ACTA Mineralogica Petrographica

ACTA MINERALOGICA-PETROGRAPHICA, FIELD GUIDE SERIES, VOL. 12, PP. 1–12.

# Minerals, history and wines – trip to Miskolc, Miskolctapolca and the Bükkalja region

Edited by **FERENC MÁDAI***

Department of Mineralogy and Petrology, University of Miskolc, H-3525 Miskolc-Egyetemváros, Hungary; askmf@uni-miskolc.hu, *corresponding author

Written by **NORBERT NÉMETH[1], ATTILA SZENDI[2], LÁSZLÓ LÉNÁRT[3] AND ATTILA HEVESI[4]**

[1] Department of Geology and Mineral Resources, University of Miskolc, H-3525 Miskolc-Egyetemváros, Hungary; foldnn@uni-miskolc.hu

[2] Central Library, Archives and Museum, University of Miskolc, H-3525 Miskolc-Egyetemváros, Hungary; konsendi@uni-miskolc.hu

[3] Department of Hydrogeology and Engineering Geology, University of Miskolc, H-3525 Miskolc-Egyetemváros, Hungary; hgll@uni-miskolc.hu

[4] Department of Physical Geography and Environmental Sciences, University of Miskolc, H-3525 Miskolc-Egyetemváros, Hungary; ecoheves@uni-miskolc.hu

## Table of contents

1. Geological introduction to Miskolctapolca and the Bükkalja region (Norbert Németh) ........ 1
2. Field stops ........ 3
  2.1 Field stop 1: The Selmec Museum Library at the University of Miskolc (Attila Szendi) ........ 3
    2.1.1 Historical background of the Library and the Academy ........ 4
    2.1.2 Detailed guide to the Selmec Museum Library ........ 4
  2.2 Field stop 2: The thermal cave spa of Miskolctapolca (László Lénárt) ........ 7
  2.3 Field stop 3: Wine tasting in Tibolddaróc vineyards with a short introduction to the geomorphology and geology of the Bükkalja region (Attila Hevesi) ........ 11
3. References ........ 12
  Appendix – Itinerary for IMA2010 HU4 Field trip ........ 12

## 1. Geological introduction Miskolctapolca and the Bükkalja region

(Norbert Németh)

The Bükk Mts. (Fig. 1) is an uplifted, exhumated part of the basement of the Great Hungarian Plain, surrounded by thick Neogene sediments and volcanics. Its rock assemblage ranges from the Upper Carboniferous to the Middle Jurassic in age and comprises parallel successions formed in different geographical and faciological environments. The most apparent rock types are Middle and Upper Triassic, platform facies, karstified limestone formations, forming high cliffs and plateaus with several caves and karst springs.

The present position of the rocks is the result of a complex history of metamorphism, folding and large-scale horizontal displacements. During the Tertiary period the rock mass now forming the Bükk Mts. suffered a 100-km scale displacement along the Mid-Hungarian Mobile Belt. The "Bükkian" rocks differ from their present neighbours in certain characteristics, such as the presence of a marine Permian–Triassic boundary and the Triassic calc-alcaline volcanics. The torn-apart blocks

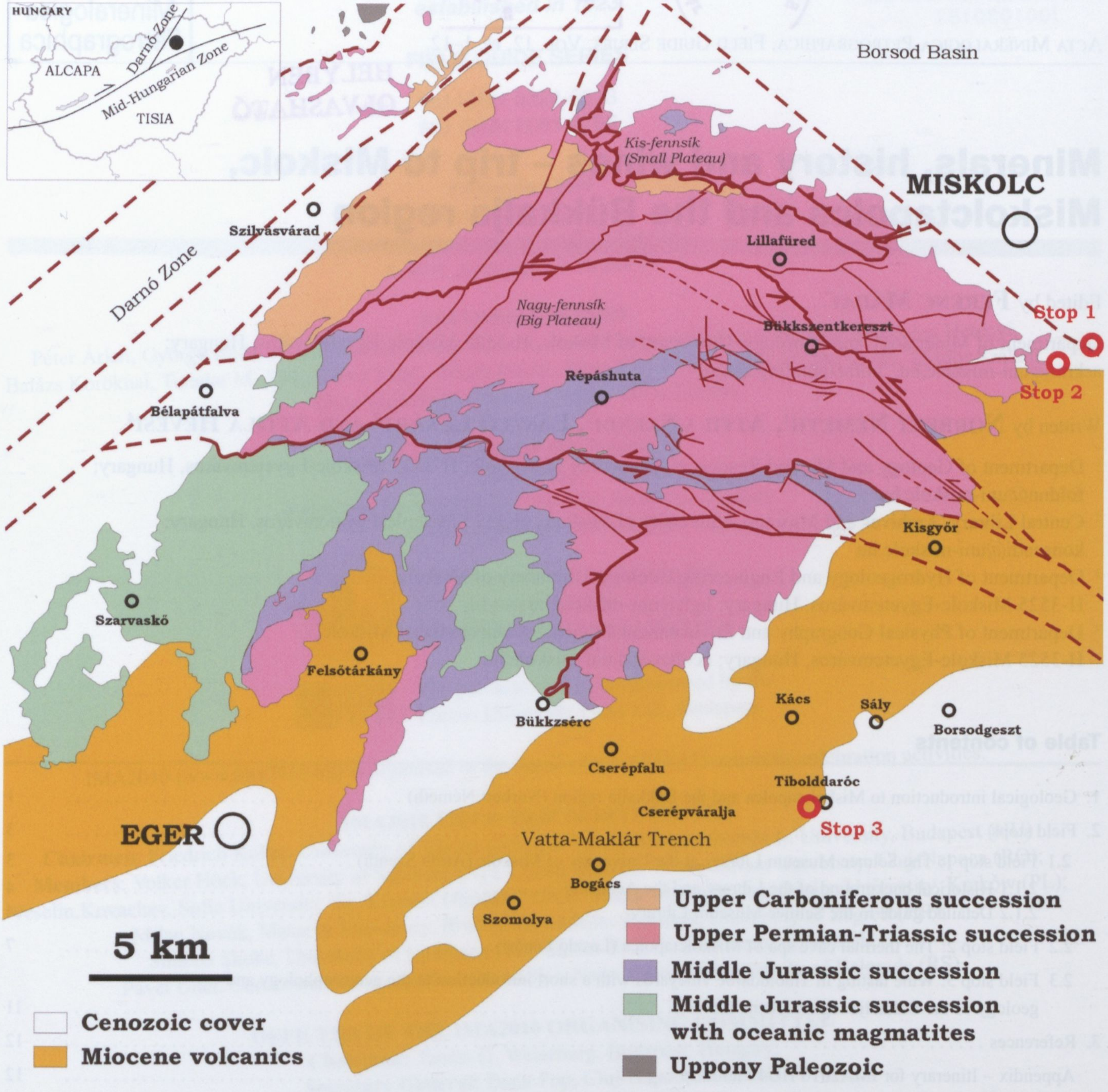

**Fig. 1.** Tectonic sketch map of the Bükk Mts. and its foreground (based on Less & Mello, 2004).

of the Paleozoic–Triassic succession can now be found in the Serbian Jadar Mts., other analogies along the Periadriatic Lineament (*e.g.* in the Carnic Alps) (Filipović *et al*., 2003).

Major characteristics of the Bükkian successions are marine facies from the Upper Paleozoic and the Lower Triassic, carbonate platform formation interrupted with acidic and neutral volcanism in the Middle Triassic, basin sedimentation producing cherty limestone interrupted with basic volcanism in the Late Triassic, and finally slope and basin facies successions with basic magmatism in the Middle Jurassic. There are two major unconformities: the gap between Upper Carboniferous and Upper Permian and the gap between Upper Triassic and Middle Jurassic. Lower Jurassic rocks, however, are present as blocks in some Middle Jurassic slope facies assemblages, which – together with the Jurassic basalt and gabbro bodies – are supposed to have formed an accretionary complex (Pelikán & Budai, 2005). From this period on, formations are lacking up to the Eocene, although at the NW edge the Darnó strike-slip zone (a regional fault zone attached to the Mid-Hungarian Zone) also contains Senonian conglomerate.

The rocks were folded and partly metamorphosed during the Middle and Late Cretaceous, but not with uniform $p$-$T$ history, according to the K-Ar and Zr fission track ages, illite and chlorite crystallinity measured in several samples (Árkai *et al.*, 1995). In some blocks the temperature exceeded 300 °C and the metamorphism reached the epizone, while other parts remained in deep diagenetic conditions. Similarly, contemporaneous folding was intensive, passive shear or flexural-shear similar folds and axial plane cleavage were developed with dynamic recrystallization in most involved rock types in certain tectonic units, while the same rock types in other blocks retained their sedimentary or magmatic texture with stylolitic contractional cleavage and flexural-slip parallel folds. The main strike of the cleavage and the associated folds is SW–NE in the W part and WNW–ESE in the E part of the Bükk Mts. According to the tectofacial and minor stratigraphic differences, at least three major units can be distinguished, of which the central part is the most deformed and metamorphosed, escorted by weakly deformed units in the N and in the S.

The recent arrangement of these blocks developed in another period, which was characterised by strike-slip faulting, associated thrusting and chevron folding of the cleavage. Formation boundaries are generally steep, in several cases overturned. The major fault zones often follow the contact of formations with high (e. g. massive limestone) and small shear strength (mainly slate), but often contain out-of-sequence blocks of carbonate rocks as well. Several fault planes of these zones are parallel with the steep or subvertical bedding and cleavage surfaces. While the strike of the master faults was E–W with NW–SE deviation in the E part of the area, cross-cutting thrusts, imbrications, even nappe-scale overthrust in the NE (Small Plateau) area were formed. In the W part the Darnó Zone dominates the structure of the Bükk Mts. with its NE–SW strike.

The sedimentary record of the Tertiary period starts in the Upper Eocene, but it is not continuous; small remnants of sediments and tuffs of different ages inside the Bükk Mts. show that there were events of changing uplift and subsidence, denudation, karstification and sedimentation, unequally distributed in the area. During the Miocene, while the sea flooded the northern side (producing the seams of the Borsod Coal Basin), in the south (in the Bükkalja area), a several hundred meter (perhaps up to 1 km) thick, continental volcanoclastic succession was deposited.

The volcanic activity covered the 21–12 Ma interval, but with certain interruptions. Like in other parts of the Pannonian Basin, the succession can be divided into three phases. The oldest (Ottnangian) one produced mainly pumice-rich airborne and avalanche rhyolite tuffs, partly ignimbrites by Plinian-type eruptions (Gyulakeszi Rhyolite Tuff Fm.). Eruption centres were most likely to lie south of the Bükkalja. The middle phase (at the end of the Karpatian stage) produced rhyodacitic-andesitodacitic ignimbrites and welded tuffs (Tar Dacite Tuff Fm.). The third one (from the Badenian up to the Lower Pannonian) comprises mainly airborne tuffs and redeposited tuffites, without ignimbrites, of a characteristically rhyolitic composition (Harsány Rhyolite Tuff Fm.) (Less *et al.*, 2005).

The thick tuff cover was also indicated by the apatite fission-track measurements inside the mountains, as the tracks show a thermal effect corresponding to a burial exceeding 1 km thickness (Árkai *et al.*, 1995). Apart from some remnants, it was almost perfectly eroded during the intensive Late Pliocene–Quaternary uplift. This uplift was induced by a general E–W shortening, which produced thrusts and strike-slip faults at the edges of the present Bükk Mountains (Németh, 2005). The process has not yet come to an end, as shown by the occasional earthquakes.

During this last uplift, the karst water level subsided several hundred meters, leaving the older valleys and caves dry; the oldest known cave fillings were deposited in the Early Pleistocene (Hevesi, 1980). The steeply dipping limestone blocks of the southern part extend to a considerable (yet unknown) depth, also under the tuff cover of the Bükkalja, and contain thermal water explored by several boreholes. The natural spring of the thermal water (together with a major cold karst spring) is located at Miskolctapolca, where a N–S striking thrust zone of some 100 m throw, forming the edge of the Bükk Mts. and blocking the way of the water, crosscuts an E–W striking left-oblique fault. The thermal water dissolved the caverns of the Cave Spa from the massive Carnian limestone.

## 2. Field stops

### 2.1 Field stop 1: The Selmec Museum Library at the University of Miskolc

**(Attila Szendi)**

The Selmec Museum Library is the only special library of its kind in Europe that was founded in the 18th century and survived sound and safe and almost completely until now. It is, therefore,

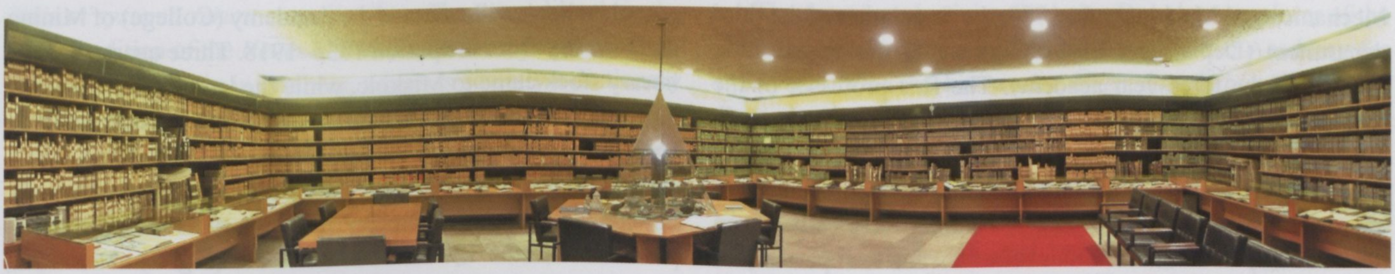

**Fig. 2.** Panoramic view of the Selmec Museum Library Hall.

under national protection. The Selmec Museum Library was originally the library of the Academy of Mining and Forestry, the predecessor of the University of Miskolc. This institution was developed in the 1760s on the basis of the school of mining and metallurgy established in1735 in Selmecbánya (colloquially Selmec), the most important mining town of the age in the Kingdom of Hungary (Now Banská Štiavnica in Slovakia, also well-known by its German name, Schemnitz.) In the museum library room (Fig. 2), almost 7500 volumes are arranged in the in the same order as they were displayed at the Academy in 1862.

### 2.1.1 Historical background of the Library and the Academy

In 1735 the Court Chamber of Vienna founded a school of mining and metallurgy at Selmecbánya in order to train leading technical experts for mining and metallurgy according to the requirements of the age, the early period of the industrial revolution, and to improve the precious metal and copper mining of the Habsburg Empire. This school of mining and metallurgy was the first educational institution of the Habsburg Empire that was founded by the state and operated under non-ecclesiastical control. One of the first professors of the school was Samuel Mikoviny, who was an engineer and mathematician of outstanding knowledge, and a dominant figure in early Hungarian cartography.

In 1762, Empress Maria Theresa, Queen of Hungary, issued a decree on the establishment of the Imperial and Royal Academy of Mining (*k.k. Bergakademie*). The existing school of mining and metallurgy (*Bergschule*) provided a practical and intellectual basis for the institution. By the establishment of three departments, the academy evolved gradually from the school between 1762 and 1770, and trained specialists for the entire Habsburg Empire. The language of teaching was German. Selmecbánya was among the first institutions in the world that gave specialist engineering training in mining and metallurgy (other institutions in the order of their year of foundation are Freiberg, 1765; Berlin, 1770; St. Petersburg 1773; then Clausthal, Madrid, Paris, Mexico City etc.).

In 1763 the anti-phlogistonic chemist N.J. Jacquin, later professor and rector of the University of Vienna, was appointed head of the first department, the Department of Metallurgy, Chemistry and Mineralogy. His successor was G.A. Scopoli, who came from the University of Pavia (Italy). In 1765 N. Poda was appointed head of the Department of Mathematics, Mechanics and Machinery. In 1770, the foundation of the third department (Department of Mining) ended the organisation process of the three-year academy. The first professor of the Department of Mining was Ch.T. Delius, head of the state-run mining in the Banat. He completed his studies at the University of Wittenberg and at the Mining School of Selmec. Delius and his successor at the department, J. Peithner were called from the Academy to the Court Chamber of Vienna to supervise the metallurgical and mining activities of the whole empire.

The worldwide fame of the Academy was based on the metallurgy-chemistry training method of professors N.J. Jacquin, G.A. Scopoli and A. Ruprecht that included group-work experiments performed by the students. This method represented a sharp turning point in the teaching of natural sciences: in 1794, when the technical university in Paris was established, this method was used as the model.

It is interesting to note on the occasion of the General Meeting of the International Mineralogical Association, that the "Society of Mining Sciences" (Societät der Bergbaukunde), undoubtedly the first geoscience society, which is considered by many the first internationally organised scientific society, was founded during a "workshop" of mining and metallurgy experts in 1786 at Szklenó (Sklené Teplice in Slovakia, Glashütten in German) near Selmecbánya, with the contribution of professors of the Selmec Academy. Until 1789 some 150 members from Europe and America had joined or had been elected, among them many outstanding personalities from science and industry, *e.g.* J.W. von Goethe, A. Lavoisier and J. Watt.

In 1846 the Academy of Mining merged with the Institute of Forestry, established in 1808, forming the Imperial and Royal Academy of Mining and Forestry (*k. k. Berg- und Forstakademie*). In 1867, with the Austro-Hungarian Compromise, the academy became a Hungarian state institution named the Royal Hungarian Academy (from 1904 College) of Mining and Forestry. Hungarian language was gradually introduced into teaching between 1868 and 1872. After World War I, Selmecbánya became part of the newly established Czechoslovakia, so the college moved to Sopron (Hungary) in the spring of 1919. Between 1934–49 the College belonged to the Royal Hungarian "József nádor" University of Technology and Economics, Budapest.

The Technical University for Heavy Industry was founded in Miskolc in 1949, including the Faculty of Mining and Metallurgy and the Faculty of Mechanical Engineering. The departments related to mining and metallurgy gradually moved from Sopron to Miskolc between 1949 and 1959. Based on the remaining forestry departments, the University for Forestry and Timber Industry (today part of the University of Western Hungary) was established in 1962 in Sopron. The library always moved together with the academy.

### 2.1.2 Detailed guide to the Selmec Museum Library

The Selmec Museum Library was opened to the general public in 1974. The Selmec Museum Library contains the almost complete book collection of the Academy (College) of Mining and Forestry from the period 1735–1918. Three quarters of the library stock came to Miskolc, while the last quarter remained in Sopron, in the library of the other successor institution, the University of Western Hungary.

The Selmec Museum Library, being the oldest and only intact special technical library in Hungary, is under national protection. In the 132-m$^2$ museum room (Fig. 2) about 7500 volumes of the collection can be seen and the arrangement of the books strictly follows the system that was originally applied at the Selmec Academy in 1862. The remaining part of the collection is stored in a separate, closed part of the stacks.

The characteristic appearance of the library is given by what is called the 'Selmec bindings' that was introduced in the early 1840s. The different fields of science were labelled with different colours on top of the uniform brown paper binding. The books were categorized into 12 sections as follows:

I. *Mathematischer Teil der Bergbaukunde* (Mathematics for mining – white)
II. *Physicalisch-chemischer Teil der Bergwerkskunde* (Physics and chemistry for mining – orange)
III. *Mineralogischer Teil der Bergwerkskunde* (Mineralogy for mining – apple green)
IV. *Bergtechnik* (Mine development – dark ash-blue)
V. *Hüttentechnik* (Metallurgy – pink)
VI. *Salzwerkskunde* (Salt-mining – black)
VII. *Münzkunde* (Coinage – black)
VIII. *Forstwesen* (Forestry – bottle green)
IX. *Technologie* (Technology – light olive)
X. *Wissenschaftliche Schriften vermischten Inhalts* (Miscellaneous scientific works – light blue)
XI. *Literatur* (Arts – brown)
XII. *Karten* (Maps – orange)

This list shows that mining and metallurgy in the 18th century covered or was directly related to most part of the technical and natural sciences of the time. The Museum Library holds nearly all significant books and journals of this broad discipline that were published in the 16 –18th centuries. In this period the *lingua franca* for mining and metallurgy and also for science and education was German. This is reflected by the book stock: 90% of the books are written in German, the others are in Latin, French and Hungarian. In the following, a short description is given of the showcases that are important from historical, mineralogical or mining points of view.

Showcase 1: The library is exactly as old as its sponsoring institution. The provisions of the decree issued by the Treasury in Vienna concerning the foundation of the mining school in 1735 defined exactly the special mining and metallurgical textbooks to be acquired by the school for educational purposes. These books indeed covered the most important issues of mining and metallurgy of that period.

The first textbook is a collective work on mining: *Corpus iuris et systema rerum metallicarum*. The second book is the second edition of the *Neues und vollkommenes Bergbuch* written by Ch. Herttwig in Freiberg, which is actually a dictionary of mining and mining law. The third book is a famous posthumous work by B. Rösler from Freiberg: *Speculum metallurgiae politissimum, oder Hell polierter Berg-Bau-Spiegel* (1700), which – in the order of publication – is the third important textbook on the art of mining. The fourth is the *Probier Buch* by L. Ercker, a fundamental work of metallurgy for two centuries, until the establishment of metallurgy on the basis of chemistry. The fifth book was the first textbook to be published on mine surveying written by N. Voigtel: *Geometria subterranea oder Markscheide-Kunst* (1713).

Showcase 2: From the point of view of the further development of the library, the acquisition of the book collection of J.T.A. Peithner, professor of the art of mining, was of decisive importance because 526 of a total of 1392 titles were of technical-scientific character (1774–1776). Among Peithner's autographically signed books (the most frequent inscription being *Ex Bibliotheca Thad. Peithner*) we can find both the fundamental technical-scientific works published in the 16th and 17th centuries that were rarities already at the time such as Agricola's *De re metallica*, 1557, first German edition; the works on fossils, collected and published by C. Gesner in 1565 (*De omni rerum fossilium genere...*); Pliny's *Historia naturalis* (1496 and 1553); Ubaldo's *Mecanicorum liber* (1615) and contemporary literature from the middle of the 18th century (works by Belidor, D. Bernoulli, Gellert, Herttwig, Jugel, Kern and Oppel, Rössler, Stahl etc.).

Showcase 3. The first section of the library covers mathematics, which, in addition to mathematics as we understand it, meant also geometry, mine surveying, mechanics, machinery and architecture, 61% of the 602 books originally included in this section are in Miskolc with another 37% held in Sopron. One third of the books was written in the 16–17th centuries.

Showcase 4: In this showcase fundamental works of mechanics and mathematics are exhibited, such as *Hydrodynamica* by D. Bernoulli (1738); the third, French, edition of works by Marriotte (1717); a book on machinery by Ubaldo del Monte, *Mecanicorum liber* (1615); an issue of Euclid's *Elements* from the 17th century and a book of mathematics written by Münster in 1551. According to the ex libris, the book by G.B. Benedetti *Diversarum speculationum mathemiaticarum et physicarum liber* (1563) originally belonged to the library of the famous Danish astronomer, Tycho Brahe.

Showcase 5: The second section covers physics and chemistry for mining. This is the largest section of the library, a total of 1527 volumes, with about 40% from the 16–18th centuries. Among others a 1699 edition of Galilei's *De Motu* (On Motion and on Mechanics) is shown in this showcase.

The Austrian physicist, Christian Doppler – explorer of the Doppler effect – was a professor of the Selmec Academy for two years. One of his works *Über das farbige Licht der Doppelsterne und einiger anderer Gestirne des Himmels* (Prag, 1842) can be found in this showcase.

Showcase 6 introduces the collection of chemistry books. The only one alchemical work of the library, *Magna alchymica* (1587) by Thurneisser, a well-known alchemist of the 16th century is exhibited here. The ruling theory of the early 1700s, the phlogiston theory was worked out by G.E. Stahl. Five of his 26 books are held in the Selmec Library, among others his most important work, *Fundamenta chymiae dogmaticae et experimentalis* (1766).

The phlogiston theory was overcome by the fundamental works of Lavoisier, such as *Traité élémentaire de chimie* (1789). The famous Swedish chemists, Bergman, Scheele, Cronstedt and Wallerius, represented by several works in the library, laid the foundations of analytical chemistry by means of analyses of minerals. Their results provided fundamental arguments for the anti-phlogistonist scientists.

Showcase 7: The leading role of the Selmec Academy in technical and natural sciences in the late 1700s is reflected in the books exhibited in this showcase. N.J. Jacquin (1727–1817), professor of the Selmec Academy and later professor and rector of the University of Vienna, was one of the first anti-phlogistonist scientists. His experiments that were completed in Selmec, contributed greatly to the victory of modern chemistry, advocated by Lavoisier. During his Selmec period, Jacquin completed his work *Chymische Untersuchung der Meyerischen Lehre von der fetten Saure und der Blackischen von der fixirten Luft*, which was first published in Latin in 1769 and later (1771) in German.

A.F. Fourcroy, a leading anti-phlogistonist chemist, submitted a proposal to the French Convent in 1794 that in the newly established technical college (École Polytechnique) chemistry should be taught following the practice of the Selmec Academy, thus through individual laboratory work of students. Later this method of education spread over Europe and the world from Paris. Fourcroy's work, *Système des Connaissances chimiques* (1800) is exhibited in the showcase.

Showcase 8: More and more scientific journals were published in the second half of the 18th century and their number rose steadily from the 1870s. The complete collection of periodicals collected since the first volumes proves that the Academy and its library held strong connections with the international scientific community. The library holds the complete series of the first exclusively chemical journal, Crell's *Chemisches journal*, which was the most respected journal until the end of the 18th century.

Another important chemical journal, the *Annales de Chemie* (1789) was edited by a group of French chemists around Lavoisier, who established modern chemistry (Guyton de Morveau, Berthollet and Fourcroy).

Showcase 9: This introduces the mineralogical section of the library, which includes in the modern sense different disciplines of the earth sciences such as mineralogy, crystallography, petrology, geology, palaeontology and economic geology. All 466 volumes that are listed in the inventory are present in the library. More than one third of the books are from the 16–18th centuries. The exhibited books are the 1749 edition of *Protogaea*, the great geognostical work by Leibnitz, a German edition of Buffon's *Époques de la Nature* (1781) and the fundamental book of modern geology: the *Principles of Geology* by Charles Lyell (1872).

Showcase 10: It is a collection of some important books on mineralogy and geology from Hungary. The first mineralogy book in Hungarian was written by Ferenc Benkő in 1784, following the instructions of the famous geologist from Freiberg, A.G. Werner. The first crystallographical work on Hungarian minerals (mainly on specimens from Selmec) was completed by a professor of the Academy, G.A. Scopoli in his monograph *Crystallographia Hungarica* (1776, Fig. 3). F.S. Beudant, a well-known French mineralogist published the first detailed geological description and the second geological map of Hungary in his four-volume book, *Voyage minéralogique et géologique en Hongrie* (1822).

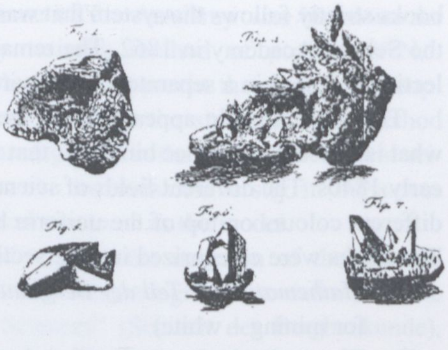

**Fig. 3.** Detail from one of the tables with specimen drawings from Scopoli's *Crystallographia Hungarica* (1776).

Showcase 11: One of the earliest books on mineralogy is the work by C. Gesner, *De rerum fossilium lapidum et gemmarum*. This famous collection of texts forms one of the most important contributions to 16th century geology and mineralogy. It consists of eight separate treatises by seven authors on the subjects of fossils, gems and metals; all edited by Gesner and with his general introduction and extensive commentaries. C. Linné's celebrated *Systema Naturae* (1735), which also proposed a mineralogical system, is also found in this showcase. Wallerius' *Mineralogia* (1747) was among the mineralogy books published from the middle of the 18th century that established a firm foundation on which the science of mineralogy could develop. This development is illustrated by the exhibited works of the famous French mineralogists Romé de l'Isle (*Essai de cristallographie,* 1772) and Haüy (*Traité de minéralogie*, 1801).

Showcase 12: An early periodical devoted to mineralogical subjects was the *Mineralogische Belustigungen* (Mineralogical Amusements) edited by J.C. Adelung. It was published between 1768 and 1771 and was intended first of all as a forum for mineral collectors and other members of erudite circles of the enlightenment, who were interested in mineralogy

Showcases 13-14: The fourth section of the library contains the books on mining and includes in the modern sense not only mine development, but also mining law, mineral economics and mining machinery. The most precious books of

Fig. 4. Hand coloured wood prints in Agricola's *Vom Bergwerck* from the collection of the Selmec Library.

the library are the first impressions of Georgius Agricola's *De re Metallica* in Latin (1556) and in German (1557, Fig. 4). The original (1546) edition of *De natura fossilium*, containing Agricola's studies on earth sciences, including *Bermannus*, which was the first attempt to organise scientifically the knowledge on minerals derived from practical experience, is also exhibited. Works by Agricola, the first classic author on mining and metallurgy, were translated into several languages in the course of centuries as it is demonstrated in showcase 14.

Showcase 23: Manuscripts by professors and students of the Selmec Academy are presented in this showcase. One of them is a student's notes on the mineralogy lectures of Professor János Pettko from the 1840s and another is a manuscript by G.A. Scopoli containing his lectures about mineralogy from 1769. The manuscript of the German–Hungarian mining dictionary, compiled by Pettko is also exhibited, Fig. 5).

Showcase 24 presents textbooks written by the first professors of the Selmec Academy. The book by Ch.T. Delius on mining (*Anleitung zu der Bergbaukunst*, 1773) is reputed as the first comprehensive summary of mining disciplines after the 16–17th c. works of Agricola, Löhneyss and Rösler. It was published in 1778 in Paris (*Traité sur la science de l'exploitation des mines*) and was used as a textbook on mining for several decades in France.

The mineral collection of the Selmec Academy, which was used as a teaching aid, comprised around 4000 specimens. The small exhibition displays the most valuable gold ore treasures of this collection, mineral rarities from the legendary mines of Hungary and Transylvania from the 18t–19th centuries, Roşia Montană / Verespatak, Baia de Arieş / Aranyosbánya / Offenbánya, Dognecea / Dognácska, Cavnic / Kapnikbánya, Banská Štiavnica / Selmecbánya / Schemnitz and Kremnica / Körmöcbánya / Kremnitz. Most of the specimens of the Selmec Mineral Collection that survived the relocations and hardships during its history are now kept at the Department of Mineralogy and Petrology of the University of Miskolc.

## 2.2 Field stop 2: The Miskolctapolca Cave Spa

(László Lénárt)

The Cave Spa is found in Miskolctapolca, a resort area of Miskolc, within the outermost units of the karstic limestone masses of the Bükk Mts. (Figs. 1 and 6). The most precious natural treasure of the area is the thermal karstic cave system that has been originally carved and dissolved by the water in the karstifiable Triassic limestone. The cave sys-

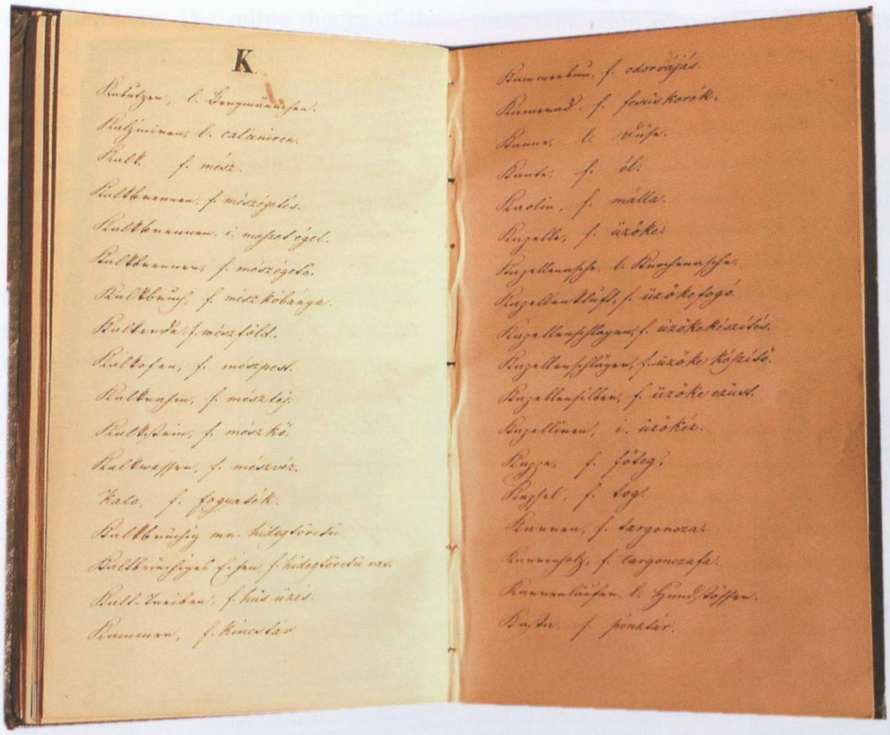

Fig. 5. A page from Pettko's German–Hungarian mining dictionary (manuscript).

tem was transformed in the 1950s to a cave bath.

Although the thermal caves have already been known by prehistoric man, they were first mentioned only in a study by Kerekes (1936). The cold and hot springs of the locality, however, were already reported by Papp (1907). The cave bath was opened in 1959 after a long-lasting preparatory work (Borbély, 1958; Kessler, 1959; Lénárt & Stuhán, 1999; Szlabóczky *et al.*, 1993). The Miskolctapolca Cave Spa – together with the integrated indoor thermal bath and outdoor pools (Fig. 7) – has unique features compared to other spa resorts of Europe.

The thermal spring of Miskolctapolca is a significant karstic hot spring with dissolved Ca-Mg hydrogen carbonate ions and a temperature of 24–31 °C. Generally the water has a temperature of 30 °C. The Miskolctapolca Cave Spa is

Fig. 6. The thermal karstic system of surrounding of Miskolc (Lénárt, 2008; base map: Smaragd-GSH Ltd., 2008) Legend for the coloured fields: dark green – karstified rocks, medium green – fractured rocks, light green – tuffs, ochre – Quaternary sand, aleurite, reddish brown – clay, marl. Legend for the coloured spots: blue – cold karstic water, T < 10 °C, yellowish brown – cold-tepid karstic water, T = 10–16 °C, dark brown – warm-tepid karstic water, T = 16–25 °C, red – warm karstic water T = 25–37 °C, purple – hot karstic water, T > 37 °C.

**Fig. 7.** Indoor and outdoor facilities of the Miskolctapolca Cave Spa.

located at the Eastern edge of the Bükk Mts. right on the border of Triassic limestones (Bükkfennsík Limestone Fm. and Répáshuta Limestone Fm.) and Miocene clastic sedimentary rocks (Egyházasgerge Fm.) (Pelikán & Budai, 2005). Pressure difference of the karstic water level between the uplifted reservoirs in the Bükk and the buried ones of the foreground is about 40 bars. This pressure difference forces the cold karstic water underneath the thick clastic sediments of the foreground resulting in a regional confined aquifer. In a few hundred to few thousand metres depth, the karstic water heats up due to geothermal heat flow and arises along faults to the surface, forming tepid and warm thermal springs as it occurs in Miskolctapolca, or can be reached by deep wells *e.g.* at the Miskolc-Selyemrét bath (Fig. 8) (Lénárt *et al.*, 2008).

Originally several dozens of warm and tepid thermal springs arouse directly within the Cave Spa and from the Miocene and Quaternary formations around the cave's mouth (Lénárt, 2005a). About 80-100 m to North from these, cold karstic water sprang out of the rocks. Nowadays tepid and warm springs cannot be found at the surface, the water demand of the whole spa resort is supplied by an artificially unified water source (Hot Waterworks of Miskolctapolca). The Cold Waterworks of Miskolctapolca is the most important water resource of the town of Miskolc.

Entering the Cave Spa, we meet an artificial waterfall and a jet-stream shower and then pass through a wet adit into the caves. On the floor of the adit, a few mm thick, 2–4 cm wide tetarata rows (Fig. 9), precipitated from the trickling thermal water, can be found. In the middle of the passage the rows are obscured due to the fast moving water, whilst they are sharper, better developed on the margin (Lénárt, 2005b).

Hanging dogteeth-like stalactites and straws form from the water seeping out of the fractures in the adit. The rate of precipitation reaches 1 mm/year, which is 10–15 times faster than the precipitation rate observed in Hungarian caves with cold atmosphere. In the middle of the adit, in a black hollow above us, calcite druses with crystals of a few cm in size can be seen.

The adit turns at its end. In summer, turning left and passing through a 30-m adit, we reach the outdoor pools. The concrete

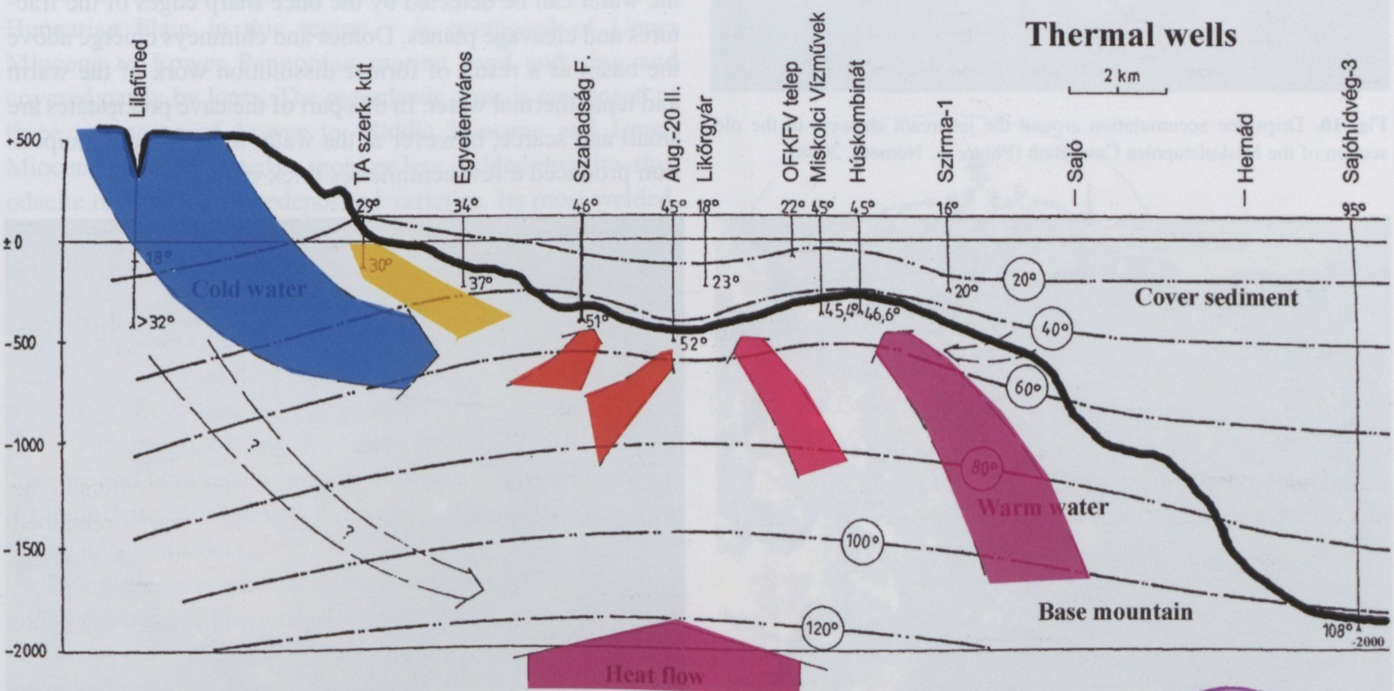

**Fig. 8.** Formation of thermal karstic water by geothermal heat flow in the vicinity of Miskolc (based on Szlabóczky, 1974)

**Fig. 9.** Tetarata rows developed on the floor of the adit in the Miskolctapolca Cave Spa (Photo: L. Lénárt, 2004).

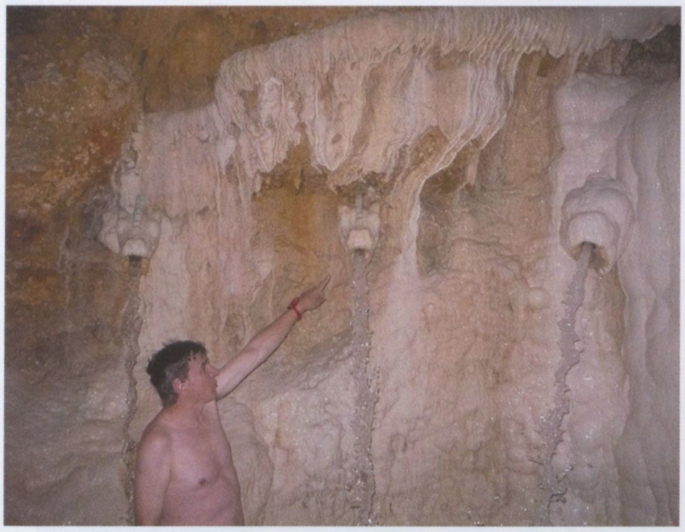

**Fig. 10.** Dripstone accumulation around the jetstream showers in the old section of the Miskolctapolca Cave Bath (Photo: Á. Németh, 2008).

shell (built in 1969), partly covering the outdoor pools, is a characteristic feature of the spa complex. Turning right at the end of the adit, after 5-6 metres, we find a natural karstic hollow, which continues in a tectonic crevice partly filled with ferric precipitates. Going on to the right, we reach the jet-stream shower, which was built in a 12-m high dry pipe, where the thermal water is pumped to 5 m height (Fig. 10). The water flows down by gravitation into a pool, producing wonderful precipitated crystals and tetaratas. From these only the stalagmite crust is seen on the rims of the pool. The precipitation rate here is even higher, estimated to be 2–4 mm/year.

The originally artificial hall gradually becomes similar to a natural cave due to the thick precipitates. The waterspouts forming dragon's head are only hardly recognizable due to the thick calcite incrustations on them. The rim has grown at least 20 cm in thickness during the past 20 years, which means that the maximum precipitation rate reached an extremely high value of 10 mm/year.

Beside the red ferric precipitations and yellowish brown dripstones, some green spots can also be discovered around the lamps. This is what is called lamp-flora, which develops due to the artificial lighting. It is mainly composed of algae with a few filaments of moss.

Looking up at the jet-stream shower, a nice calcareous tuff precipitation can be seen, which has already been partly dissolved and worn down by the passing water. Next to the calcareous tuff body a fine occurrence of brecciated limestone can be found with a series of niches within.

Stepping down on the stairs, we reach the main basin of the Cave Spa. Its hanging walls have intensively fractured but the individual blocks are usually cemented by calcite that forms dripstone crusts on the walls. The dissolving force of the water can be detected by the once sharp edges of the fractures and cleavage planes. Domes and chimneys emerge above the basin as a result of former dissolution work of the warm and tepid thermal water. In this part of the cave precipitates are small and scarce, however at the water level recent precipitation produced a few centimetres thick crust.

**Fig. 11 a–b.** Calcite crystals in the underwater cave of the thermal spring below the Miskolctapolca Cave Bath (Photo: L. Szarka, 2006)

From the 'old' part of the Cave Spa – completed in the 1950s – we can reach three more basins of the new section through dry adits. One of these resembles a dome, and another a quadratic hall. Other facilities of the Cave Spa include the indoor thermal pools and the outdoor shell and the other outdoor pools, which are also worth a visit.

The thermal spring itself arises within a 3-metre diameter well of more than 30 metres in depth. On the bottom of the well, across a narrow adit an underwater cave can be reached. This section is certainly available only for professional scuba divers. Nice, well-developed calcite crystals appear on the walls of this underwater cave (Fig. 11).

## 2.3 Field stop 3: Wine tasting in Tibolddaróc vineyards with a short introduction to the geomorphology and geology of the Bükkalja region

(Attila Hevesi)

The Bükkalja (literally 'foot of the Bükk [Mts.]') region is located in the junction of the Great Hungarian Plain and the Northern Hungarian Mid-mountain range. Its terrain slopes from south towards north from 150–160 m to 400 m.

The Bükkalja is the largest and most uniform piedmont surface of the North Hungarian Mid-mountain range, extending from the Tarna valley towards north-east to the Hejő and Szinva valleys. It is composed primarily of Miocene pyroclastic rhyodacite- and rhyolite tuffs extending on a 40-km long and 10–15-km wide belt on the surface. This pyroclastic zone is connected to the Southern Bükk by a narrow sedimentary belt of Eocene limestone and marl and Oligocene clay and siltstone. The southern zone of the Bükkalja – which borders the Heves–Borsod Mezőség, the northern edge of the Great Hungarian Plain in this region – is composed of Upper Miocene to Lower Pannonian marine sand and clay and covered partly by loess. The pyroclastic zone is composed of three sequences of Lower to Middle Miocene and Upper Miocene unconsolidated or more or less welded rhyolite–rhyodacite tuffs and their redeposited varieties. Its most welded, very hard varieties, the ignimbrites, extend in two uninterrupted belts, striking (S)W–N(E) with varying widths.

While the geological structure of the Bükkalja is characterized by W–E striking bedding, the characteristic relief features are N–S striking valleys and interfluves. The N–E striking tributary valleys turn sharply to east or west where they are faced with the ignimbrite belts, which are more resistant against erosion, and terminate in the main valleys. Therefore south of the ignimbrite belts the valley density is significantly less than on the northern side.

Alongside the ignimbrite belts, cuestas have been developed on the interfluves. These cuestas have steep headwalls towards the inner part of the Bükk Mountains and gently sloping sides towards south with short, narrow derision valleys. These southern slopes are the best yielding regions of the Bükkalja for grape and fruit production not only for small-scale but also for modern, large-scale vineyards. The so-called Bükkalja wine region traditionally consists of the western, Eger wine region (Eger, Egerszalók, Noszvaj, Novaj, Ostoros), and the eastern (Sály, Kács, Tibolddaróc) one. The Eger region is an important and well-known member of the historical wine regions of Hungary, however the eastern region had also been famous from its outstanding wines until the Phylloxera vine disease in the second part of the 19th century. While the recultivation of the Eger wine region has been started just after the disease, in the eastern part it was commenced only in the early 1960s.

Due to its geological conditions, the Bükkalja is favourable also for wine fermentation and storage. The moderately hard seams of rhyolitic and rhiodacitic tuff can easily be carved and are suitable for good-quality cellars.

Where the N–S striking major valleys cut the ignimbrite belt, they form small canyons. One of the most spectacular of these is the Felső-szoros ("Upper canyon") near Cserépváralja, where the valley is bordered by 4–5 m high, 1–1.5 m thick rhyolitic ignimbrite slabs showing columnar jointing. One of the characteristic features of the Bükkalja is what are called hive-stones (kaptárkő), high cones that formed by erosion from the less-welded rhyolite tuff at the S–SW headwalls of the tributary valleys. Their popular name came from the rectangular niches carved into them and thought to have been used as beehives.

The N–S striking valleys of the Bükkalja served as natural corridors from the Bükk to the plain for prehistoric man and Celtic iron-smith masters who lived in the caves and later in fortresses in the Bükk Mountains. Agriculturist and stockbreeder tribes of the Copper, Bronze and Iron Ages found shelter in the valleys in the periods of peril.

Hungarians inhabited the area at the turn of the 9th and 10th centuries. The settlement network evolved in the period of the

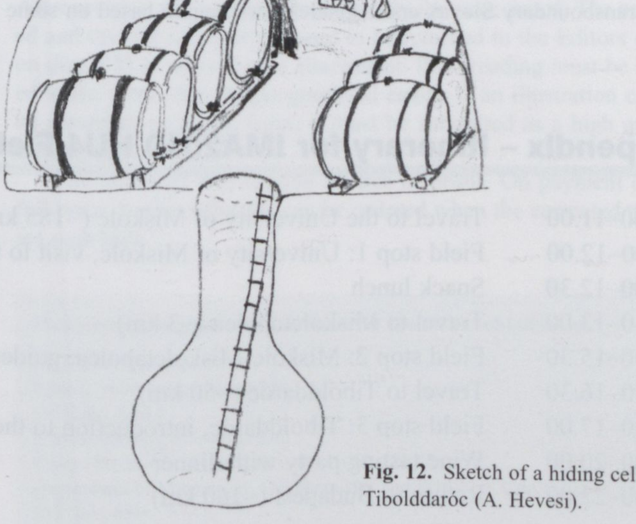

**Fig. 12.** Sketch of a hiding cellar at Tibolddaróc (A. Hevesi).

foundation of the Hungarian state (around 1000). First written mentions of the settlements are dated from the 13th century.

Pretty wine houses and cellars are found in several villages of the Bükkalja region. One of the most interesting from these is the building complex at the western edge of Tibolddaróc. Under the base level of these cellars, so-called "hiding cellars" were carved (Fig. 12). These pear-shaped, 3-4 metres deep and downwards 2-2.5 metres wide carved holes served as hiding places for the barrels with the best wines and other valuables in the periods of peril (*e.g.* during Turkish wars, 1526–1686). The cover plate of the hiding cellar could be reinserted practically without joint gaps. During wartime only the lower-quality wines were stored at the basement. When predators found and drank them, they were no more able to find the best-quality barrels.

## 3. References

Árkai, P., Balogh, K. & Dunkl, I. (1995): Timing of low temperature metamorphism and cooling of the Paleozoic and Mesozoic formations of the Bükkium, innermost Western Carpathians, Hungary. Geologische Rundschau, **84**: 334–344.

Borbély, S. (1958): "Lake-cave" of Tapolcafürdő. Borsodi Földrajzi Évkönyv, **1**: 2–3 (In Hungarian).

Filipović, I., Jovanović, D., Sudar, M., Pelikán, P., Kovács, S., Less, Gy. & Hips, K. (2003): Comparison of the Variscan, Early Alpine evolution of the Jadar Block (NW Serbia) and "Bükkium" (NE Hungary) terranes; some paleogeographic implications. Slovak Geological Magazine, **9** (1): 23–40.

Hevesi, A. (1980): Data to the Quaternary palaeogeographic image of Bükk Mts. Földtani Közlöny, **110**: 540–550 (In Hungarian with French abstract).

Kerekes, J. (1936): The Görömbölytapolca "lake-cave". Barlangvilág, **6** (1–2): 23–28 (In Hungarian).

Kessler, H. (1959): The Miskolc-Tapolca Cave Bath has been opened. Karszt- és Barlangkutatási Tájékoztató, September 1959: 26–28 (In Hungarian).

Lénárt, L. (2005a): Thermal karsts in Northern Hungary and Southern Slovakia; Traces of thermal-cave forming in the caves of these areas. In Genesis and formation of hydrothermal caves. Int. Conf. on the Occasion of the 100th Anniversary of the Discovery of Pál-völgy Cave. Budapest, June 21–24. 2004. Papers. Budapest: Hungarian Speleological Society, 54–60.

Lénárt, L. (2005b): Some aspects of the "3E's" (Economics-Environment-Ethics) model for sustainable water usage in the transboundary Slovak and Aggtelek karst region based on some examples from the Bükk Mountains. PhD Thesis, Technical University of Košice, Slovakia.

Lénárt, L. (2008): Cold, tepid and warm zones of karstic water in the Bükk Mts and its surroundings. In: Mineral waters in the Carpathian Basin, 5th International Scientific Conference. Csíkszereda, 25–25 July, 2008, 41–50 (In Hungarian).

Lénárt, L. & Stuhán, G. (1999): Miskolc-Tapolca Cave Bath. Tájak-Korok-Múzeumok Kiskönyvtára, 598B. Budapest: TKM egyesület.

Lénárt, L., Lénárt, E. & Szalontay, G. (2008): Warm and tepid karst springs in the Bükk Mts. and Gömör–Torna Karst since the Turkish period. ALCADI '06 Conference 2006.09.24–30. 45–58, Budapest (In Hungarian).

Less, Gy. & Mello, J. (eds) (2004): Geological map of the Gemer–Bükk area, 1:100 000. – Budapest: Geological Institute of Hungary

Németh, N. (2005): Uplift phase deformation features of the NE part of the Bükk Mts. (NE Hungary). Geolines, **19**: 89.

Papp, K. (1907): Die geologischen Verhältnisse der Umgebung von Miskolcz. Mitteilungen aus dem Jahrbuch der königlich ungarischen Geologischen Reichsanstalt, **16** (3): 93–142.

Pelikán, P. & Budai T. (eds) (2005): Geology of the Bükk Mts. Explanations to the 1:50 000 map of the Bükk Mts. Budapest: MÁFI, 284 p. (In Hungarian with extended English summary)

Szlabóczky, P. (1974): Thermohydraulic study on karstic reservoir system based on data from the Miskolc area. Hidrológiai Közlöny, **54**: 516–523 (in Hungarian with German abstract).

Szlabóczky, P., Hegedűs, F. & Czakó, L. (1993): Recent hydrogeological and speleological explorations and developments envisaged at Miskolc-Tapolca. Hidrológiai Közlöny, **73**: 87–92 (in Hungarian with English abstract).

## Appendix – Itinerary for IMA2010 HU4 Field trip

| | |
|---|---|
| 08.00–11.00 | Travel to the University of Miskolc (~185 km) |
| 11.00–12.00 | Field stop 1: University of Miskolc, visit to the Selmec Museum Library |
| 12.00–12.30 | Snack lunch |
| 12.30–13.00 | Travel to Miskolctapolca (~3 km) |
| 13.00–15.30 | Field stop 2: Miskolc-Miskolctapolca, guided tour in the Cave Bath followed by optional bathing |
| 15.30–16.30 | Travel to Tibolddaróc (~50 km) |
| 16.30–17.00 | Field stop 3: Tibolddaróc, introduction to the geomorphology and geology of the Bükkalja region |
| 17.00–20.00 | Wine tasting party with dinner |
| 20.00–22.00 | Return to Budapest (~160 km) |