last quarter of the 20th Century were found unique morphologically well crystallized up to 1 cm large crystals, which were the largest crystals of this mineral in the world. It occurs in association with chalcostite and tetrahedrite (Peterec et al., 1990, Kúšik, 2007 b).

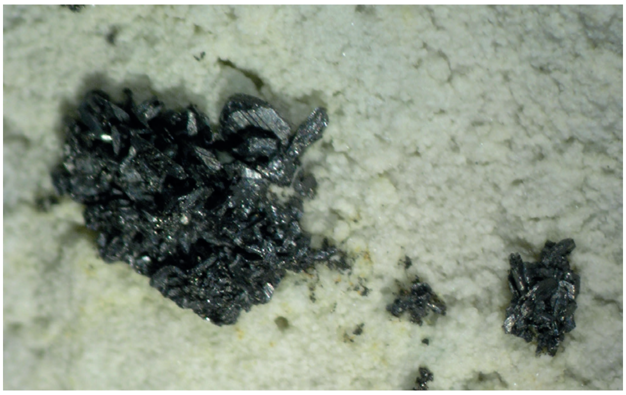

Fig. 2.21 Characteristic skinnerite crystals from the K – 401 chamber forming intergrowths on Mg-carbonate from the Košice – Bankov deposit. Image width 2.2 cm. Photo: D. Kúšik

STRASHIMIRITE $Cu_8(AsO_4)_4(OH)_4{\cdot}5H_2O$ was described mainly from Novoveská Huta, near the Horný Bartolomej Adit (Řídkošil, 1978, 2007), where it forms light-coloured crystalline coatings on the surfaces up to several 10 cm^2. At the time of its finding, it was the third occurrence in the world, and today samples from Novoveská Huta are probably the best in the world.

TINTINAITE $Pb_{22}Cu_4(Sb,Bi)_{30}S_{69}$ in macroscopic form is one of the rare sulphosalts. In Slovakia, so far, as in the case of kobellite, are located most of the sites in the world and probably also the largest crystals of this sulphosalt in the world occur here. Five cm long needles were described in the Mária Lode at Rožňava, and at Henclová up to 3 cm long ones (Szakáll et al., 2002, Ďuďa & Ozdín, 2012). In most locations in the world, this sulphosalt occurs only in microscopic sizes up to several millimetres.

TRIDYMITE SiO_2 on the site of Vechec, although it has been known for decades now, it has been discovered at the turn of the 20th and 21st centuries, that probably the largest crystals were found here, compared to the rest of the world. White pseudo-hexagonal crystals reach a size of up to 1 cm (Bernard & Rost, 1992), and interpenetration twins reach up to 1.5 cm (Pauliš & Ďuďa, 2002).

TYROLITE $CaCu^{2+}_5(AsO_4)_2(CO_3)(OH)_4{\cdot}6H_2O$ in Novoveská Huta, until the end of the 20th Century, one of the most beautiful and largest aggregates of this mineral in the world have been discovered. Generally, they are composed of fan-shaped aggregates of characteristic dark green colour with pearlescent shine in fissures of Permian sediments. Individual petal-like crystals reach up to 2.5 cm (Řídkošil, 1977) and cover an area of up to 400 cm^2 (Števko, 2014).

VALENTINITE Sb_2O_3 has classic locations in Europe in Pernek and Pezinok (Fig. 2.22). It has long been known in Pernek before describing it from a typical locality in France, when Born (1790) had described it. It formed up to 2 cm large radial and star-shaped aggregates in association with sénarmontite, kermesite, antimony and schafarzikite. Later, the max. 2 cm large, white to grey radial aggregates occurring on thin veins and planes over 100 cm^2 in size were also found on the Pezinok – Kolársky vrch deposit.

Fig. 2.22 Star-like aggregates of valentinite on the antimony ore. Image width 2.8 cm. Photo: D. Ozdín

The localities of Pezinok and Pernek together with the Czech site of Příbram are still considered to be the old classical and most important localities of this mineral in Europe (Ozdín, 2012c).

ZINKENITE $Pb_9Sb_{22}S_{42}$ is quite abundant Pb-Sb sulphosalt, but especially on the Dúbrava deposit it has probably the largest accumulation in the world, where its solid and feltlike grey aggregates form up to several dm large associations (Sejkora & Kouřimský, 2005) or independently fill the hydrothermal veins (Ozdín, 2012d) .

2.4 Conclusions

Mineralogical sites in Slovakia are still the source of new scientific discoveries and attractive samples for world-class museums and private collections. To date, 21 new minerals have been described in the world, of which 11 in the 19^{th} Century, only 4 in the 20^{th} Century and in the first 17 years of the 21^{st} Century they are already 6. While in the 19^{th} Century the new minerals from our territory had described predominantly Austrian, or German mineralogists, around the year 1900 predominantly Hungarian mineralogists, at the turn of $20^{th}/21^{st}$ centuries Czech mineralogists and currently Slovak mineralogists, which only document the development of mineralogical sciences in Slovakia over the last 15 years. Among the other 43 minerals that have made Slovakia famous in the world of science, museology and collections, their distribution has been more evenly distributed over the past 200 years, proving that the interesting minerals in Slovakia have been known from the beginning of the study of mineralogical sciences in Europe to the present day, only the quality of mineralogical research Slovakia has changed over time.

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