Bulletin
of the Slovak Speleological Society

ISSUED FOR THE PURPOSE OF THE 18th INTERNATIONAL CONGRESS OF SPELEOLOGY – UIS, SAVOIE 2022

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Cave pearls in the Demänová Cave System.
Speleofotografia Contest.
Photo: L. Kubičina

SPELEOLOGICKÁ SSS SLOVENSKÁ SPOLOČNOSŤ

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SLOVAK CAVERS IN 2022

Peter Holúbek,
chairman of the Slovak Speleological Society

In Slovakia, which has an area of 49,034 km^2, about 5.5 % of the territory is made of karstic rocks. The Slovak Speleological Society is deeply interested in this phenomenon. It is a civic association of enthusiasts and volunteers that was established in 1949 by a transformation of the Caving Group of the Slovak Tourist and Skier Club. Currently it has almost 1,000 members in 51 clubs which cover the entire territory of the Slovak Republic. Every year, they perform several thousand field projects in caves and karst terrains. The members also operate abroad. The Slovak Speleological Society is a founding member of the International Speleological Union (UIS) and in addition it is a member of the European Speleological Federation (FSE). In the year 1921 the first list of Slovak caves was published in a tourist periodical, and it contained 28 localities with an estimated length of 5 kilometres. In June of this year, there are 7,776 caves and abysses registered in the national database with the total length exceeding 448 kilometres. This was possible mainly due to the members of the Slovak Speleological Society, who in the last 15 years discovered 101 kilometres of underground spaces and mapped 155 kilometres of passages. At the same time, it is estimated that in Slovakia, cavers discovered and explored only 3 % of the existing cave areas. According to the Constitution of the Slovak Republic, the caves are owned by the state. Each cave in Slovakia is protected as a natural monument, the 44 most important ones are listed in the highest category as a national natural monument, several caves are a part of the UNESCO World Natural Heritage. Almost all cave activities: exploration (practical, scientific), discovery (new spaces, archaeological and paleontological findings), documentary activities (location of entrances, surveying of underground spaces, photography, protection (closing and constructing cave and abyss entrances), publishing periodical and non-periodical publications, publishing new knowledge and carrying out environmental, educational cultural activities related to the underground. In their activities, Slovak cavers closely cooperate with the Slovak Museum of Nature Protection and Speleology (documentation, paleontological and archaeological findings) in Liptovský Mikuláš and the Slovak Caves Administration (protection, documentation, closing of entrances, scientific research). Together, these three organizations have a significant impact on events in the karst areas and caves of Slovakia. Slovak cavers actively participated in the International Year of Caves and Karst in 2021 and their activities certainly contributed to raising public awareness of this remarkable phenomenon in Slovakia.

Discovered and surveyed cave passages in Slovakia in the last 15 years

year	discovered (km)	surveyed (km)
2007	10.9	12.3
2008	6.5	10.1
2009	11.9	11.8
2010	5.5	11.5
2011	8.7	16.7
2012	5.9	14.6
2013	5.9	9.3
2014	5.1	9.5
2015	5.5	11.2
2016	7.2	11.5
2017	7.0	11.3
2018	7.1	11.9
2019	5.7	5.2
2020	5.7	6.0
2021	2.2	2.3
total	**101**	**155**

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LIST OF THE LONGEST AND DEEPEST CAVES IN SLOVAKIA

Ján Tencer, (March 1, 2022)

No.	Longest Caves	Length (m)
1.	**Demänovský Cave System** Demänovské Hills, Low Tatras Mts.,	**43,719**
2.	**Mesačný tieň Cave** Eastern Tatras, High Tatras Mts.	**31,840** 9,031*
3.	**Stratenská Cave System** Spiš-gemer Karst, Slovenský raj	**23,809**
4.	**Jaskyňa mŕtvych netopierov** (Cave of Dead Bats) Ďumbier Hill, Low Tatra Mts.	**21,387**
5.	**Štefanová Cave** Demänovské Hills, Low Tatras Mts.,	**18,294**
6.	**Javorinka Cave** Eastern Tatras, High Tatras Mts.	**11,990**
7.	**Jaskyňa zlomísk cave** Demänovské Hills, Low Tatras Mts.,	**11,255**
8.	**Domica – Čertova diera, Cave System** Slovak Karst, Silická Plateau	**8,894** 22,027**
9.	**Skalistý potok Cave** Slovak Karst, Jasovská Plateau	**8,215**
10.	**Hipman's Caves** Demänovské Hills, Low Tatras Mts.	**7,650**
11.	**Jaskyňa v Záskočí – Na Predných, Cave System** Demänovské Hills, Low Tatras Mts.,	**5,034**
12.	**Bobačka Cave** Spiš-Gemer Karst, Muráň Plateau	**4,719**
13.	**Liskovská Cave** Choč Mts., The Podtatranská kotlina (Sub-Tatra Basin)	**4,502**
14.	**Prosiecka Cave** Prosečné Mts., Choč Mts.	**4,425**
15.	**Belianska Cave** Eastern Tatras, Belianske Tatras Mts.	**4,113**
16.	**Jasovská cave** Slovak Karst, Jasovská Plateau	**3,924**
17.	**Čachtická Cave** Nedze Mts., Little Carpathians Mts.,	**3,865**
18.	**Bystrianska cave** Horehron Valley, Bystrianske Mts.	**3,531**
19.	**Nová Stanišovská Cave** Demänovské Hills, Low Tatras Mts.,	**3,241**
20.	**Stratený potok Cave** Spiš-Gemer Karst, Muráň Plateau	**3,233**

No.	Deepest Caves	Depth (m)
1.	**Hipman's Caves** Demänovské Hills, Low Tatras Mts.	**499**
2.	**Javorinka Cave** Eastern Tatras, High Tatras Mts.	**480**
3.	**Mesačný tieň Cave** Eastern Tatras, High Tatras Mts.	**451**
4.	**Skalistý potok Cave** Slovak Karst, Jasovská Plateau	**376**
5.	**Jaskyňa mŕtvych netopierov** (Cave of Dead Bats) Ďumbier Mts., Low Tatra Mts.	**324**
6.	**Javorová Abyss** Demänovské Hills, Low Tatras Mts.	**313**
7.	**Jaskyňa v Záskočí – Na Predných, Cave System** Demänovské Hills, Low Tatras Mts.	**284**
8.	**Čiernohorský Cave System** Eastern Tatras, High Tatras Mts.	**232**
9.	**Kunia Abyss** Slovak Karst, Jasovská Plateau	**203**
10.	**Tristarská Abyss** Eastern Tatras, Belianske Tatras Mts.	**201**
11.	**Demänovský Cave System** Demänovské Hills, Low Tatras Mts.	**197**
12.	**Stratenská Cave System** Spiš-Gemer Karst, Slovenský raj	**194**
13.	**Havran** Low Tatras Mts., Demänovské Hills	**187**
14.	**Čertova diera Cave** Slovak Karst, Horný vrch Plateau	**186**
15.	**Nová Kresanica** Červené vrchy, Western Tatras Mts.	**183**
16.	**Brázda (Barazdaláš) Abyss** Slovak Karst, Silická Plateau	**181**
17.	**Vajsáblova Abyss** Plavecký Karst, Little Carpathians Mts.	**179.5**
18.	**Bystriansky závrt Abyss** Horehron Valley, Bystrianske Mts.	**174.5**
19.	**Belianska Cave** Eastern Tatras, Belianske Tatras Mts.	**174**
20.	**Sedlákova diera Cave** Eastern Tatras, Belianske Tatras Mts.	**168**

* resurvey in progress, **part of Domica-Baradla transboundary cave system (SK-HU). Survey of new-discovered ca 800 m in progress (2022)

WHO IS WHO IN SLOVAK SPELEOLOGY?

Lukáš Vlček

Slovak Speleological Society – SSS

The Slovak Speleological Society (SSS) was established in September 1949 as a unified organization of volunteer cavers in Slovakia, which continued the activities of the already existing Caving Corps of the Slovak Skier and Tourist Club (JZ KSTL), founded in 1944. The mission of the first SSS was the research of karst areas and caves, care for access to them, enabling their visits, enhancement, and protection of the cave wealth, which included the collection and presentation of work results from the field of speleology, monuments from caves and karst, their scientific processing and management in the Museum of the Slovak Karst (MSK; today's Slovak Museum of Nature Protection and Speleology – SMOPaJ). After the decline in the 1950s, the activities of the organization were renewed in 1969 and the SSS operated at the Museum of the Slovak Karst until 1990, when it became independent. At present, the SSS has 51 basic organizational units – regional cave groups and clubs with a total of almost 1000 members. The main mission of SSS members is to discover, register, document and protect caves and other karst phenomena in Slovakia. Thanks to them, more than 7,700 caves are known here; all of them are natural monuments, several of them have been declared national natural monuments and are inscribed in the list of Ramsar sites or UNESCO World Natural Heritage. Every year, SSS organizes national events (with international participation) Speleomiting (until 2022 – 31 years) and Caving Week (until 2022 – 63 years), as well as other events focused on education, cave mapping and training in cave abseiling techniques. In Slovakia, it cooperates mainly with the Slovak Cave Administration (SSJ) and the Slovak Museum of Nature Protection and Speleology (SMOPaJ). SSS publishes a quarterly speleological magazine, the SSS Bulletin – Spravodaj Slovenskej speleologickej spoločnosti (since 1970) and many occasional publications. Slovak cavers are also successful abroad. SSS is one of the founding members of the International Speleological Union (UIS) and in 1973 it was a co-organizer of the 6th International Speleological Congress UIS. It has been a full member of the European Speleological Federation (FSE) since 2008. In the Czech Republic, a similar Czech Speleological Society (ČSS) has been operating since 1978 with 60 basic organizations (ZO ČSS), but for example, there is no central speleological society in neighbouring Poland, and e.g., Croatian cavers have two.

Slovak Caves Administration – SSJ

The state organization in the field of the environment is currently under the State Nature Protection of the Slovak Republic (ŠOP SR; it also manages National Parks and other protected landscape areas of the Slovak Republic). Originally an organization managing twelve show caves in Slovakia; it is now in charge of all caves and abysses, and deals with the protection, documentation and promotion of caves, as well as the management of all show caves in Slovakia. It works closely with cavers associated in the Slovak Speleological Society and with the Slovak Museum of Nature Protection and Speleology, universities, as well as foreign organizations in the field of science, research, and nature conservation. The SSJ fundamentally contributed to the inclusion of the caves of the Slovak and Aggtelek Karst in the UNESCO World Natural Heritage List. It organizes a biennial conference on Research, Utilization and Conservation of Caves and has also organized international congresses such as IWIC (International Workshop on Ice Caves), ISCA Congress (International Show Caves Association Congress), Cave Bear Symposium (paleontological symposium on cave bears), ALCADI (International Symposium on History of Speleology and Karstology in the Alps, Carpathians and Dinarides). Twice a year, SSJ publishes a scientific magazine dealing with karst and cave research – Aragonite and cooperates with the SMOPaJ museum in publishing the magazine Slovenský kras (Acta Carsologica Slovaca).

Slovak Museum of Nature Protection and Speleology – SMOPaJ

The specialized museum in Liptovský Mikuláš, which has been modified from the original Museum of the Slovak Karst (MSK), specializing in karst, caves, and caving in Slovakia collects findings, documents and presents karst phenomena and activities around them. A permanent exhibition is dedicated to the karst, caves, and caving. Among other things, the museum manages a central database of caves. There is a map archive and the largest speleological library, which serves all those interested in caves in Slovakia. SMOPaJ has been publishing a proceeding since 1958, today the professional magazine Slovenský kras (Acta Carsologica Slovaca; together with the SSJ) and since 1989 the bulletin Sinter, which was focused on caving, especially in first years. For more about the museum see p. 62.

Cave Rescue Service – JZS HZS

The rescue service in caves in Slovakia is integrated into the Mountain Rescue Service (Horská záchranná služba – HZS). It is a specialized rescue unit in the Ministry of the Internal Affairs, used to save the life and health of people in underground spaces. Rescuers are available 24 hours a day on the 183-00 hotline. The toll-free emergency line throughout Europe is 112. Before visiting a cave, it is recommended to take out national or international insurance, which covers the mountains accidents throughout the year. The Slovak Speleological Society volunteer cave-rescuers work closely with the HZS Cave Rescue Group. You can find a list of them and their contacts on the SSS website.

Slovak Bat Conservation Society – SON

It is a non-governmental organization that deals with the conservation and research of bats in Slovakia (a similar Czech Bat Conservation Society operates in the neighbouring Czech Republic). Its strength lies in its cooperation with volunteer cavers and amateur and professional nature conservationists, who, among other things, take part in the annual winter-counting of bats in caves. In cooperation with professional natural scientists, they prepare expertise on the current state of these rare animals in the Slovak Republic and determine the forecasts of their life in the future. SON publishes the Vespertilio magazine, which contains articles on Slovak caves, mines, and artificial underground spaces as an environment for bats.

DISCOVER SHOW CAVES

13 caves in Slovakia are open to the public in the classical way:

Belianska Cave in Belianske Tatry, **Brestovská Cave** in Western Tatras, **Bystrianska Cave** in Hron Basin, **Demänovská Ice Cave** and **Demänovská Cave of Liberty** in Low Tatra Mts. Both of them are parts of the Demänová Cave System), **Dobšinská Ice Cave** in Slovak Raj Mts., **Domica Cave** in Slovak Karst, **Driny Cave** in the Little Carpathians, **Gombasecká Cave** in Slovak Karst, **Harmanecká Cave** in Veľká Fatra Mts. **Jasovská Cave** in Slovak Karst, **Ochtinská Aragonite Cave** in Revúcka Highland, **Važecká Cave** in Liptov basin.

Bystrianska Cave. Photo: L. Vlček, M. Danko and Z. Musilová

The **Bojnická Hradná Cave** is accessible as a part of the conducted tour of the Bojnice Castle. Another five caves are in the hands of cavers who lease them from the government. These are: **Jaskyňa mŕtvych netopierov (Cave of Dead Bats)** and **Malá Stanišovská Cave**, both in the Low Tatra Mts., **Krásnohorská Cave** in the Slovak Karst, **Zlá diera (Bad Hole)** in Branisko Mts, and one speleodiving locality – a flooded shaft **Morské Oko (Sea Eye Cave)** in Rimava basin. The thermal cave **Parenica** in the Štiavnické vrchy Mts. is open to the public within the spa treatment area, and at the entrance of the **Prepoštská Cave** near Bojnice Castle there is an archaeological site with an exhibition open to the public. A few smaller caves are open for visitors only for a few days in the year, for special occasions, e.g., **Pružinská Dúpna Cave** in Strážovské Mts.

(-lv-)

ACHIEVEMENTS AND CHALLENGES: 33 SUMPS IN THE SKALISTÝ POTOK CAVE

Zdenko Hochmuth
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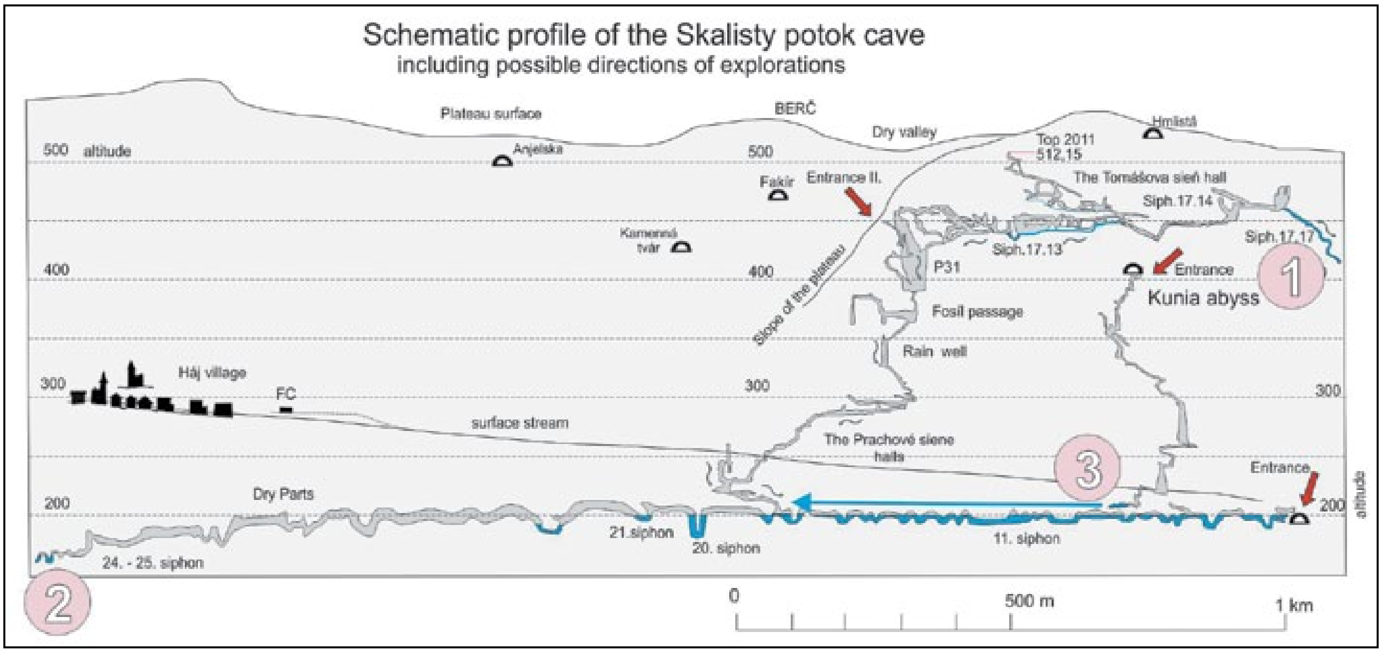
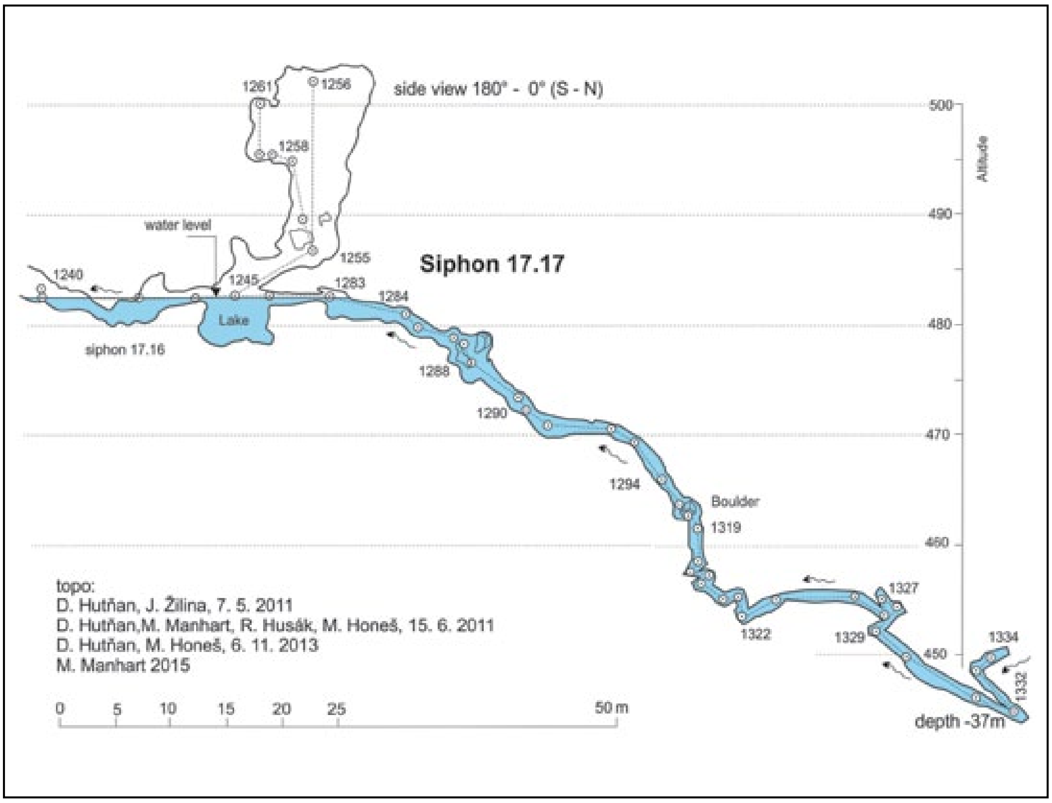
The most important speleo-diving site in Slovakia and, until recently, the longest cave in the Slovak Karst has been in research for 35 years with breaks. After the classics of Slovak diving (Kucharovič, Sláčik) left the site, the incoming generation of divers (Hochmuth, Koľbik, Šimkovič, Ďurček, Mikloš) could not cope with the fact that a promising locality should end here after two sumps. The group within the then organizational structure called "East" in 1986 resumed the research at this location at the foot of the easternmost one of the plains of the Slovak Karst. In a short time and after an intensive exploration, a riverbed was found with a gradually increasing number of sumps of various lengths, mostly of small depth. Alternating with difficult to pass dry sections.

Already in 1990, we reached both the horizontal dry or periodically flown through continuation, and the rising parts of the character of a mountain cave with waterfalls and vertical steps. The limits of the possibilities of the then technique were reached approximately in 1993–94, when the maximum elevation was reached. The generation of discoverers was gradually reduced and finally even the youngest member of the group Daniel Hutňan went to Czech Republic. This was followed by a phase of occasional research by Czech divers of the Speleoaquanaut club under his leadership. A horizontal continuation was discovered on the main riverbed at a relative height of about 200 m above

M. Honeš (†) in a narrow opening of the 17th sump. Photo: V. Čech



1. Siphon 17.17, 2. „Straight direction", Siphon 23, 3. connection to the Kunia Abyss



the lower sump section. An intensive exploration of the upper parts was possible only after digging a separate entrance by the activity of the original group into these parts from the surface. The periodically flown through lower section of the cave was also extended and at the border of the then physical forces a distance of 2.3 km from the resurgence in sumps 22 and 23 was reached.

The group, including new members from Slovakia, has been transformed into "Speleodiver". In the unfortunate year of 2014, several unfortunate events occurred. The significant discoverer Martin Honeš died in a car accident, the author of the article ensuring the continuity of the research in the cave suffered a serious injury in another cave and D. Hutňan fell seriously ill. Nevertheless, in 2014 and 2015, the research of the last sump, Siphon 17.17, was carried out and the length of the cave reached 8125 m at an elevation of 376 m. Since then, the research has been virtually stagnant despite visits from a renewing team. There are three big challenges left, which the next generation will hopefully take advantage of after successes and experiences abroad. I will present the status and visions of what this survey would bring.

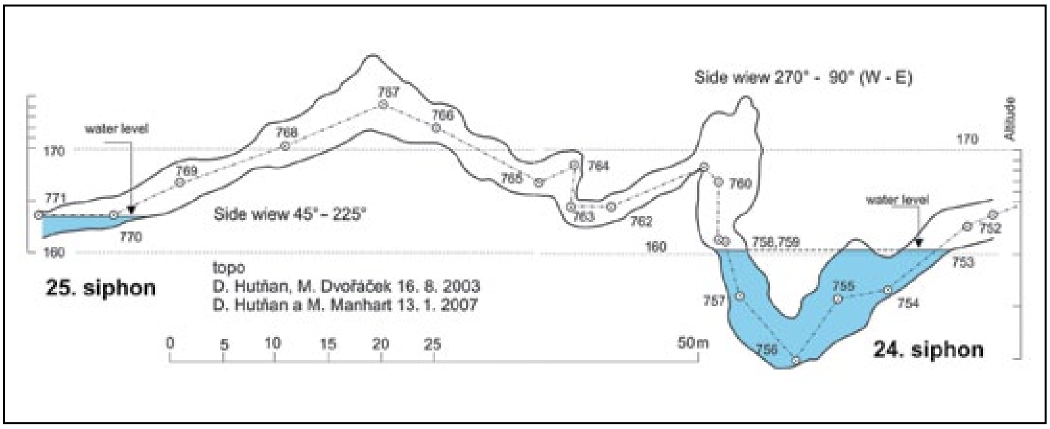
Siphon 17.17

The main riverbed is in the most promising direction, making it possible to clarify the origin of the non-karst material in sediments. It began to be systematically examined only after breaking the upper entrance (2007-8). Tight sump, Siphon 17.14, was broken through by M. Manhart and M. Honeš in 2009. Hutňan, Husák and Kýška were engaged here. The waterfall falling from the chimney had to be overcome by a climbing post. After shorter sumps, the situation radically changed, and the continuation was in a sump with a wedged boulder at a depth of 17 m. After disrupting the boulder in 2015, the sump spirals down to a depth of almost 40 m, which is the limit of possible risk.

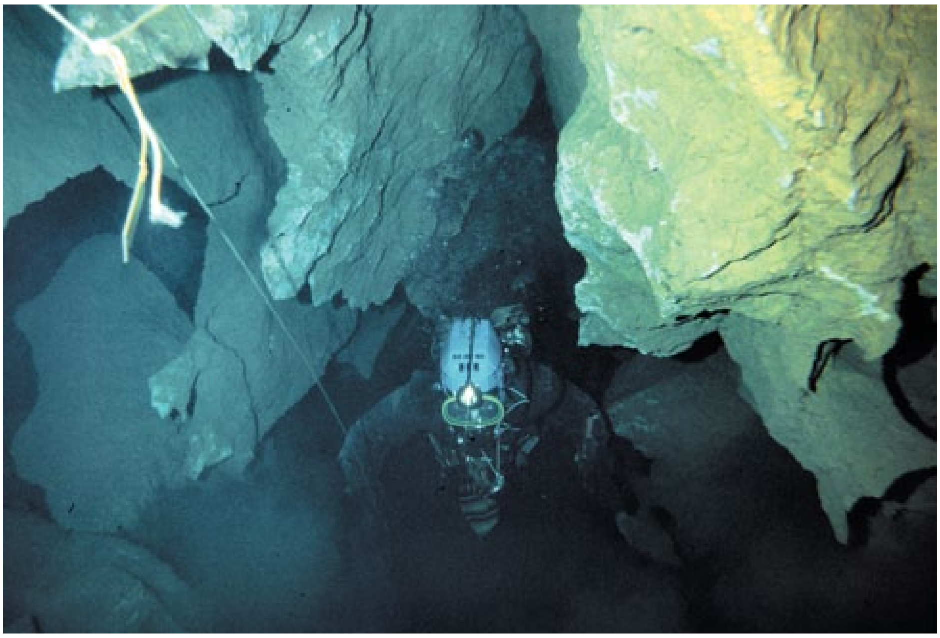
Straight direction, Siphon 23

Already after coming to the surface from Siphon 19 in the "Straight direction", on the lower riverbed we noticed that water stagnates there, sometimes even flows in the opposite direction. After the so far deepest sump, Siphon 20, we got into extensive dry horizontal parts with sump elbows, in the dry period without water. With my friend V. Ďurček (†), the last of the older generation we reached Siphon 22 in 1994.

This was overcome only in 2000 by the younger generation of Speleoaquanaut group and they conti-



nued by mapping the corridors of a similar nature over 1.5 km long. The path to the end, which ends in **sumps 23 to 25**, is at the limit of human possibilities. We are verifying the water regime and considering another entrance from the surface that would radically help.



Tectonic-corrosive nature of the majority of sumps. Speleodiver V. Ďurček in the 6th sump. Photo: Z. Hochmuth

Connection with the Kunia Abyss

The Kunia Abyss represents a kind of a reduced analogy to the vertical parts of the Skalistý potok Cave. It lies a few hundreds of meters from them. A weak flow is flowing through it. There's a sump at the bottom. V. Ďurček dives here to a distance of about 50 m with a free continuation. The transport to the sump is difficult. In the Skalistý potok Cave, water flows out of the Kunia abyss in sump 17.8.1 (verified by colour tracing test, 4 days). Several experiments in tight spaces were carried out here by Koľbik (1990) and Hutňan in 2007. Reaching the connection would extend the system by about another one km.

A typical shape of corridors behind the 15th sump. Photo: K. Kýška

DISCOVERIES IN SAMOVA DIERA CAVE IN THE JÁNSKA VALLEY IN THE LOW TATRAS

Peter Holúbek, Dušan Jančovič

Jánska Valley represents a remarkable phenomenon of the Low Tatras (Western Carpathians), where important Slovak caves were formed. Active speleological research has been carried out here by enthusiasts for more than 100 years. Watercourses flow from the non-karst crystalline core of the Low Tatras, cut into the Mesozoic limestones and form surface and underground karst phenomena. The Jánska Valley is dominated by the strong spring Hlbokô (774 m alt.), which has an annual flow from 548 to 2000 l/s and a substantial part of these waters comes from sinking allochtonous streams. The spring in Medzibrodie (762 m alt.) has an average discharge approx. 125 l/s and drains mainly vertical caves formed in the Krakova hoľa massif (1752 m). This spring drains the cave system Starý hrad – Večná robota, where 7.6 kilometres of corridors with a vertical span of 499 m are discovered and documented. However, the water course that flows through its underground has a flow rate only 20 l/s. In the nearby genetically related Cave in Záskočie, a stream flows with a flow rate 5 l/s, so a substantial part of the drainage is unknown. As of May 31, 2022, there are 301 caves and pits in the Jánska Valley, with 44.91 km of explored and documented spaces. Despite the efforts of hundreds of cavers, a substantial part of the underground spaces is still unknown.

Cavers before the exploration of Samova diera. Photo: P. Holúbek

A typical cave corridor. Photo: L. Kubičina

HISTORY

In 2020, new spaces were discovered in Samova diera Cave, which shifted the level of knowledge of the caves in Jánska Valley. What preceded it? Sometime in March 1989, the caver and hunter Dušan Jančovič returned from the search for deer antlers in the vicinity of the Predbystrá lodge on the border of limestones and crystalline rocks. He was accompanied by the hunting dog Samo, who was lost at a late hour, already in limited visibility. After a while, he appeared, and his back was wet from white moonmilk. It was clear that he rubbed against a cave ceiling. Subsequently, an unknown cave with a length of 16 m was found, where a bear's den was. The site is located at an altitude of 934 m. It has a fluvial origin, but there was no place where one could logically look for a continuation. We did not even register a draft here, which would indicate its further continuation. In November 2000, it was documented and explored by an employee of the Slovak Museum of Nature Protection and Speleology. Then the site fell into oblivion for a few years. The nearby overhang of Viecha, related to Samova diera was documented in 1997 by M. Hurtaj, J. Mikloš and P. Holúbek. It is a site which lies above Samova diera at an altitude of 954 m. In the past, it was inhabited, probably used by shepherds and forest workers. Hoarfrost was found in the back of it in winter, which testifies to its further continuation. To advance to the new spaces, they dug here. Bones of small Pleistocene animals were found there. Zoologist J. Obuch, who identified the findings, believes that it may be the food of a Palaeolithic man. We therefore stopped digging here and are waiting for archaeological research.

Viecha archaeological site. Photo: D. Gratkowska

DISCOVERIES

On August 29, 2020, we (D. Jančovič, P. Holúbek) visited the site to inspect the bear den with a bear expert Michaela Skuban. As we searched for traces of this creature inhabiting the cave, we noticed traces of claws on the walls in the white sinter. By analyzing them, we concluded that a little bear cub rolled into unfamiliar areas and that his mother, to get to him, was scratching the wall in fury. A group of cavers from Čachtice and Ružomberok

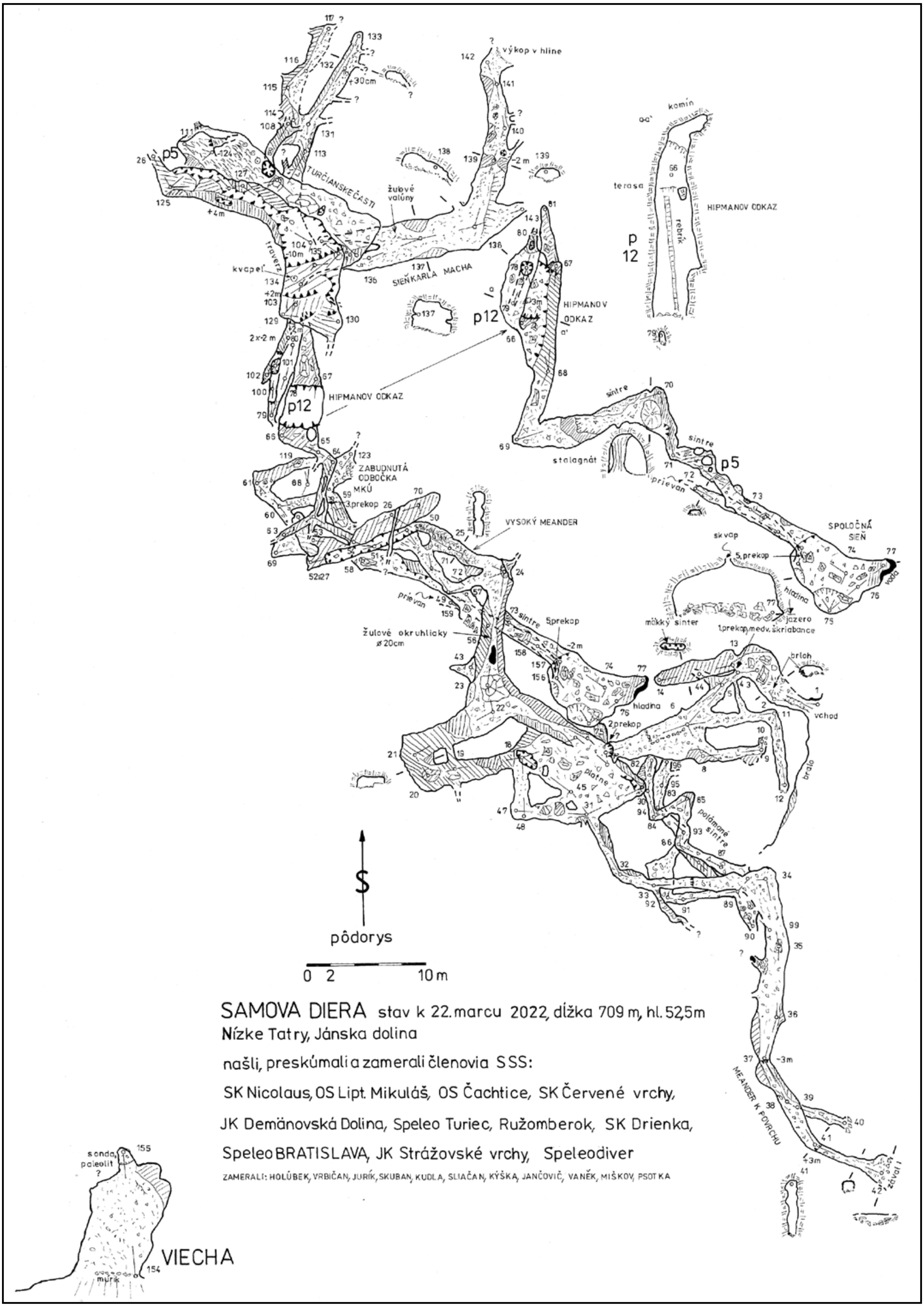
Bear scratches on flowstone. Photo: P. Holúbek

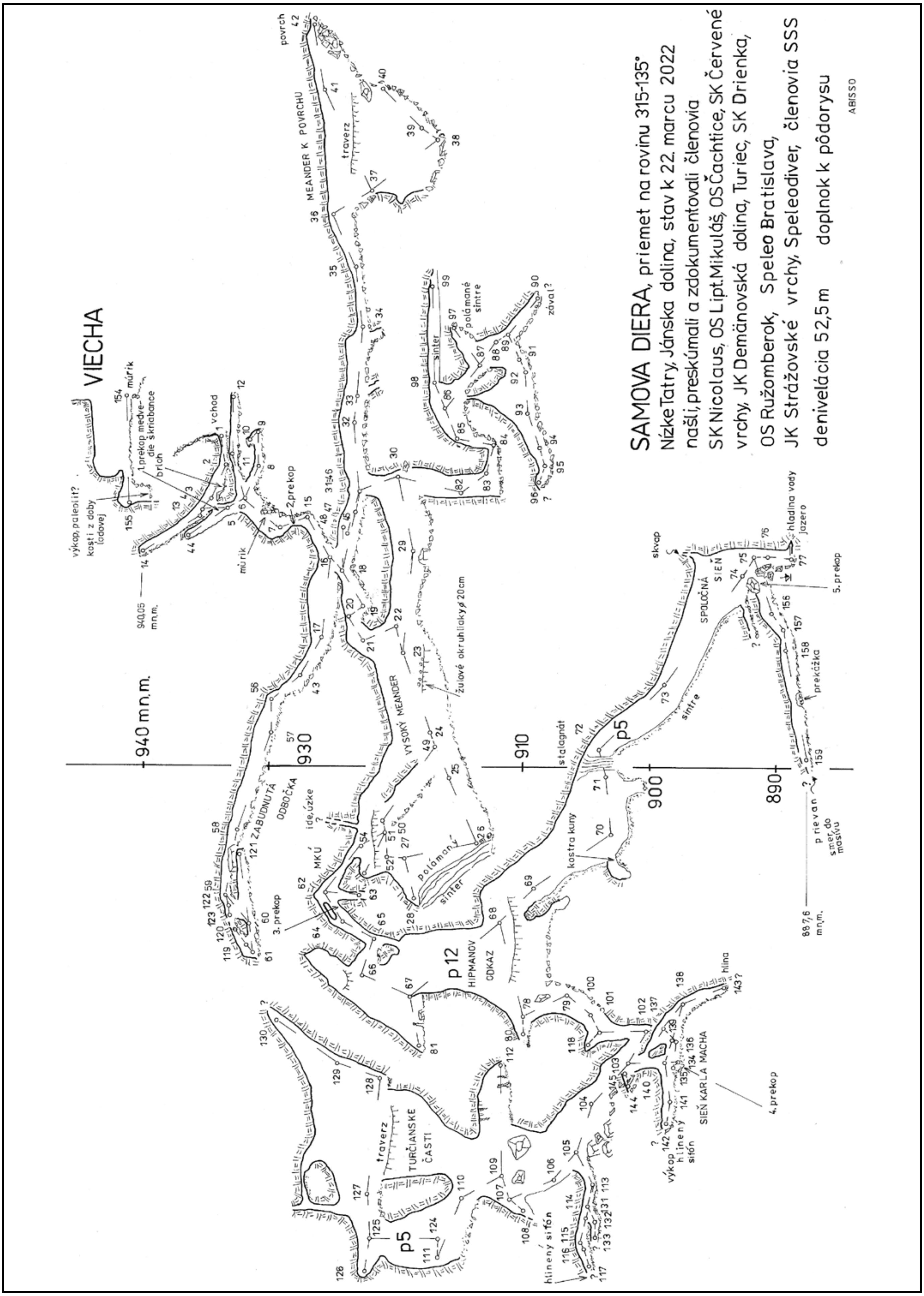
An enthusiast from a group of friends M. Vrbičan got through this sqeeze (MKÚ) and we stopped before a free continuation with a 12 m deep pit. This was overcome during the trip on November 5, 2020, and we entered a three-dimensional labyrinth of passages that we did not explore. During the next trip on November 12, 2020, M. Vrbičan, Z. Jurík, M. Kudla, P. Procházka, P. Pokrievka Jr., J. Šmoll, M. Prokop, D. Jančovič and P. Holúbek discovered about 200 meters of new spaces. The following exploration and documentation (P. Magdolen, R. Nevařil, M. Vrbičan, J. Psotka, P. Sliačan, M. Miškov, M. Kudla, M. Danko, Z. Jurík, K. Kýška, T. P. Holúbeková, J. Vajs, P. Procházka) advanced slightly and the exploration ended in unpleasant narrows and a loamy sediment-clogged sump, which looks like a long dig. In the lowest place there was a lake, which M. Vrbičan drew out and proved that it was not a sump. During an excursion to the Caving week held in the Demänovská Valley in 2021,

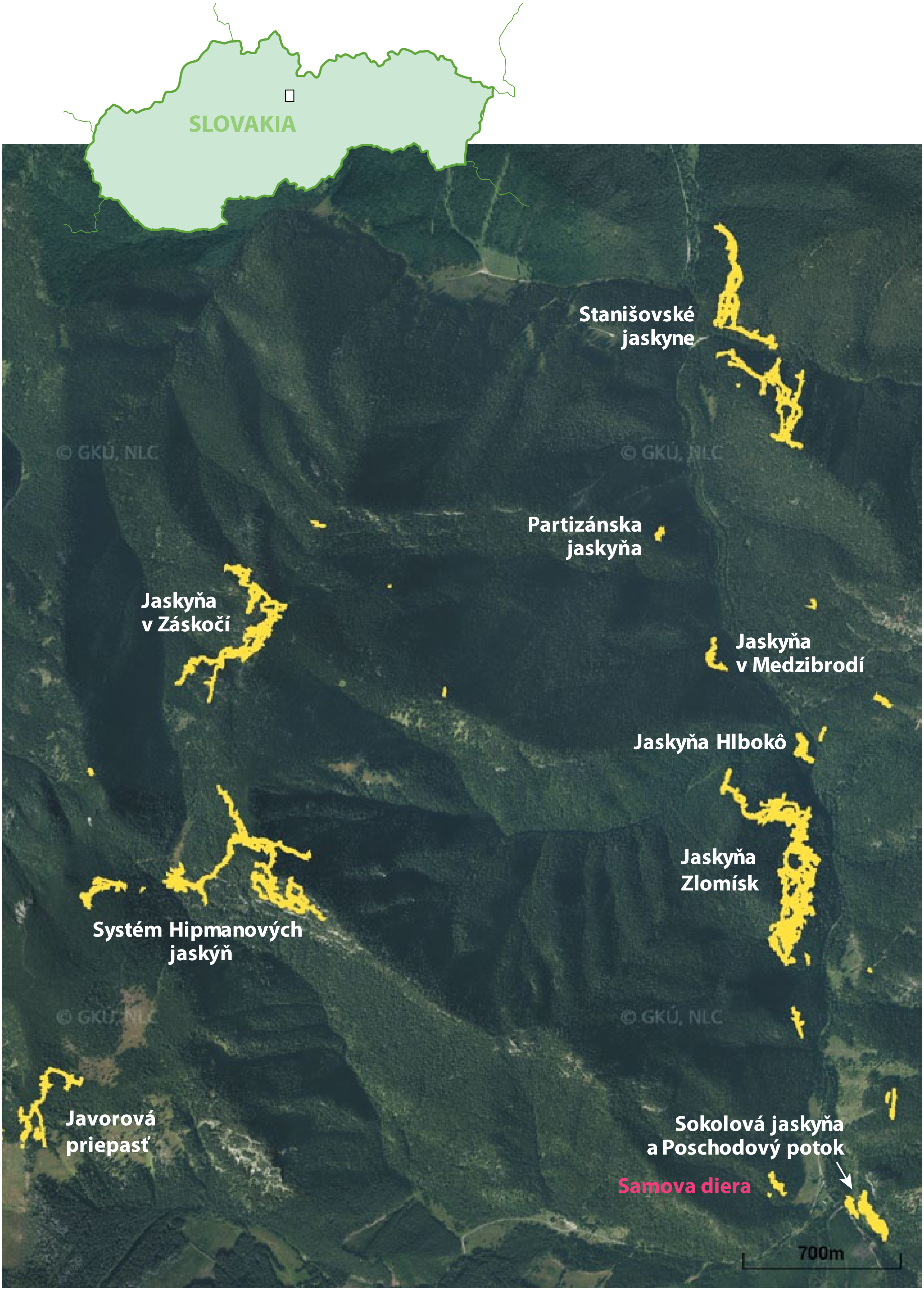
Descent into the shaft "Petr Hipman's legacy". Photo: P. Pokrievka

(L. Kubičina, Z. Otruba, I. Beran, M. Kudla) led by Dušan Jančovič set out to verify this theory on October 17, 2020. After a few minutes of work and rolling out of a larger boulder, a 10 x 5 m room was uncovered, where the bear cub could roll. The length of the cave after the survey reached 52 m. After two excavations at the lowest point, on 24 October 2020 D. Jančovič, Z. Jurík and P. Holúbek managed to discover another 200 m of new spaces. These are high meanders with a lot of granite pebbles. This is obviously a stream cave formed by sinking streams originating in the granite part of the Low Tatras. In the main direction, the cave ended in a massive flowstone obstacle with a volume of tens of cubic meters. Thorough the exploration and climbing of all narrows above this barrier we found a small hole through which we could see further.

The bottom of Samova diera Cave. Photo: P. Pokrievka

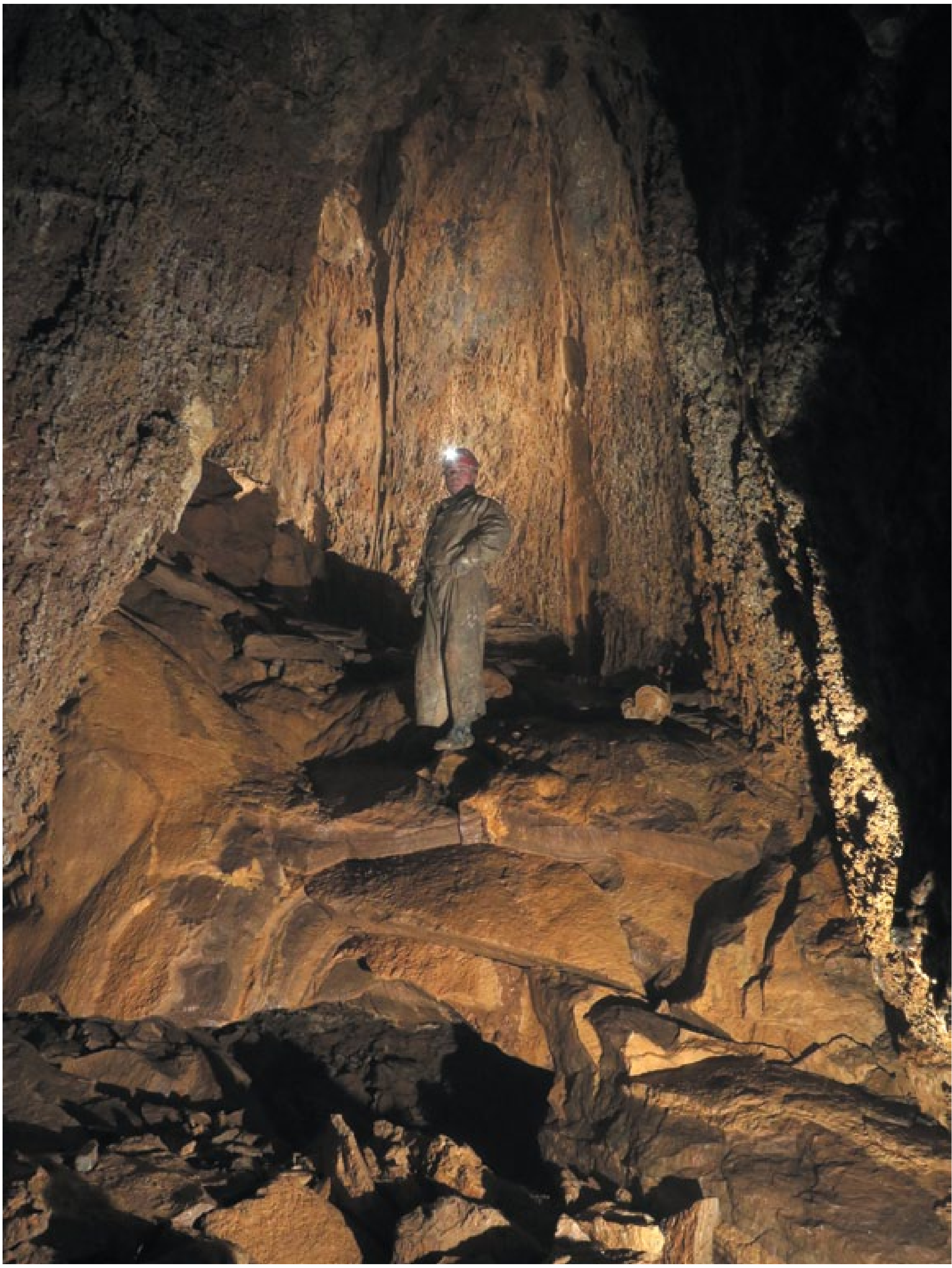

SAMOVA DIERA stav k 22. marcu 2022, dĺžka 709 m, hl. 52,5m
Nízke Tatry, Jánska dolina
našli, preskúmali a zamerali členovia SSS:
SK Nicolaus, OS Lipt. Mikuláš, OS Čachtice, SK Červené vrchy,
JK Demänovská Dolina, Speleo Turiec, Ružomberok, SK Drienka,
Speleo BRATISLAVA, JK Strážovské vrchy, Speleodiver
ZAMERALI: HOLÚBEK, VRBIČAN, JURÍK, SKUBAN, KUDLA, SLIAČAN, KÝŠKA, JANČOVIČ, VANĚK, MIŠKOV, PSOTKA
pôdorys
0 2 10 m
VIECHA
HIPMANOV ODKAZ
SIEŇ KARLA MACHA
TURČIANSKE ČASTI
VYSOKÝ MEANDER
SPOLOČNÁ SIEŇ
ZABUDNUTÁ ODBOČKA MKÚ
MEANDER K POVRCHU
vchod


SAMOVA DIERA, priemet na rovinu 315-135°
NízkeTatry, Jánska dolina, stav k 22. marcu 2022
našli, preskúmali a zdokumentovali členovia
SK Nicolaus, OS Lipt.Mikuláš, OS Čachtice, SK Červené
vrchy, JK Demänovská dolina, Turiec, SK Drienka,
OS Ružomberok, Speleo Bratislava,
JK Strážovské vrchy, Speleodiver, členovia SSS
denivelácia 52,5 m
doplnok k pôdorysu
ABISSO
VIECHA
940 m n.m.
930
910
900
890
940,05 m n.m.
887,6 m n.m.
vchod
povrch
MEANDER K POVRCHU
traverz
VYSOKÝ MEANDER
ZABUDNUTÁ ODBOČKA
MKÚ
HIPMANOV ODKAZ
SPOLOČNÁ SIEŇ
SIEŇ KARLA MACHA
TURČIANSKE ČASTI
hlinený sifón
1.prekop
2.prekop
3.prekop
4.prekop
5.prekop
p5
p12
stalagnát
kostra kuny
sintre
polámané sintre
závaly?
hladina vody jazero
prekážka
prievan smer do masívu
hlina
žulové okruhliaky ø 20cm
výkop, paleolit? kosti z doby ľadovej
múrik
1.prekop medvedie škriabance
brloh
skvap



Location of Samova diera Cave in the Jánska dolina Valley

V. Ruček and M. Vrbičan found a branch at the bottom in an illogical direction with a hint of continuation. In winter, during an extremely dry period at the turn of 2021–2, drafts appeared here, which is a clear direction for further exploration. It is a low and muddy passage, where you can see a few meters ahead. It is necessary to wait until a drier period to continue. Sinter and mud must be removed from uncomfortably tight spaces. Since 2020, thirteen SSS groups and clubs have participated in the survey and documentation of Samova diera Cave (SK Nicolaus; Komisia pre speleopotápanie – pracovná skupina Východ; JS Arachnos – Slovenský kras; OS Liptovský Mikuláš; OS Ružomberok; OS Čachtice; SK Červené vrchy; JK Demänovská dolina; JK Speleo Turiec; SK Drienka; Speleo Bratislava; Speleodiver; JK Strážovské vrchy). So, after years, one of the last wishes of Petr Hipman (1940–1999), a prominent speleologist working in the Jánská Valley, is being fulfilled: *We must unite so that we can overcome challenging obstacles underground.*



The broken flowstones are characteristic of the entire cave. Photo: L. Kubičina

PERSPECTIVE

The length of the surveyed parts of Samova diera Cave is 709 m and about 30 m of insignificant narrows are still not documented. The lowest point where the local watercourse sinks is at a depth of 52 m at an altitude of 887 m, so the spring Hlbokô is still 113 meters lower and in 2350 m direct distance further. The nearest place in the collapse end of the Jaskyňa Zlomísk Cave (length 11 km), which has an altitude of 825 m, is in a direct distance of about a kilometer. There is a strong assumption that the two sites are interconnected. In this section, we also expect passages and a tributary of water from the Krakova hoľa massif. We assume that the passages leading from the Občasná vyvieračka (Intermittent spring) whose entrance is 1700 meters to the west, at the mouth of Čierna dolinka (at 1042 m alt.) connect here. Occasional drafts in the cave testify to the sump that forms here, which can significantly complicate the exploration of the site. So, we have hopes and expectations. Time and discovery activity will tell what will happen next.

RE-MAPPING OF THE PARTIZÁNSKA CAVE IN THE JÁNSKA VALLEY

Michal Danko – Miroslav Kováčik – Lukáš Vlček

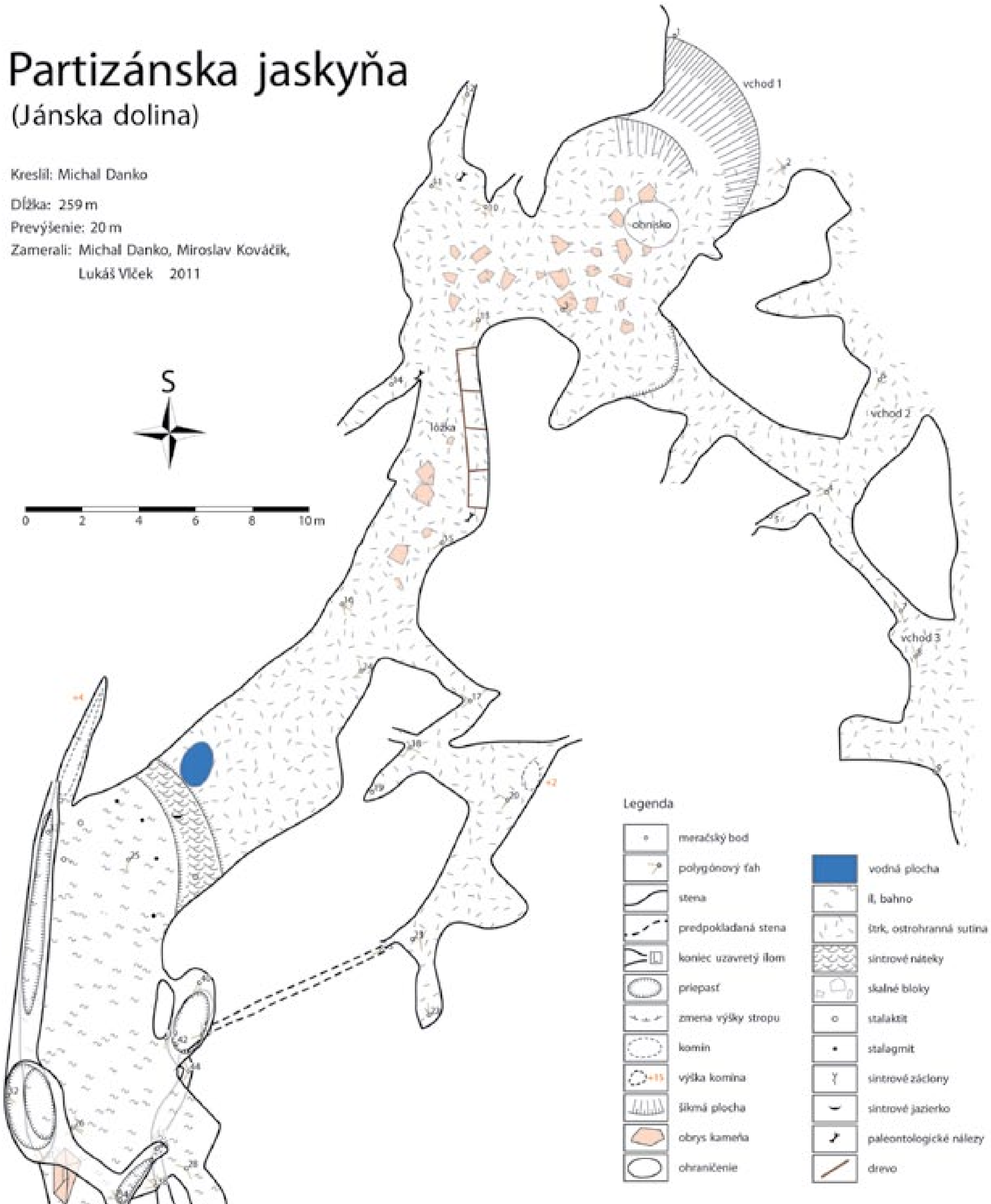
A few years ago, we had the idea to compile a Therion 3D map of the area including Jánska dolina and Demänovská dolina valleys and the Krakova hoľa massif, located between them. We are constantly adding more locations to the valley maps. Since there are no surveying data or notebooks from several, albeit relatively large, caves, step by step we are surveying these caves. One of them is the Partizánska Cave in the ridge between the Šindliarka and Jánska valleys.

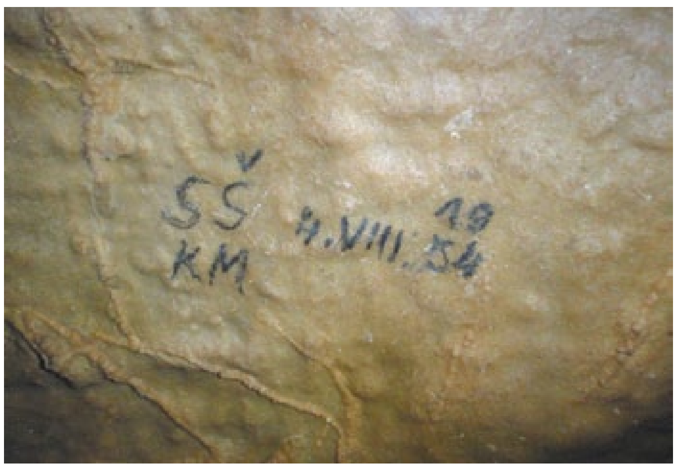
Steep slopes near the cave's entrance. Photo: L. Vlček

The only map we had was A. Droppa's map from 1959, which covers 144 m of an underground space. However, after the first view of the map, checking the survey stations on it and comparing it with the attached scale, it was clear to us that some of the passages were not measured and drawn only by estimation. Therefore, we decided to survey the cave and make a 3D plan of it with the help of Therion SW. So, we got to work.

On Friday, July 8, our trio Michal Danko, Miroslav Kováčik and Lukáš Vlček arrived in Jánská dolina valley. Driven by a storm at our heels, we ran to the cave portal. With the help of Disto X, we surveyed 100 m of passages only in the immediate vicinity of the entrance, and after a short rest in the portal while observing dripping raindrops wildly whipping the surrounding forest, we continued into the bowels of Krakova hoľa. We also focused on the areas in the chimney above the main corridor and the lower parts of the cave together with the abyss.

Above the abyss. Photo: L. Vlček



Wall inscriptions of the first known cave explorers. Photo: L. Vlček

At the same time, we quickly made a photo documentation of the cave. After counting the surveyed centreline legs, the final length of the cave was 259 m with a vertical span of 20 m. The map shows that the cave areas go much further into the Krakova hoľa massif compared to A. Droppa's map. The biggest surprise (although not unexpected) for us was the inscription S. Š., K. M. with a date from 1954, which we immediately concluded to come from Stanislav Šrol and Karel Mach, in the deepest part of the cave.

A small recollection from times not so long ago, when Lukáš and I ran through Jánska Valley, searching, pondering, drawing, photographing and, in particular, survey the caves that escaped attention at that time. There was no usable survey notebook, and the maps were often just useless sketches for our efforts to digitize maps and create a 3D model of the valley. One of the maps was published in 2011 on the website of the Nicolaus Speleoclub under the title "Survey of the Partizánska Cave in Jánska dolina".

(-md-)

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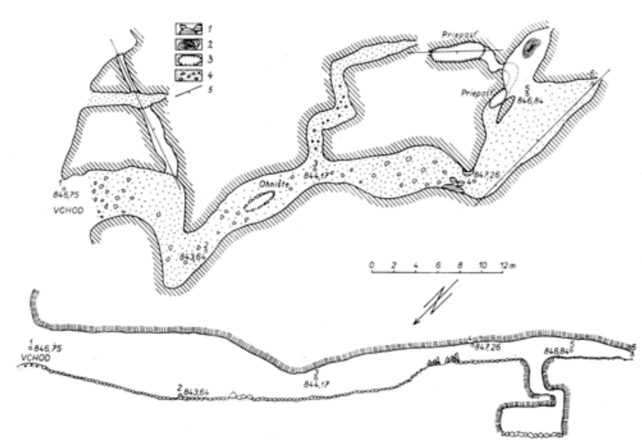


Partizánska jaskyňa. 1 — kvapľová výzdoba; 2 — jazierka; 3 — priepasti; 4 — vápencová sutina; 5 — smer a sklon puklín. — Partizánska Cave. 1 — dripstone decoration; 2 — lakelets; 3 — chasms; 4 — limestone debris; 5 — strike and dip of fissures. *A. Droppa 1959*

Map of the Partizánska Cave from 1959 by A. Droppa

In the deepest parts of cave. Photo: M. Danko ▶

JOURNEY INTO THE BOWELS OF THE DEEPEST CAVE OF THE LITTLE CARPATHIANS – VAJSÁBLOVA PRIEPASŤ CHASM

Alexander Lačný
Speleoklub Trnava

It is almost symbolic that the deepest cave of the Little Carpathians (western part of Slovakia) can be found under the highest peak of this mountain range – Záruby (768 m). This area belongs to the central part of the Little Carpathians and it is a part of the Plavecký Karst. We started working on the site in 2017 and gradually discoveries of open spaces were made. The discovery actions alternated with work focused on excavation or stabilization of dangerous cave-ins (Lačný & Halama, 2018). We named the Vajsáblova priepasť Chasm after Imrich Vajsábl, who explored the opening as one of the explorers in the period around 1922. Discoveries in the Vajsáblova priepasť Chasm continued in 2019. Prezidentská sieň (Presidential Hall), Zabudnutá sienka (Forgotten Little Hall), Žabia chodba (Frog Passage), and Sieň vytrvalosti (Hall of Endurance) were discovered (Lukačovič & Lačný, 2019). The last-mentioned hall became the deepest point of the cave (-57 m) for a period of approximately one year. A narrow fissure led out of it in a south-eastern direction, and a draught was blowing from it.

At the beginning it was a coincidence again

Immediately after the discovery, we started to focus on this place. The first work started here on 10 August 2019, when the narrow fissure was widened by about 2 m forward. However, the demotivating thing was that the fissure still appeared to be very narrow at the front, albeit with a noticeable draft. This may have also resulted in us moving to other caves in the vicinity. These were the Veterlín probe on Veterlín Ridge, or the significant terrain reduction of Bana pod Zárubami. One of the last actions just before Christmas was directed to the deepest place of Vajsáblova priepasť Chasm. There was a funny incident when A. Lačný accidentally dropped his hammer into an open but impassable space. Since then, his caving colleagues tease him that the hammer is already in the discovery, but we are not yet.

We returned to "Vajsáblovka" more than half a year later – on 12 July 2020. As before, coincidence again intervened significantly. It was supposed to be a work, the

Participants of the second discovery action, bottom row left: A. Lačný, M. Vrbovský, M. Vaško, top row left: E. Mikulášová, M. Baľo, M. Zvonár, J. Kondrček and M. Ševčík. Photo: self-timer

Descent into the first discovered chasm. Photo: M. Zvonár main purpose of which was to dismantle the pipe used for venting the Coral Pond, which we needed at the Vápenice Dolina in the Kuchyňa-Orešany Karst. And since there were several of us, some of the cavers went to work again in the deepest place. E. Mikulášová and M. Vrbovský started dismantling the pipe, while M. Vaško and A. Lačný continued widening the fissure in the deepest place. Later, M. Vrbovský joined them. During this day, we again moved forward in the expansion by about 1.5 m. However, the action was important for one key reason. It was a significant echo. We came back to the surface, cold but excited about the echo.

A dream discovery with problems

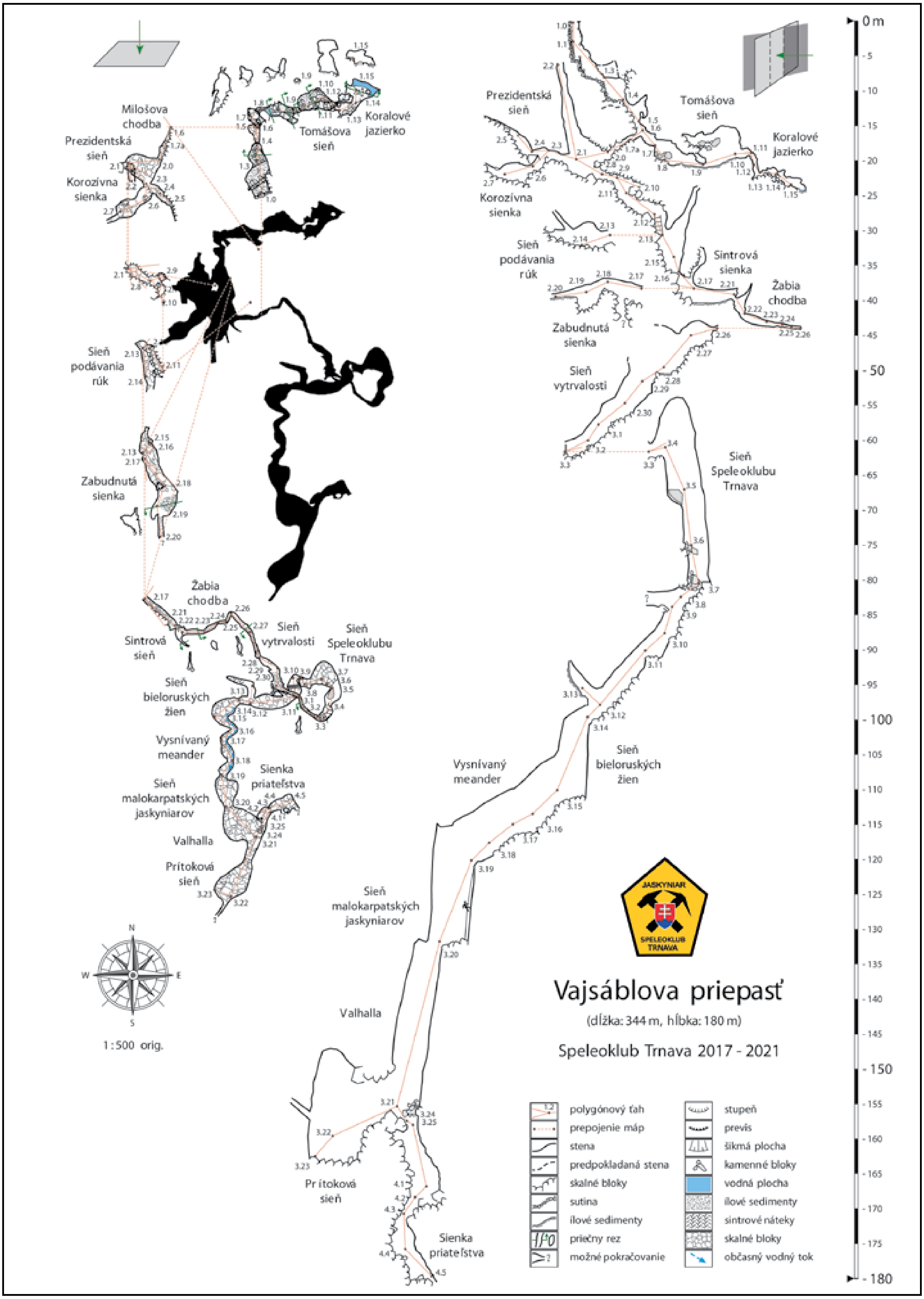
A week later, another work was planned. Three cavers went to the cave: M: Vrbovský, M. Vaško and M. Baľo. After widening

Sieň Speleoklubu Trnava (Hall of the Speleoclub Trnava). Photo: J. Kondrček

View of the flowstone-waterfall in Sieň Speleoklubu Trnava (Hall of the Speleoclub Trnava). Photo: M. Zvonár

Detail of ornamental flowstone structure at the bottom of Sieň Speleoklubu Trnava (Hall of the Speleoclub Trnava). Photo: A. Lačný

a part of the fissure, the cavers reached an open space, which was dominated by a dripstone about 1 m high. What was interesting, however, was the discovery of a huge abyss of several tens of meters deep behind this part, which is unusual for the conditions of the Little Carpathian region. However, due to the lack of ropes and climbing gear, it was impossible to descend into it. On this day, a dramatic, but in the end quite a funny incident occurred. Although the cavers did reach open spaces with the help of gravity, the way up was not so easy. Only one of them – M. Vrbovský – managed to make it. M. Vaško and M. Baľo remained involuntarily trapped in the newly discovered spaces. After climbing out of the cave, M. Vrbovský immediately called the nearest resident caver, M. Zvonár, who was about to go to the Pytliak's Hole. He also informed the club president and vice-president about the situation. The rescue operation could begin. In 50 minutes, M. Zvonár was in front of the entrance to the cave, where M. Vrbovský was waiting for him. In the meantime, the trapped cavers were


Milošova chodba
Prezidentská sieň
Korozívna sienka
Tomášova sieň
Koralové jazierko
Sieň podávania rúk
Zabudnutá sienka
Žabia chodba
Sintrová sieň
Sieň vytrvalosti
Sieň Speleoklubu Trnava
Sieň bieloruských žien
Vysnívaný meander
Sienka priateľstva
Sieň malokarpatských jaskyniarov
Valhalla
Prítoková sieň
1 : 500 orig.
N
W
E
S
Sintrová sienka
Sieň Speleoklubu Trnava
JASKYNIAR
SPELEOKLUB TRNAVA
Vajsáblova priepasť
(dĺžka: 344 m, hĺbka: 180 m)
Speleoklub Trnava 2017 - 2021
polygónový ťah
prepojenie máp
stena
predpokladaná stena
skalné bloky
sutina
ílové sedimenty
priečny rez
možné pokračovanie
stupeň
previs
šikmá plocha
kamenné bloky
vodná plocha
ílové sedimenty
sintrové náteky
skalné bloky
občasný vodný tok
0 m
50
100
150
180

not lazy, they started to widen and dismantle the parts of the fissure that prevented the ascent. Eventually they managed to climb out on their own, but they had to take off their overalls to get through. About a minute before their ascent to the surface, the president of the group arrived. We all agreed that we were lucky that nobody was seriously hurt.

After the previous work, many of us suspected that a historic discovery would be made the next week: on 26 July 2020. This was indicated by a wide chasm (unusual in the Carpathian conditions), where stones were falling with a thud somewhere far away. Seven long days passed, and we stood in front of "Vajsáblovka" – M. Vaško, M. Baľo, M. Vrbovský, M. Zvonár and A. Lačný. Then the packing of the necessary things followed, especially the climbing gear, ropes, anchors, and a heavy drill with batteries. There were five of us with six transport bags. On the way we passed everything among ourselves. The narrow spaces of some parts made it hard to get through even on the way down. We got behind a narrow crawl space at a depth of about 60 m into a smaller hall, like a balcony, where we could see the afore mentioned chasm from the previous action. M. Zvonár was drilling holes for anchoring. After a while A. Lačný climbed down onto a huge block which was wedged in the chasm. M. Vaško arrived and we have created another intermediate anchorage. M. Vaško climbed down. He was at the bottom. There was a huge space 25 m high and about 10 m wide. We noticed a beautiful ornamentation. Almost one whole side was a huge sinterfall. Later, all the members of the team came together. At the bottom between the blocks, blackness could be seen in several places. M. Vrbovský lowered himself into one of the wells and reported that it rolled on. We followed him. M. Zvonár was measuring the depth of the chasm with a laser rangefinder and M. Vrbovský with a barometric altimeter. We expected hundred, because the deepest cave in the Little Carpathians is 110 m deep.

M. Vrbovský reported that the depth of 100 m was conquered. To our surprise, the cave rolled further into the depth. M. Zvonár and M. Vrbovský went to see a side passage... There would be more places like this. We

Stabilization of survey stations.
Photo: J. Kondrček

Semi-oval well in Sieň bieloruských žien (Hall of Belarusian Women).
Photo: J. Kondrček

continued along the main route of the cave. Below us there was another big well.

We didn't hesitate and M. Vaško was the first to get to the bottom of it. But the entire rope was gone and Miloš had to climb up. What next? We decided to cut the rope in one part where it was not needed and extend the current one. It was going well. Miloš, and later the others, entered another huge space. The bottom was stable, the passage was high, and the effects of water were visible. The cave was flushed, almost free of sediment. The passage began to meander. It was about 2 m wide and several meters high. We moved on. The space widened again into a huge hall, where stones also fell with a clatter. But there were no ropes. We have reached a depth of 120 m and with the laser rangefinder we sent a beam to a good 17 m into the unexplored darkness. So far it looked like a mountain type cave. Huge chasms, almost no ornamentation and cold with temperature around +5 °C. Also, we were glad that we haven't gone further. We were exhausted and those who are tired – make mistakes. It was time to return. On the way back we argued about how to call the halls (chasms). We called the first one with a huge flowstone-waterfall Sieň Speleoklubu Trnava (Hall of the Speleoclub Trnava). The meandering meander got the name Vysnívaný meander (Dream Meander). And we symbolically called the large hall at a depth of 130 m in which we have not been yet Sieň malokarpatských jaskyniarov (Hall of the Little Carpathian Cavers). We paid tribute to all generations of Little Carpathian cavers. Each of us was wondering what would happen next. But the journey to the surface was a challenge. The chasms had to be climbed again by a rope. And then the terrible drudgery in the narrow crawl spaces of Žabia chodba (Frog Passage)... We came to the surface. Tired, but happy.

We visited the cave during the cavers' reunion in Jágerka on the first weekend in August. The goal was not its exploration, but expanding of narrow parts of the cave, which complicate the already difficult climb to the surface.

Reaching the depth of 170 m

On 16 August 2020, there was another important action. The goal was not only to discover, but also to take pictures and map. We gathered up, eight of us, which was enough to divide people into teams. The first team consisted of M. Zvonár, M. Vrbovský and M. Vaško. Their task was clear – to explore of unknown spaces and equip the chasms with ropes. The second team, consisting of A. Lačný and M. Baľo, later joined by M. Ševčík from Speleo Bratislava, were supposed to map new spaces discovered during the last action. We were joined by J. Kondrček, whose task was to take pictures of the new areas. E. Mikulášová was responsible for the connection on the surface in case of any complications.

Around 9:40 AM we started to climb down into the cave. We took only necessary things. Even so, they were packed in seven transport bags. The discovery team slowly advanced, still tying and shortening ropes along the way. Meanwhile, the second team started the mapping of the area from Sieň vytrvalosti (Hall of Endurance) with the depth of -57 m, through the narrow crawl space to the first chasm. It smoothly passed into a larger and more massive one, called Sieň Speleoklubu Trnava (Hall of the Speleoclub Trnava). From there we mapped other smaller chasms, but also areas where you could walk freely without a rope. While mapping, we got to the hall above Vysnívaný meander (Dream Meander). Here, however, we encountered technical complications and that was why we stopped mapping at this place for the rest of the day. The hall below us has not yet been named. In the cave, it has become a habit that we name places after current events. For example, during the first round of the presidential campaign, we named one of the halls Prezidentská (Presidential). Today, we named a hall at a depth of 110 m as Sieň bieloruských žien (Belarusian Women's Hall), in support of the Belarusian women. During the mapping M. Ševčík noticed a unique thing in these places – cryogenic calcites, which were formed here when the cave was partially glaciated. The discovery team did not idle either. They reached the bottom of Sieň malokarpatských jaskyniarov (Hall of the Little Carpathian Cavers) at a depth of about 130 m. A huge blackness loomed beneath them. They discovered the deepest chasm of "Vajsáblovka". More than 25 m deep in one descent. Almost the entire huge chasm was washed out by water with solid walls. It can be 5 to 6 m wide. It has been given the mythological name of Valhalla. The mythical Valhalla was a huge high hall where fallen heroes come after death. However, we believe that we will live for a long time, but maybe our souls will meet there one day. The cavers, however, penetrated even deeper and began to probe in more places. They discovered one littler wall above which there were several-ton boulders held up only by force of will. This hall was named Prítoková sieň (Tributary Hall), because a few meters up one of the walls there was a sort of tributary stream coming from the southern, yet unexplored parts of the cave. There were several more such unexplored places. At the bottom of Prítoková sieň (Tributary Hall), after removing the stones, we found a pool of water measuring approximately 2 × 2 m and about 30 cm deep. We have not been able to find any other continuation in this part yet. It will be necessary to climb the inaccessible places in the heights with the help of climbing equipment and explore them thoroughly. We calculated that there may be several hundred meters of open space. At the bottom of Valhalla, a narrow fissure could be reached between the blocks. When M. Vrbovský and M. Zvonár started to clean the fissure at its widest point, suddenly the whole bottom under them moved and they fell about three quarters of a meter lower! However, they were caught in the fissure. Together they agreed to call it a day. It was difficult to get out, Matej was standing on Michal's back, later on his shoulders. After the climb, Miloš Vaško passed Michal a strap and they pulled him out together. There was almost no sinter decoration in the newly discovered parts. There were mostly sharp outcrops of rock blocks and water "gnawed" shapes in the dolomite rock. The newly discovered parts were literally washed out, only shallow traps could be found, besides carbonates, transported shales of the Lunz Formation. Suprisingly, even in the deepest parts we found bats. It is possible that they have come here from parts we do not know about yet.

On 22 November 2020 there was quite a big work action. In the Tributary Hall, located next to Valhalla, Matej Zvonár climbed up about seven meters with the help of climbing equipment to investigate the place where the water was coming out and where we were convinced that the cave could continue, based on the "blackness". Unfortunately, after climbing there Matej stated that the space was too narrow to go through. It would be necessary to widen it. In the meantime, Michal Vrbovský and Boris Blaškovič were widening narrow spaces in the deepest part of the cave. After a few hours they succeeded, and we gained more meters of depth. Water was flowing all around us and we followed it. In the depth it even formed a small waterfall. In the depth the cave was very dangerous. We were aware of it. Boris had his leg pinned by a stone on this day and a rock slammed into A. Lačný's shoulder.

Characteristic abyssal sections in the lower parts of the cave.
Photo: J. Kondrček

In the middle of July 2021, during dry days, we went to gauge the deepest parts, which were discovered back in 2020. However, it was not possible to gauge them at that time due to intensely dripping water. After gauging the polygon thrust line, we found that the cave was 179.5 m deep and 344 m long. The deepest part of the cave was named Sienka priateľstva (Little Hall of Friendship). The cave has thus beaten the deepest cave of the Little Carpathians – the Čachtická Cave – by an impressive 69.5 meters and has thus become the deepest cave of the Little Carpathians. It did not disappoint in the national scale either and became the seventeenth deepest cave.

Finding of cryogenic calcites

At the end of August, during a work action, we also took samples of cryogenic calcite from the walls above Sieň bieloruských žien (Hall of Belarusian Women): depth about 100 m, see map. We also noticed a similar finding on the walls a little deeper in Vysnívaný meander (Dream Meander): depth about 120 m. The initial research was carried out by Dr. Monika Orvošová from the Slovak Museum of Nature Protection and Speleology. The presence of cryogenic calcite as well as the destruction of cave ornamentation are frequent evidence that many caves were glaciated in the Quaternary Ice Ages. Cryogenic calcite is a reliable indicator of glacial cave fill that formed in the permafrost zone (*permafrost is defined as a continuously frozen surface area where the average temperature of the area must be below 0 °C for at least two years or more*) during warmer periods in the transitions from glacial to interglacial or interstadial (sudden warming during an ice age, e.g. during the last ice age we know of up to 24 warming events when it warmed by up to 8 °C in a human lifetime). At that time, water from melting permafrost entered the dry and supercooled cave walls and froze, pure H_2O bound to the ice, and the residual solution was progressively enriched in salts. Cryogenic calcite crystallizes from the supersaturation of these salts.

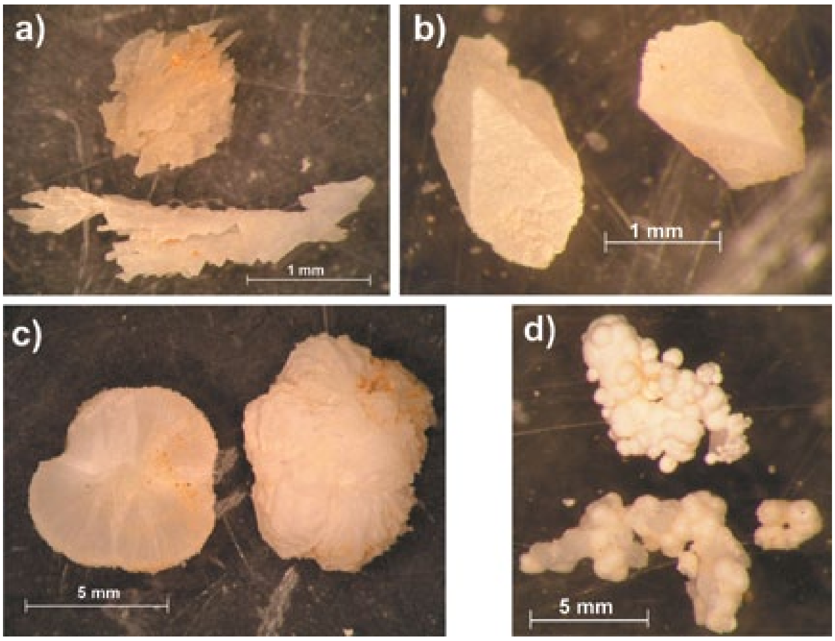


Photo-table of characteristic crystalline aggregates of cryogenic calcite from the site above Sieň bieloruských žien (Hall of Belarusian Women), in the depth of about 100 m a) skeletal crystals – dendritic calcite crystals, represent the most common morphotype of the studied accumulation, b) single crystals of milky-white rhombohedra are also relatively common, c) combined rotated rhombohedra form hemispheroids – half pearls, d) spheroidal calcites or aragonites (with the working name – polystyrenes) crystallize in a succession among the last morphotypes.

We found that there was an incredible number of morphotypes within a single accumulation. The cryogenic calcites, although smaller, probably represent multiple generations. There may be several explanations. Either ice formed in the cave several times during the glacial period, or several accumulations formed within the ice monolith and were eventually deposited (flushed) in one place, as we have found them. However, this question will be answered later by oxygen and carbon isotope analyses and dating of individual morphotypes.

Within these, types ranging from dendritic calcite crystals (photo tab. a), which dominate the accumulation, can be found in the cave. Single crystals of transparent to milky rhombohedra are common (photo tab. b), up to their multiple aggregates. Furthermore, there are rotated rhombohedra, which by fan stacking of surfaces change the rhombohedral shape into rounded aggregates to spheroids (photo tab. c). Clear scalenohedral aggregates or their rafts also occur here. Spheroidal aragonites of spatial growth (with the working name – polystyrenes) crystallize last (photo tab. d), or rafts of flat forms of milky and semi-transparent aragonites. The loaded processes that are represented, for example, by the coalescence of calcites with aragonites are unique. If we compare this with the closely adjacent Hačová Cave, which also represents a chasm, we find that these sites have one thing in common, and that is a great variability or many morphotypes. It is not yet known what causes this morphological diversity, so our goal now is to find a relationship between morphology, chemistry, isotopic composition, and crystal structure (see Milovská et al., 2019).

In terms of drafts, the cave currently appears to be a dynamic system. The formation of cryogenic calcites, however, requires static microclimatic conditions for its crystallization. That is, the cave was frosted gradually from the surface to the subsurface during the low temperatures of the glacial period.

From the above it follows that the presence of cryogenic calcites confirms the minimal depth of permafrost at the sites of their occurrence. Which is a fantastic paleoclimatic data considering their depth of occurrence in Vajsáblová priepasť Chasm (-120 m) together with its location (latitude), which is far south in Slovakia, compared to other Slovak caves with occurrences of cryogenic calcites. The age of the found cryogenic calcites will show us when such cold climatic conditions were present in the Little Carpathians.

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PROSIECKA CAVE – A CAVE FOR CAVE DIGGERS

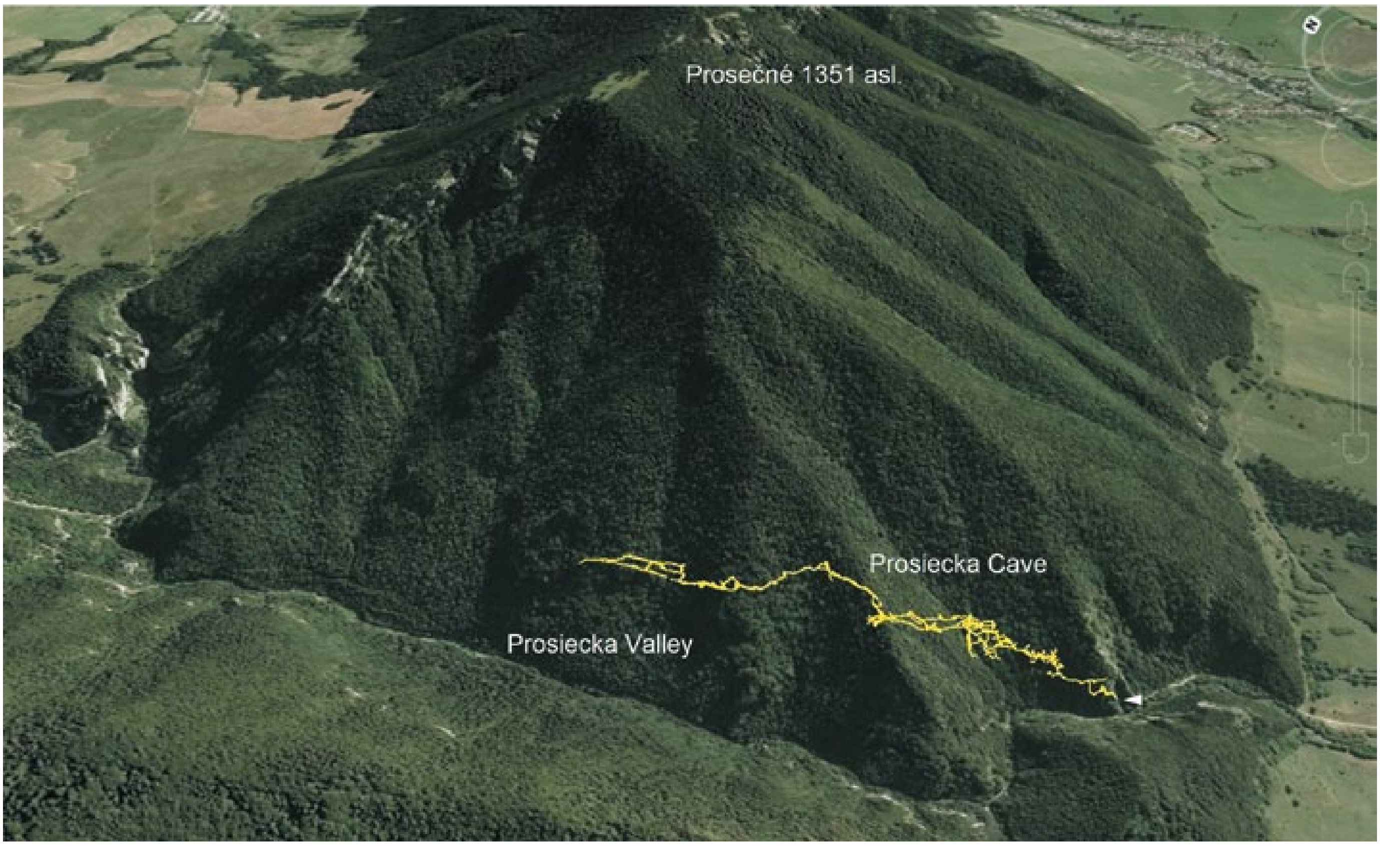
Juraj Szunyog
Speleoclub Chočské vrchy

Prosiecka Cave, as the longest cave of Chočské vrchy Mts. (4,410 m length), is one of the biggest projects of several generations of cave diggers in Slovakia.

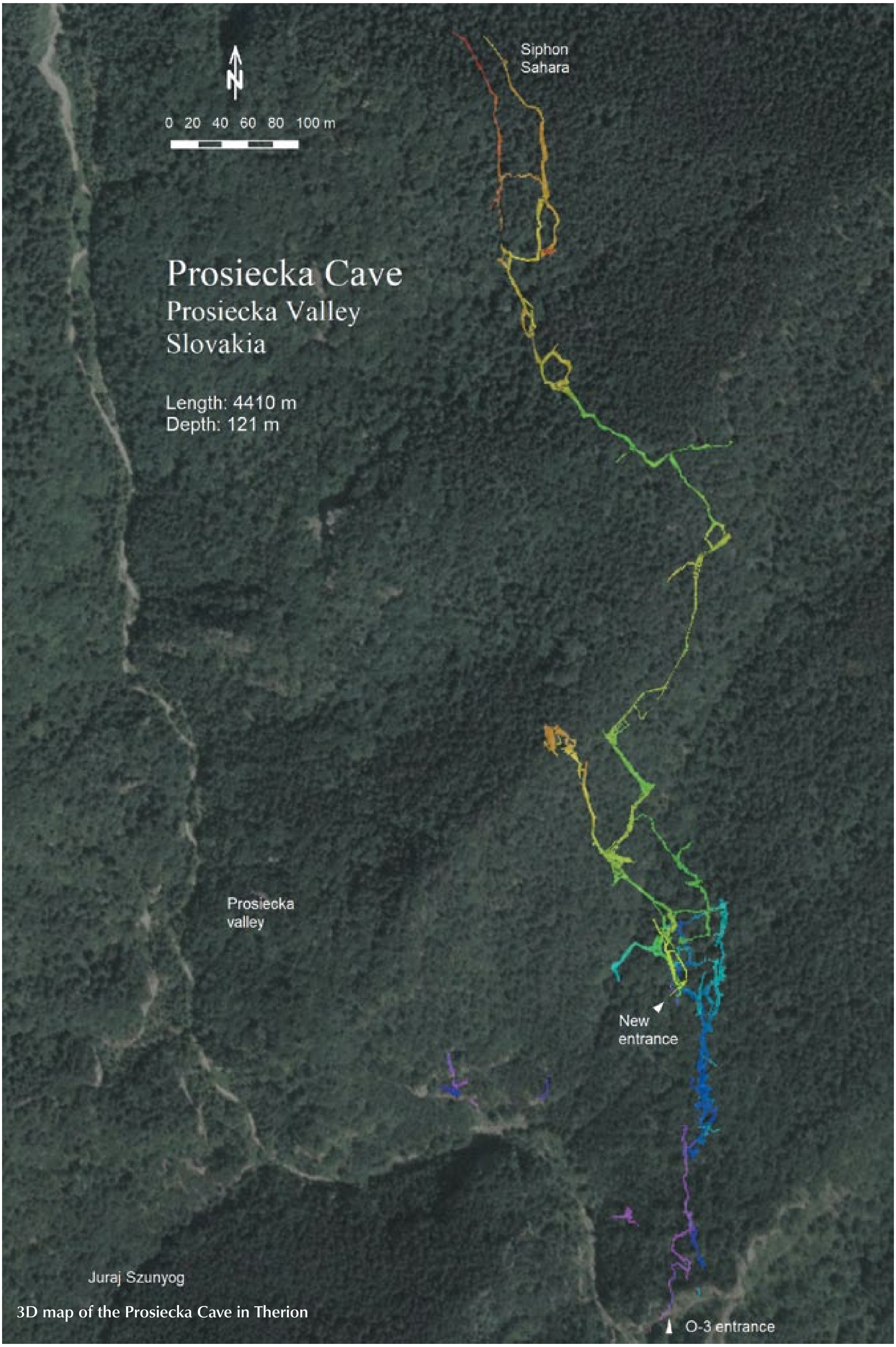
Pavol Andaházy from the village of Prosiek (1885–1945) was the first cave digger, who assumed the existence of a caving system in Prosiecka valley and started to dig in several places around 1924. He penetrated to the length of 24 m by enlarging a narrow fissure in entrance O-3. The next prolongation was done by cave diggers from Ružomberok: Zdenko Hochmuth, Peter Patek (1969–1978) to the length of 45 m and cave diggers from Liptovský Mikuláš: Peter Holúbek, Miroslav Kováčik (1992–1993) to the length of 56 m. Speleoclub Chočské vrchy dug in O-3 since 1997 and widened a non-ferrous duct in the length of 136 m. All the material (debris and mud) had to be taken outside by barrels pulled by ropes through four material storages.

The yearned-for discovery came on August 2, 2011, when we discovered the 1st level of the cave in the length of 286 m. Then the extension of a small chimney with diameter 10 cm and singing air draught followed. After the extension of a 3 m high chimney at the end of 2012 we discovered the 2nd level of the cave with the length of 1200 m. It was difficult to pass these two levels because of narrow and inclined ducts that we had to extend in several places. Passing of a 21 m high chimney to the 3rd level was a big challenge in 2013. Its first half was a vertical crawl that we had to systematically extend. The 3rd level of the cave is a real cave with walking passages, lakes, limestone formations. Nevertheless, we had to use our digging skills. We have found a vertical wall at the end of the main route after passing the half-sump Aragonite Lake on January 26, 2019. We have known that we can find a continuation under the flat sand floor. Good place for digging, but hiking to the end of the cave took us 3 1/2 hour with a bath in the Aragonite Lake.

We worked on digging of the new entrance for two years when this sandy end was discovered. So, we have increased our effort and the new entrance led directly to the beginning of the main route of the 3rd level after 2 1/2 year of digging. This dug shaft in solid limestone with the length of 15 m was finished on July 27, 2019,



Location of the Prosiecka Cave in Prosečné Mt. (J. Szunyog, sw. Therion)



3D map of the Prosiecka Cave in Therion

Digging the Sahara Sump. Photo: J. Szunyog

chassis of an old buggy with a cut barrel on it for transport. We reached the end of the Sump Sahara at the 32nd meter after 2 years and 2 months on May 1, 2022. We have found the Alex corridor in the length of 80 m after the Sump Sahara. The new end of the cave is in a sand half-sump with a 10 cm gap under the ceiling with a shallow draft.

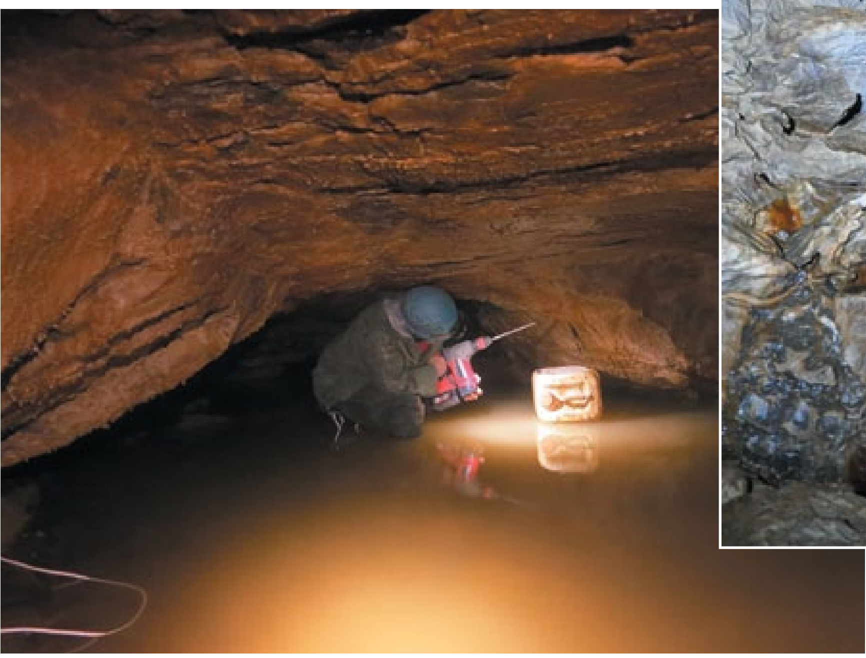
So, we never stop digging in Prosiecka Cave. If the cave prepares us a more difficult barrier, than we have a higher motivation to break it. Totally, we have passed 41 places where it was necessary to work more than one day in Prosiecka Cave. After all, we know four perspective ends with a promising air draught...

and it shortened our trip to the end of the cave to one hour.

Another story was the increasing of the ceiling above the Aragonite Lake in order to prevent swimming in it. It was possible to drill the ceiling above water level only while sitting on a camping chair in the lake. It took 19 working days from January 5, 2020, to April 24, 2021.

So, we could start digging the Sump Sahara, where straight horizontal corridor jumped 3.5 m lower and continued horizontally as a plugged sand sump without draft. It was easy to dig in the sand. The transport was exhausting. We started with buckets, and later a wheelbarrow helped us up to the distance of 80 m. In the sump we used the

Dragon Corridor. Photo: J. Szunyog



◀ Enlarging the passage above the Aragonite Lake. Photo: J. Szunyog

SUCHÁ 3 CAVE – NEW PALEONTOLOGICAL SITE OF CAVE BEAR REMAINS IN THE VEĽKÁ FATRA MTS.

Pavol Pokrievka
Speleoklub Turiec

The Suchá jaskyňa č. 3 (Suchá 3 Cave) is located at the end of the Belianska dolina Valley between the elevation of Suchá 1112 m above sea level and Šoproň peak 1370 m a. s. l. at an altitude of 930 m a. s. l. The entrance to the cave is located about 40 meters above the bottom of the valley, in a distinctive cliff crossing the valley itself. It is formed by a massive overhang, which is oriented to the northwest. From a geological point of view, the cave is formed in the Gutenstein limestones, which reach a thickness of up to 80 m and are located on the base of the Krížna nappe.

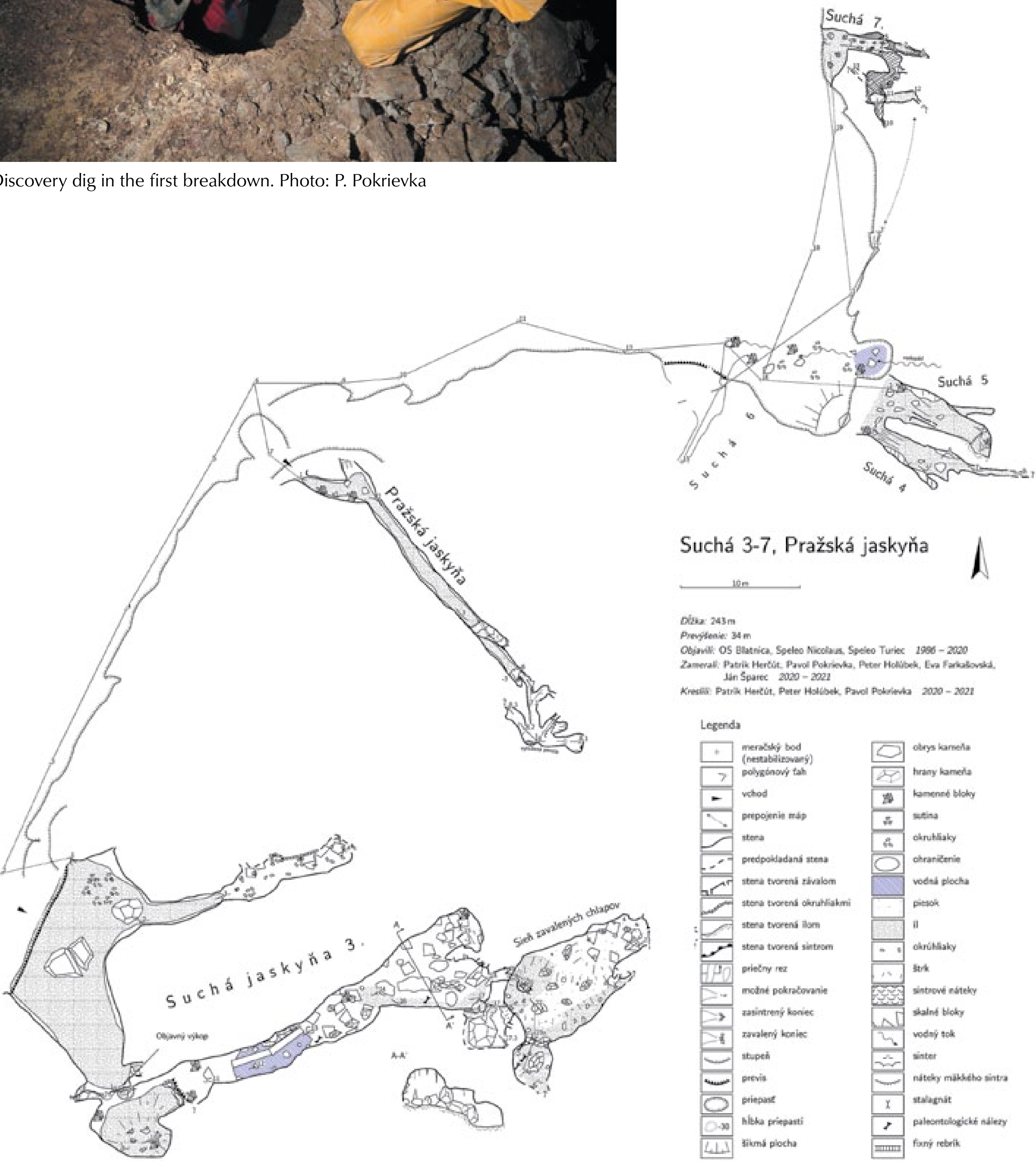
Crossing the pond, the most beautiful place in the cave. Photo: P. Pokrievka

The Suchá 3 Cave has been known for a long time. The huge entrance overhang attracted and at the same time provided a shelter for passing visitors. The cave has been known to the professional public since 1973, when it was mapped in the length of 35 m by a professional speleologist A. Droppa. Digging and exploration was carried out by members of OS Blatnica speleological group in the 1980s. The research focused on overcoming an obstacle located in the eastern part of the overhang (Stará časť – Old Part), which reached a length of 25 m, and it ends by a sintered breakdown of limestone pebbles. These parts were known for the discovery of cave bear bones. The research of small bones was carried by Ing. J. Obuch and fragments of large bones were examined by doc. P. Holec. The overhang in the main direction into the massif was ended by a breakdown. Digging in the breakdown was started by the members of the speleological club Speleo Turiec and SK Nicolaus in December 2019. The breakdown was overcome at the second working trip on January 28, 2020. Behind the breakdown, the speleologists entered a hall with the size 5 × 15 m. A low corridor with a pond emerges from it. The ceiling behind it rises again and continues comfortably to a terminal breakdown. An interesting feature of this new area was the discovery of a larger number of skeletal remains of

Entrance Hall behind the first breakdown. Photo: P. Pokrievka

Discovery dig in the first breakdown. Photo: P. Pokrievka

cave bears. After the discovery, the working efforts focused on overcoming the terminal breakdown. However, difficult digging in the mud and water proceeded slowly. At first, speleologists dug a few meters in front of the breakdown, under the wall, from where it seemed that draft was coming. Gradually, a pit almost 5 m deep was dug here, from which a low hall 7 × 5 m was discovered.



On the day of overcoming the entrance breakdown.
From left J. Vajs, P. Holúbek, E. Farkašová and P. Pokrievka. Photo: J. Vajs

However, the possible progress direction was not clear, so we focused the research again on the terminal breakdown.

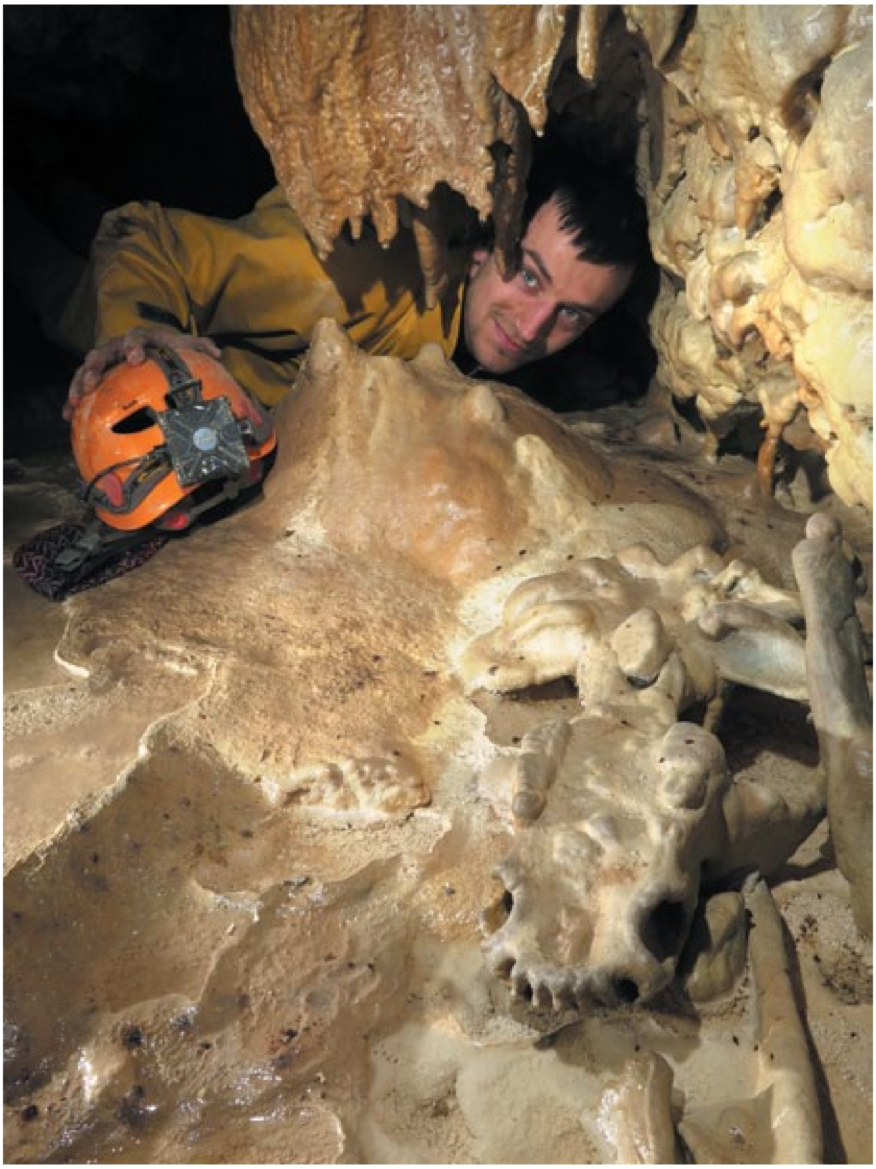
Gradually removing the breakdown in the upwards direction, a free space appeared on April 15, 2021. The process was stopped by a large block, which we managed to overcome during the next working event that took place on April 18, 2021, with eight speleologists. The problematic boulder was removed and then we entered the open space. However, the problem remained in the passage through the breakdown, which was unstable at the bottom of about 4 m deep pit. We brought an iron ladder from the entrance part of the cave, carefully leaned it against the breakdown and climbed up. We found ourselves in a hall 13 × 7 m with a ceiling height of up to 4 m. There was an imminent risk of collapse in the hall, so we quickly looked at the new space and rushed out through the breakdown. At the next working event, the passage with the ladder was again covered by a breakdown. We secured a plastic pipe and organized an event to re-dig the cave-in. It took us several hours to dig through the cave-in again. When we got to the hall again, two of us climbed up, with the pipe and the necessary tools, the others stayed to clear the breakdown. After a while, however, one wall of the breakdown started to move and the passage closed again. We communicated quickly that everything was fine, let them dig us up while we continued to mount the pipe. The guys started to dig the breakdown again, but they just stopped to hear us. The breakdown sat down so they could not hear us. We were mounting the pipe unworried, not knowing that a rescue operation was being planned outside. However, as we started to dig again and the guys got closer to us, we found out what had happened and quickly stopped the rescue action. Luckily, everything turned out well, nobody was hurt and the passage through the breakdown is now safe. Hence the name – Hall of Caved-in men (Sieň zavalených chlapov). We searched the hall at the next working event and chose a place for further work. A follow-up speleological research is currently underway.

The largest skull of a cave bear found in Suchá 3 Cave is 50 cm long. Photo: P. Pokrievka

Until recently, two important locations with the occurrence of cave bear bones were known in the western part of Veľká Fatra Mts.: Jaskyňa Izabely Textorisovej Cave and Muráň 1 Cave. In these locations the bones are situated in situ or minimally displaced. The newly discovered space in Suchá 3 Cave was included among them, as the cave is rich in the occurrence of bones of cave bears in a similar stage of preservation. To this date, the remains of more than 20 individuals have been documented at the site. The research was conducted by paleontologists A. Bendík and independently by T. Čeklovský. The finds are at least 25,000 years old. These are the remains of large individuals. The biggest of the found skulls is 50 cm long. According to T. Čeklovský, this is one of the largest skulls found in Slovakia. It belonged to a young individual aged 4 to 7 years. Bones in new cave parts carry the traces of predator bites, which may have been caused by cave hyenas (*Crocuta crocuta spelaea*). A chaotic arrangement of bones in the cave area, can also be the result of their activity. It is also interesting that the layer of sediment on which the mentioned fossils are located is currently covered by a collapse from the cave ceiling. At the time when the cave was inhabited by cave bears, the ceilings were probably solid and collapsed later. The cave had to be freely passable from the entrance opening to the Halls of Caved-in Men, as the skeletal remains are also located in these areas.

Currently Suchá 3 Cave reaches a length of 159.5 m. From a speleological point of view, the occurrence of pebbles up to 30 cm in size is important, which together with the surrounding caves indicate the prospect of further continuation towards the massif. From a paleontological point of view, it would be helpful to determine the exact age of the discoveries and compare them with the discoveries from the Jaskyňa Izabely Textorisovej Cave and Muráň Cave from the nearby Gaderská dolina Valley.

Space in front of the second breakdown. Photo: P. Pokrievka



Symbol of the cave – the skull of a cave bear covered by flowstone. Photo: P. Pokrievka

BOBAČKA CAVE: A NEWLY-DISCOVERED UPPER LEVEL AND THE POSSIBILITY OF DISCOVERIES ON THE MURÁŇ PLATEAU

Lukáš Vlček – Milan Poprocký – Ivan Rusnák – Mikuláš Mikuš – Peter Varga – Marián Ďurčík

Speleoklub Muránska planina & Slovak Exploring Team

The Bobačka Cave represents the most important endokarst phenomenon within the entire Muránska plateau karstic region. Up until the spring of 2020, the length of surveyed cave spaces reached 4,653 m and the cave continues. It is now the 12th longest cave within Slovakia. This fluvially active cave was created at least in two genetical phases, both suppose the activity of several allochthonous water streams. Despite the cave originating in the massif of Triassic and Jurassic limestones, the fluvial cave sediments consist predominantly of pebbles and sands of crystalline massifs.

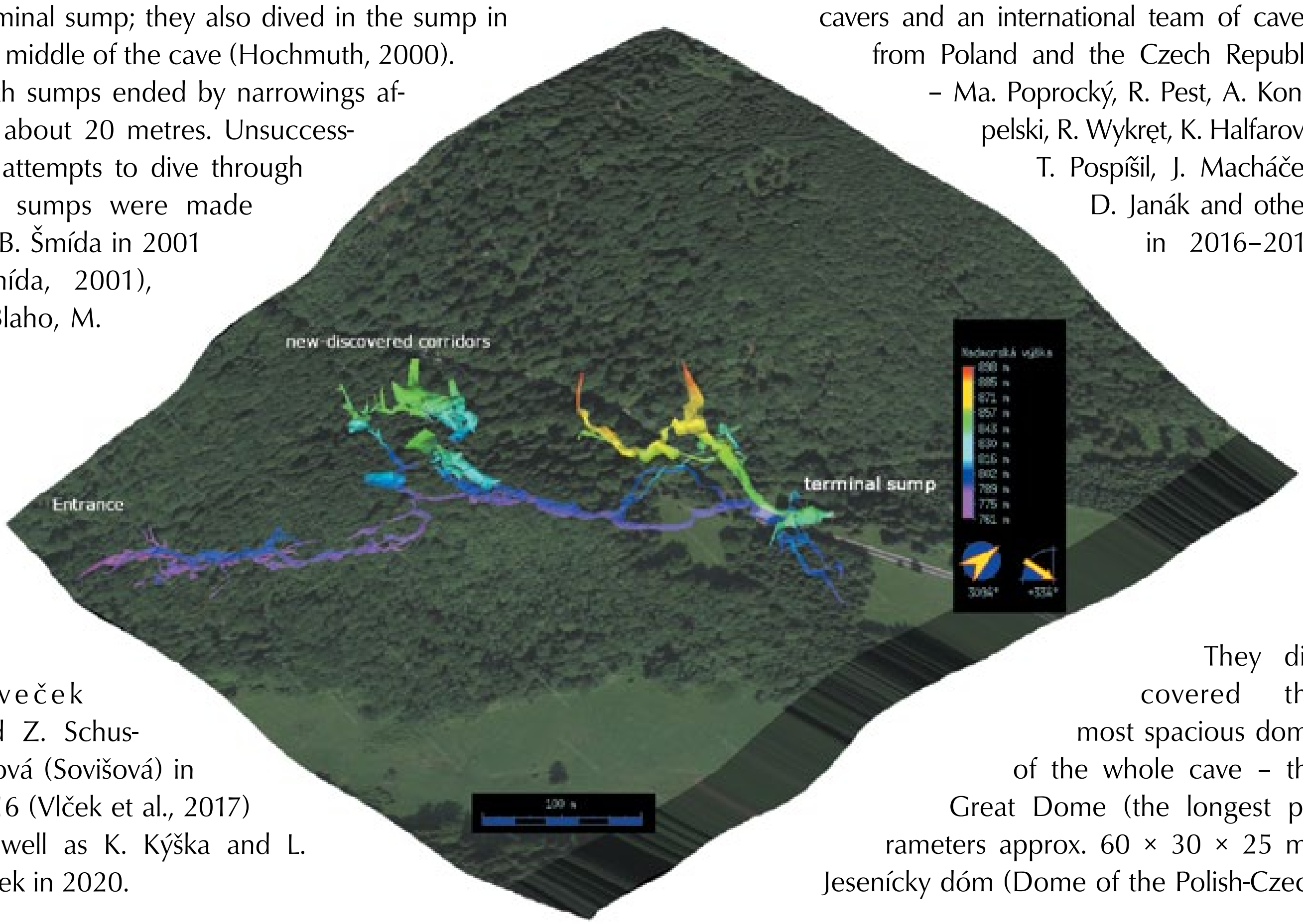
Cave explorers, speleodivers and support team in the valley of Bobačka, close to the entrance of cave in 2016. Photo: M. Zverka

The cave spaces, which were dated by P. Mitter (Mitter, 1975), are developed in several levels. The horizontal main corridor from the 2nd entrance to the terminal sump is a wonderful experience for all visiting cavers – the spaces are great, well decorated and half of the cave has an active water stream at its base. The few sumps can be easily bypassed by higher developed corridors, which are richly decorated with flowstone and dripstone formations.

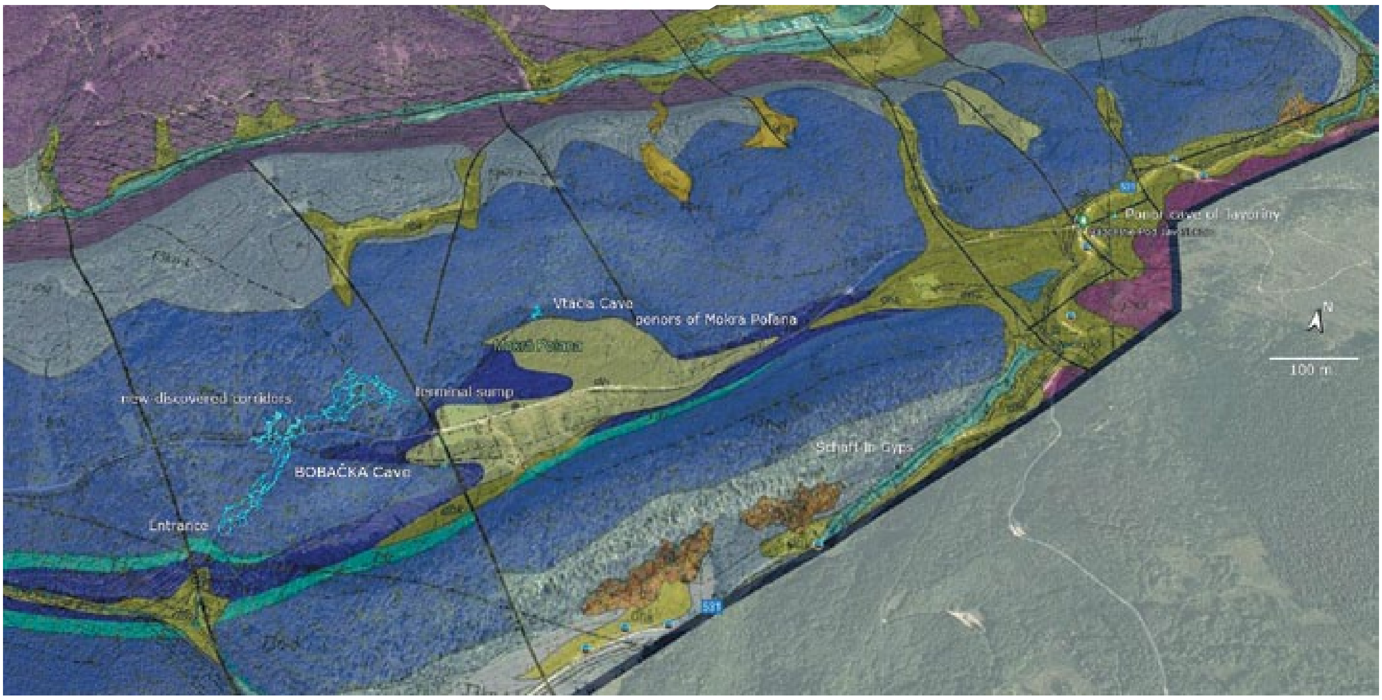
The Bobačka Cave represents predominantly a divers' challenge (Hochmuth, 1998, 2000; Kámen, 1969; Sasvári, 1999). The so-called "Old Bobačka" was known from time immemorial (Kámen, 1955; Vlček, 2011). The entrance is situated near the resurgence. The cave ended after 120 metres by a sump. This point was dived through in 1973, when P. Ošust and T. Sasvári dived to the opposite side and climbed a chimney to the cave's continuation (Sasvári, 1976). Cavers surveyed the cave to a length of 1250 m and used a cave map to decide about digging out the second "dry" entrance only a few metres from the old one. That was the time when the activity in the cave was taken over by the members of OS Tisovec (S. Kámen, B. Polák, D. Ježka et al.), cavers from Muráň, Revúca and Košice (Kováč, 1987).

Waiting for a speleodiver (K. Kýška) at the river bank of 3rd sump of Bobačka in 2020. Photo: B. Kýšková

Further important explorations and discoveries followed between 1985 – 1989 by V. Korfanta, P. Martinove, L. Kováč, K. Merta, M. Terray, M. Kuchár and others. They continued exploring and surveyed about 800 metres of corridors (Kováč & Merta, 1991). In 1989 V. Ďurček, Z. Hochmuth and F. Koľbik dived in the terminal sump; they also dived in the sump in the middle of the cave (Hochmuth, 2000). Both sumps ended by narrowings after about 20 metres. Unsuccessful attempts to dive through the sumps were made by B. Šmída in 2001 (Šmída, 2001), J. Blaho, M. Ševeček and Z. Schusterová (Sovišová) in 2016 (Vlček et al., 2017) as well as K. Kýška and L. Vlček in 2020.



The discoveries of upper-level corridors came in 2001 – Mammoth Corridor and surroundings. They were made and described by B. Šmída et al. Another upper level was discovered by the authors of this article, who climbed the chimneys, enlarged the narrowings and surveyed the newly-discovered spaces in cooperation with many local cavers and an international team of cavers from Poland and the Czech Republic – Ma. Poprocký, R. Pest, A. Konopelski, R. Wykręt, K. Halfarová, T. Pospíšil, J. Macháček, D. Janák and others in 2016–2017. They discovered the most spacious dome of the whole cave – the Great Dome (the longest parameters approx. 60 × 30 × 25 m), Jesenícky dóm (Dome of the Polish-Czech



Perspective views to the area in surroundings of the Bobačka Cave shows the logical continuation of cave spaces towards the ponors of Mokrá Poľana and Javoriny. Drawn by M. Poprocký

Speleodiver L. Vlček emerging from the terminal sump of Bobačka Cave. Photo: B. Kýšková

Way to the upper parts of cave in direction to the Silver Lake. Photo: M. Miedziński

friendship), Paks Hall, Gandalf's Dome, the corridor behind the Silver Lake etc. The domes, corridors, chimneys and shafts are richly decorated not only by flowstone and dripstone formations, but also by crystals of aragonite, gypsum, calcite helictites, morphogenetically unusual forms of flowstones, hydroxilapatite crusts etc. Many of the chimneys are still untouched by climbers and some cave corridors have not yet been surveyed. We suppose the continuation of the cave deeper inside the massif, where water streams and air draught directions lead the cavers.

The cave is important from the paleontological point of view (Vlček, Hutka, 2005; Vlček, 2016), but even more from the hydrological point of view (e.g., Kámen, 1963, 1968). The NE–SW cave direction crosses the plateau. Some of the waters are autochthonous, proved by a tracing test on Mokrá Poľana in 1963 (coloured water reached the 1 km distant resurgence with denivelation of 135 metres in 10 hours 10 min: Kámen, 1968). Here we found a new cave in 2016 – the 200 metres long Birds' Cave (Vtáčia Cave resp.; Vlček et al., 2016), with massive air draught and beautiful dripstone formations. Other waters have allochthonous provenance – they come from the Javoriny massif, where there are few known ponor depressions with caves up to 100 m long and several metres deep (Mitter, 1972; Skřivánek, 1963). Theoretically, the retention area of Bobačka resurgence rises from the Hron Valley on the north to Veľká Lúka on the south. The yield of resurgence is from 30–100 l/sec to Q_{max} = 291 l/sec to an immeasurable volume. There are geological and hydrological indices of possibility for discovering one of the longest cave systems of Slovakia (Vlček et al., 2017).

Typical shape of corridors of main passage of cave, with hibernating bats colony at the ceiling. Photo: M. Miedziński

The Bobačka Cave is one of the most important caves in Slovakia. In 1970s cavers were thinking about opening the cave to the public (Hlaváč, 1994). Because the water from the cave is still used as a source of drinking water for adjacent settlements, this idea is still a future venture.


Flowstone formation, so-called Weeping Willow. Photo: M. Miedziński

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THE WAY THROUGH THE SUMPS OF TEPLICA CAVE (MURÁŇ PLATEAU)

Lukáš Vlček – Dušan Hutka – Tibor Sasvári – Dušan Čipka – Ján Blaho – Michal Ševeček – Zuzana Sovišová – Miroslav Zverka

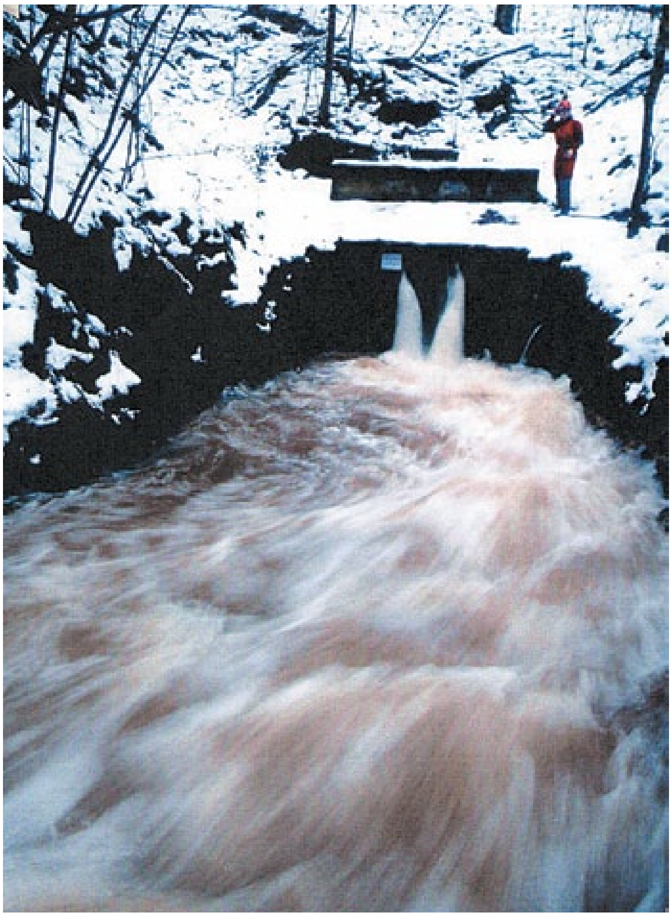
Speleoklub Tisovec – Speleo Bratislava – OS Jána Majku

Resurgenece of Teplica in second half of 19th century. Archive of Speleoklub Tisovec

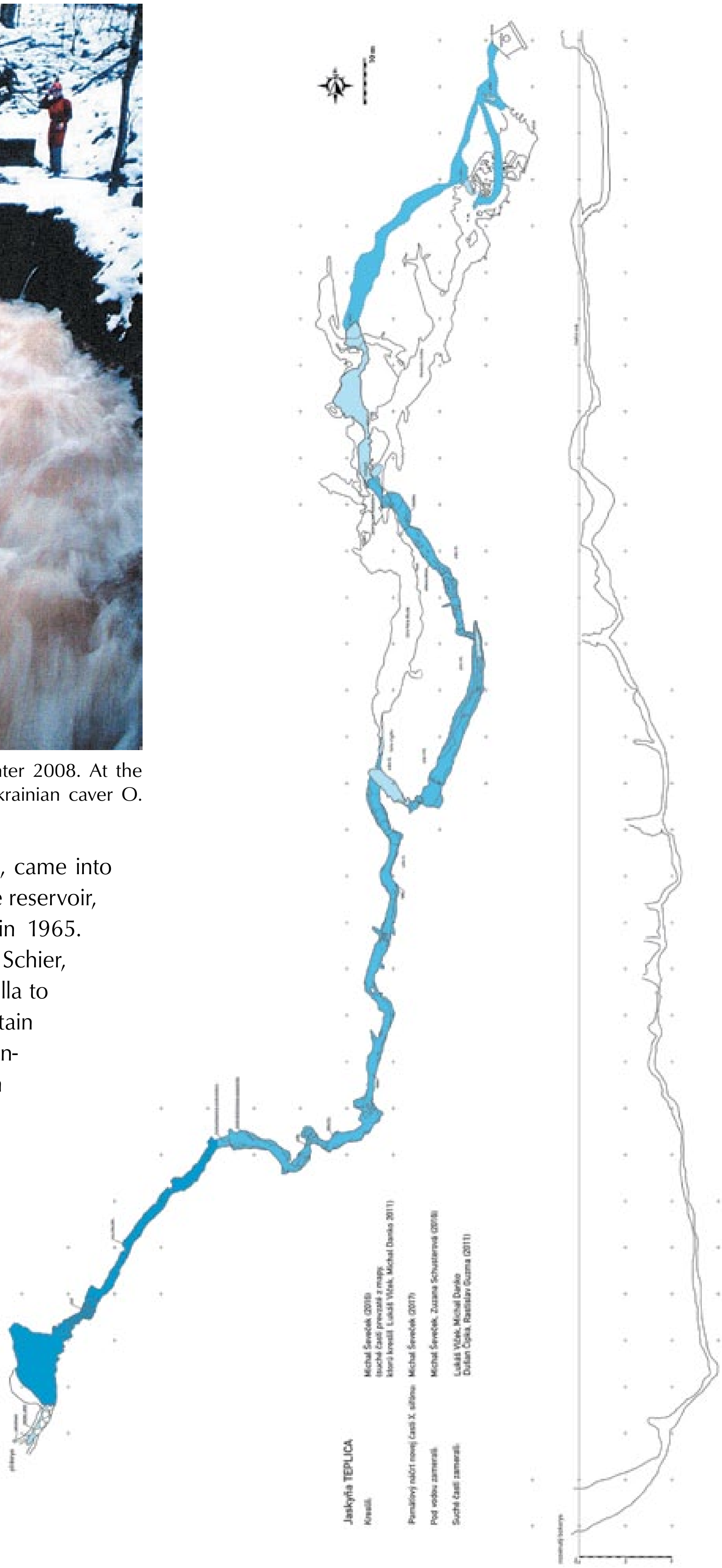
The Teplica Valley is located about 4 km from the town of Tisovec and connected with the Furmanec Valley in their southern (lower) part. The inhabitants of Tisovec often wondered why its water did not freeze even in the harshest winter, from which they derived its name – Teplica means "warm water". It was until the cavers solved this question in the 1950s, when they began diving in the place where the water of Teplica resurgence flowed from under the rock wall, so by submerging below the surface of Teplica and penetrating the underground towards to its wild river flow...

The history of serious interest in Teplica begins in the middle of the 19th century when it was often visited by important scholars and historians of that time. In the first half of the 20th century, they were considering the usage of the source of drinking water for the town of Tisovec and, of course, the largest spring

▲▼▼ First diving attempts in the resurgence of Teplica in half of 20th century. Archive of Speleoklub Tisovec



Resurgenece at highest water conditions in winter 2008. At the roof of the hydrological building is standing Ukrainian caver O. Levytska.Photo: L. Vlček



in the area, which was the Teplica spring, came into use. After 1943, there was built a concrete reservoir, in which speleodivers began searching in 1965. In 1966, Zbižo Nišponský, Ján Gál, Peter Schier, and Adolf Materna dived here using nargilla to a depth of 6 m (like in Jules Verne's Captain Nemo). It was not until eight years later, encouraged by spectacular discoveries from the nearby Bobačka Cave, that on February 2nd, 1974, the first, more than 30 m long and 6.5 m deep siphon Tibor Sasvári and Peter Ošust overcame and discovered the dry cave. They emerged on the surface of a narrow and tight fissure corridor, but full of enthusiasm emerged in its upper part, where it followed the more spacious, almost horizontal corridor of a fluviokarst cave with an underground river. Shortly after it, divers went around several other siphons, and with dry feet, they got to a distance of almost 200 m from the entrance – to the end of today's known dry parts of the cave. However,

Speleodiver Michal Megela with a support team (from left): Dušan Čipka, Štefan Pászer and Ivan Kubíni. Photo: J. Pavlík

its spaces do not end here. The cave, of course, continues underwater. Divers who have dived below the level of the 6th (9th respectively) siphon of Teplica described another 200 m long flooded corridor with dimensions of 10 × 15 m, with several spacious rising chimneys, which, however, ends in a tight, for years unsurpassed, narrowing. The length of the cave thus reached about 1 km with a vertical span of 51.5 m.

Cave divers did not come here blindly. The underground stream was traced by coloring tests as early as 1958. At that time, the cavers, under the leadership of Svätopluk Kamen, were stained with fluorescein – submerged watercourses in the Suché doly area and carefully monitored the places where they could flow from underground to the surface. The water from the Daxner ponor has overcome an air distance of 1900 m to a spring in Teplica in 22 hours and 50 minutes; the water from the ponor near Michňová Cave 1600 m in 23 hours and 30 minutes. At that moment, the assumptions of the cavers were confirmed, and the explorers began to formulate a clear plan: to penetrate the underground cave system Suché doly – Teplica by diving. The year 1974, which was the year of diving penetration into the dry areas of the new cave, was indelibly written into the history of the Tisovec cave. However, on January 15th, 1994, a fatal accident happened to Czech diver Mirek Nešvera, who died during cave exploration. Since then, the caves have been explored mainly by dry cavers; short diving experiments by Michal Megela, Jozef Gliviak and Peter Kubička were in terms of further exploration not successful.

What does it look like in Teplica? The entrance parts of the newly discovered cave, named after the valley and its watercourse, form an intricate maze of narrow and wide corridors and corridors seasonally flooded by an underground stream, intertwined with the lowest winding corridor, in which water flows all year round.

Speleodivers after succesfull day, August 6, 2016. Photo: L. Vlček

This horizon continues for a length of about 400 m with 12 siphons up to the last point reached by divers in the 12th siphon. A higher, larger, dry passage, divided into several morphologically characteristic sections, winds in parallel in the bowels of the massif. Behind the entrance maze is an obliquely rising corridor with the Bear Corridor, followed by Petr Ošust Hall, named after one of the discoverers of the dry parts of Teplica (who died tragically during a car accident in Iran on the expedition India 1975) at the end of which there is a pond forming the level of the final siphon. In the cave, there is an active dripstone decoration, flowstone lakes, and strange eccentric stalactites often forming a kind of flag-like forms. There are also several through connections with a parallel "water branch", which is dominated by a 16 m high massive waterfall. Its falling water during the rainy period fills almost the entire cave with a freezing soundstage. At the time of floods and the water maxi-

Zuzana Schusterová (Sovišová) and Michal Ševeček in the terminal sump of Teplica Cave. Photo: D. Hutka mum, the flow of underground Teplica is so huge, that it is not possible to get inside the cave at all. The water in Teplice reacts by raising the level within 24 hours of the precipitation, so the exploring cavers can relatively reliably plan their exploration according to the weather on the surface, and if they are only going to the cave for a classic half-day event, they cannot be caught unexpectedly by flooding in underground. However, this cannot be planned for submerged caves, which immediately swallow water from surface precipitation into the underground and can thus be treacherous and often extremely dangerous for explorers inside in the event of unstable weather.

The Teplica Cave is certainly the key to a huge cave system. And yet she still hasn't said her last word! During the dive on August 12th, 2017, divers Michal Ševeček and Zuzana Schusterová (nowadays Sovišová) managed to break the curse. After 43 years of unsuccessful attempts to cross the terminal siphon, they managed to cross the strait underwater and after almost 300 m in length and 30 m in depth, they emerged on the other side of the siphon – in a giant underground lake. The hall that opened in front of them took their breath away with its size! A tributary corridor runs from it into the massif, leading ahead in the direction under Suché doly area. The corridor plunges under the water again, where on July 21st, 2018, Michal Ševeček reached a depth of 27.6 m, unwinding a 120 m long reel. The corridor splits under water and **– it continues into the unknown...**

Behind the siphons of the Teplica Cave is still the hitherto undiscovered thirteenth chamber of the Tisovec Karst. The distance from its final parts to the bottom parts of the caves in Suché doly area is still about 1.5 km with a vertical span of at most 107 m in the case of the Nišponský Cave (Nišponského jaskyňa v Májovom závrte) and at least 20 m in the Nová Michňová Cave. These numbers define an area large enough for the cavers to have something to do in it for a very long time...

Upper part of waterfall in the cave. Photo: P. Medzihradský

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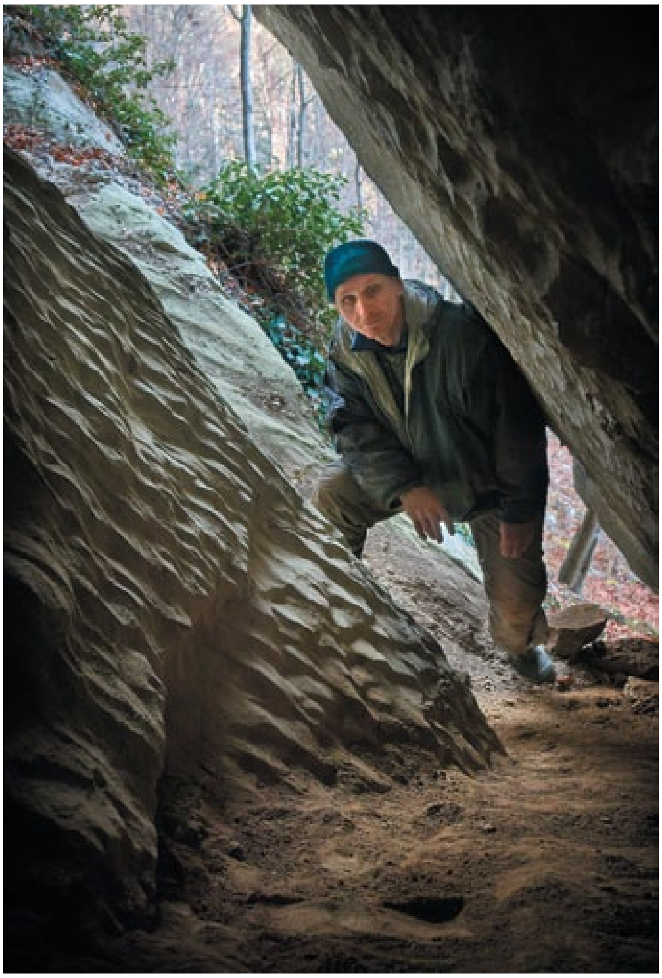
The article is dedicated to the memory of a caver, diver and great friend with a big heart – Zbigniew Nišponský (1936–2019), the first speleodiver in the Muráň Plateau

INTERESTING ARCHAEOLOGICAL FINDS IN NORTHERN SLOVAKIA

Peter Holúbek – Ján Obuch – Michal Oravec – Juraj Szunyog –Zuzana Šimková

At the end of 2021, during an exploration of the cliffs in the Choč Mountains, an overhang was located (M. Oravec), in which there were vortex holes, i.e. clear signs of flowing water. The obvious continuation was inaccessible to people because the underground was inhabited by a badger. For this reason, we focused on the entrance more difficult to access, which was located about 5 meters above the bottom of the overhang. After climbing the overhang and passing the tight corridor at the limit of pass-ability and overcoming 3 m high vertical step, we (P. Holúbek, M. Oravec) penetrated a space of 3 × 3 × 2 m. We registered archaeological finds (fragments of human skulls, bones, clay pots, a bronze nail) there, took pictures of them and contacted an archaeologist. He determined that the finds are around 5,000 years old and date back to the Late Stone Age and were associated with the Baden culture. Subsequent archaeological research confirmed this assumption and in the immediate vicinity of the cave a depot from the Bronze Age was found, i.e. objects about 3,000 years old. From these finds, it can be determined that this findspot was inhabited at least twice. Remarkably, no one has visited the cave in modern times, although it is located only about 200 m above a municipality with hundreds of inhabitants and at a distance of only one km. It is also paradoxical that the long-time chairman of the Slovak Speleological Society, which has its headquarter in nearby Liptovský Mikuláš since 1949, lived in this village.



Fluvially-modelled passage, which opens into a badger or fox den. Photo: P. Vaněk

An archaeological exploration of the cave and its surroundings is proceeding slowly, the found items are being processed. It is considered that after their research they will end up in the exposition in the Slovak Museum of Nature Protection and Speleology in Liptovský Mikuláš. Anthropologists have so far identified 4 adults and 8 children aged 0 to 12. Two pots of Baden culture have been preserved in their entirety, and others are restored by experts. A fragment of bronze sheet was found next to the ceramics and bones under a 2 cm thick layer of flowstone. So far, no one has commented on this finding.

Digging in the animal den. Photo: P. Holúbek

Preserved pot of Baden culture. Photo: P. Vaněk

Fragment of a skull. Photo: P. Vaněk

We have secured the cave against undesired visitors, and we are waiting for its further expert exploration. Due to its inaccessibility, it was visited by archaeologists only once, and further exploration will continue. Below the site with the archaeological finds, we started to dig in two senile phreatic river canals. We found a badger trap, a cartridge for a 9 mm Steyr pistol from 1917, several potsherds and a spindle whorl, which served as a weight in fabric weaving. From osteological finds, it was discovered that a fox used

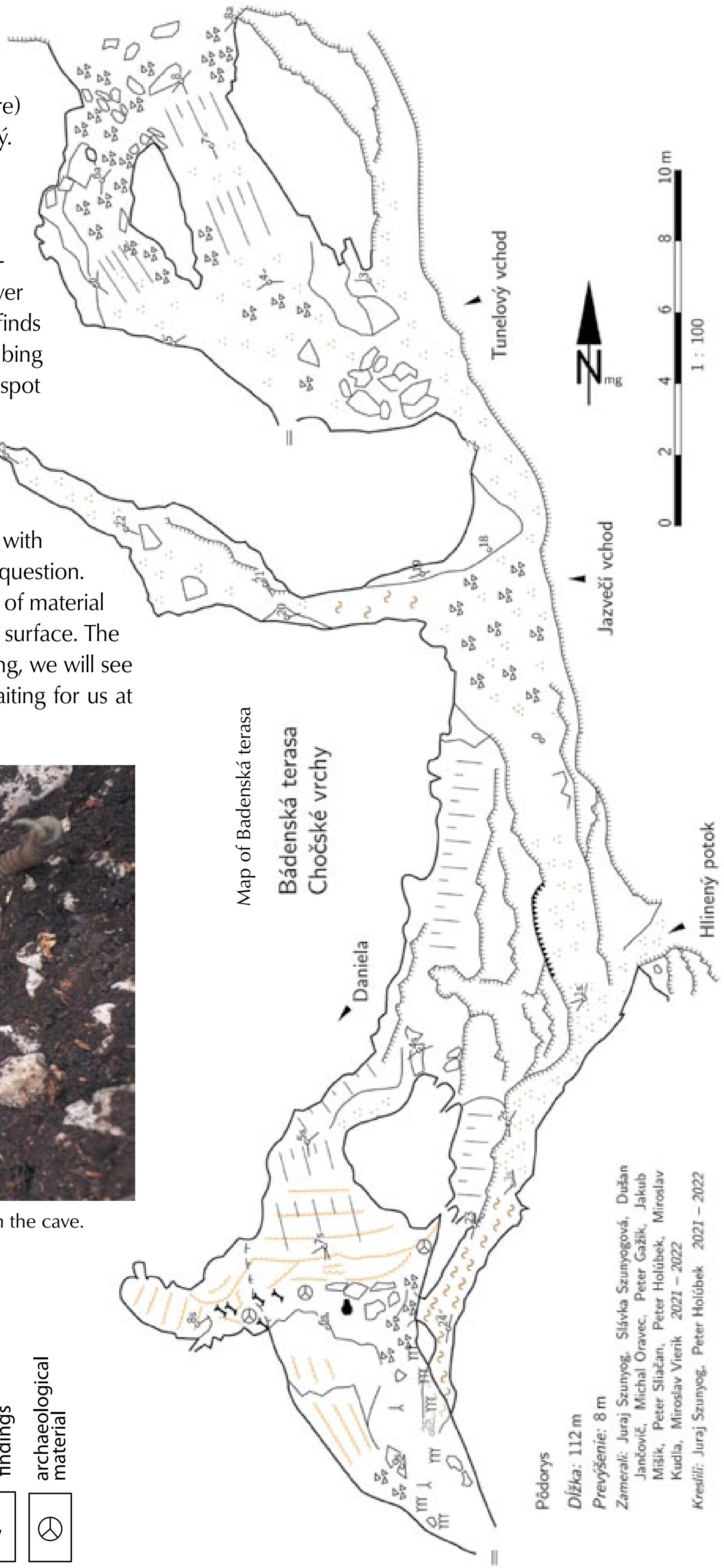
Fox food (*Vulpes vulpes*) from the locality Badenská terasa, generated by J. Obuch 7. 5. 2022

Species	**Localities**			**Sum**	**%**
	1	**2**	**3**		
Lepus europaeus			2	2	4.08
Sciurus vulgaris	1			1	2.04
Spermophilus citellus	1			1	2.04
Glis glis			1	1	2.04
Rattus norvegicus	1			1	2.04
Cricetus cricetus		2		2	4.08
Arvicola amphibius	1	1		2	4.08
Microtus arvalis	1			1	2.04
Vulpes vulpes	1		1	2	4.08
Mammalia	**6**	**3**	**4**	**13**	**26.53**
Anser anser dom.	1			1	2.04
Anas platyrhynchos	1	1		2	4.08
Anas platyrhynchos dom.	1	1		2	4.08
Buteo buteo		1		1	2.04
Tetrao urogallus		1		1	2.04
Phasianus colchicus			1	1	2.04
Gallus gallus dom.	7	4	1	12	24.48
Meleagris gallopavo dom.	1			1	2.04
Columba livia dom.	1		1	2	4.08
Columba palumbus	2			2	4.08
Dryocopus martius	1			1	2.04
Alauda arvensis			1	1	2.04
Turdus merula		1		1	2.04
Emberiza citrinella		1		1	2.04
Sturnus vulgaris			1	1	2.04
Nucifraga caryocatactes	1			1	2.04
Coloeus monedula	1	1		2	4.08
Aves	**17**	**11**	**5**	**33**	**67.35**
Rana temporaria	2		1	3	6.12
Amphibia, Reptilia, Pisces	**2**	**0**	**1**	**3**	**6.12**
Sum	**25**	**14**	**10**	**49**	**100.00**

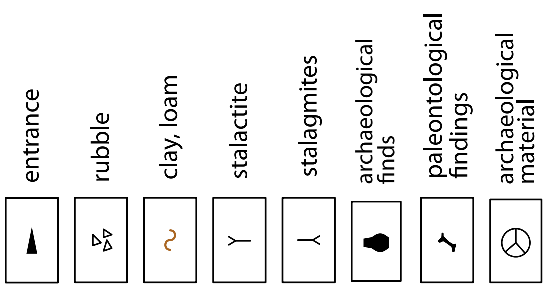
Locations:
1 – Badenská terasa, November 11, 2021, surface collection in the cave, P. Holúbek, M. Oravec
2 – Badenská terasa, November 14, 2021, collection from the excavation in the cave, P. Holúbek, M. Oravec
3 – Badenská terasa, April 22, 2022, mouth of the cave, archaeological probe 50 cm deep, P. Holúbek, J. Obuch, M. Oravec, Z. Šimková

underground spaces as a den. In addition to the bones of small vertebrates, bones of larger animals (cow, sheep, roe deer, pig, cat, wolf or dog, fox, badger, rabbit, hare) were found here, determined by T. Čeklovský. We named the locality Badenská terasa (Baden terrace) and it consists of 4 separate, yet unconnected fragments of stream caves (Daniela, Jazvečí vstup, Hlinený potok, Tunel). We do not have a clear answer to the question of how the archaeological finds got underground. One option is after climbing a 5 m high step and then overcoming a tight spot ending in a 3 m deep vertical step, or through two dens (Jazvečí vstup, Hlinený potok), which thousands of years ago could have looked completely different than it is today. We will work with zoologists and archaeologists to answer this question. We have already taken several cubic metres of material out of the underground of both dens to the surface. The passages continue, the exploration is ongoing, we will see where we can dig and what else will be waiting for us at the end of the excavations.

Depot of Bronze Age items, about 30 meters from the cave.
Photo: P. Holúbek



Map of Badenská terasa



NEW DISCOVERIES IN DOMICA-ČERTOVA DIERA, SLOVAK KARST NATIONAL PARK

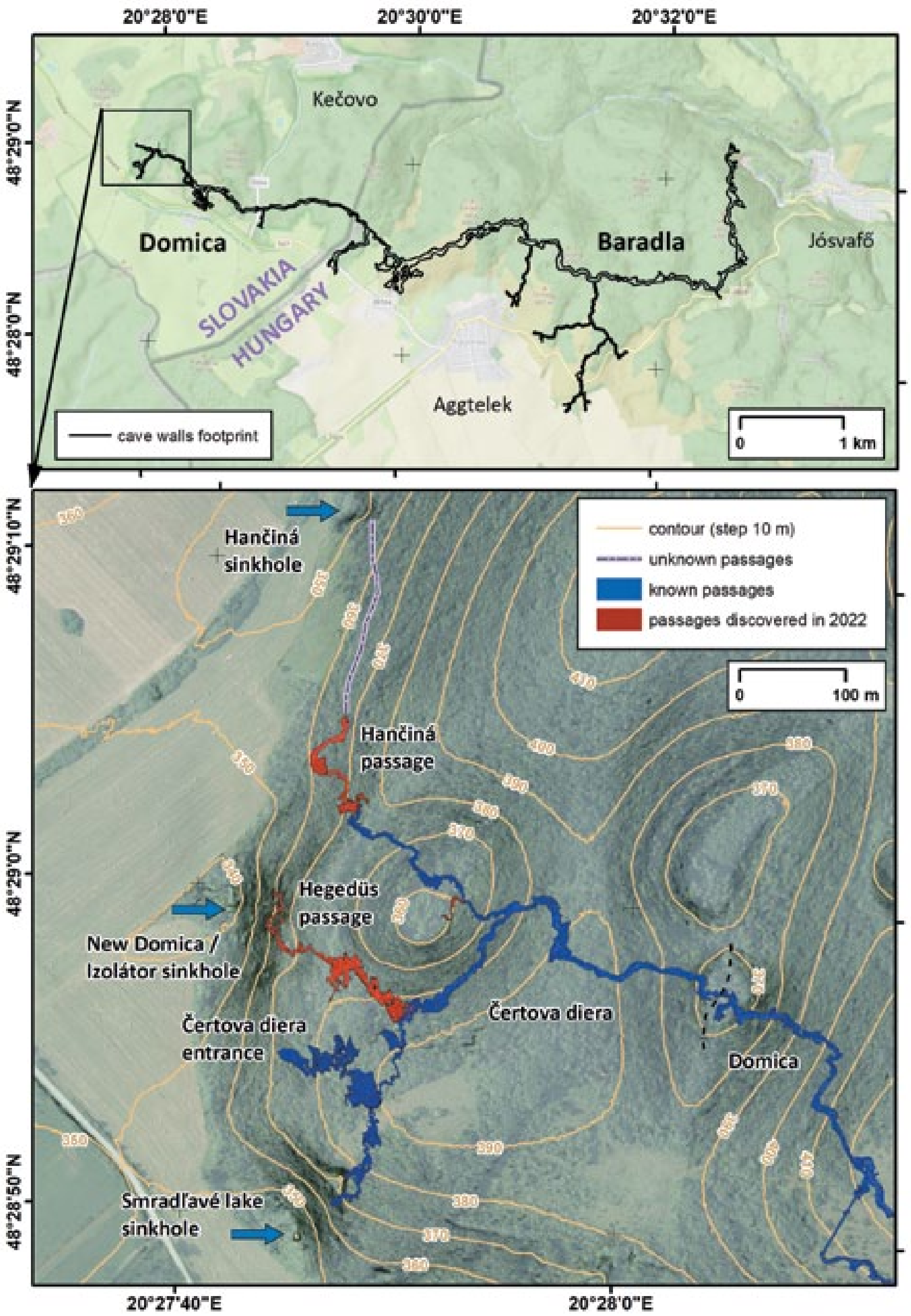
Stanislav Danko – Jozef Šupinský

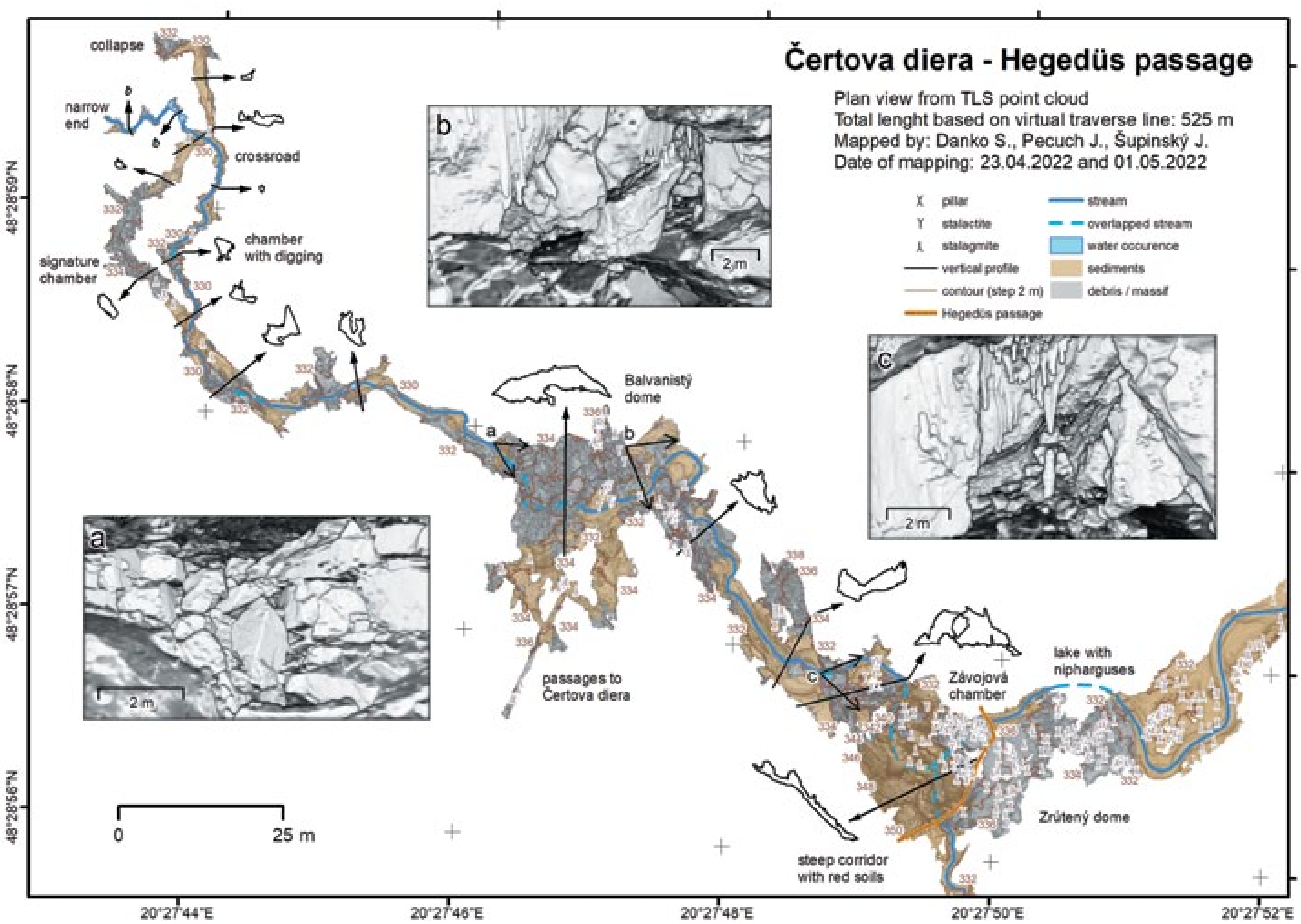
Domica-Čertova diera cave is the longest cave in the Slovak Karst, while with the Baradla Cave (MR, Aggtelek NP) it forms a cave system (Gaál and Gruber, 2014) with a total length exceeding 30 km. In 1929, Ján Majko connected the Domica cave with the nearby Čertova diera cave, (*Devil's hole*), which forms the westernmost spaces of the cave system. As of March of 2022, the total length of both caves was 8894 m (Hochmuth, 2022).

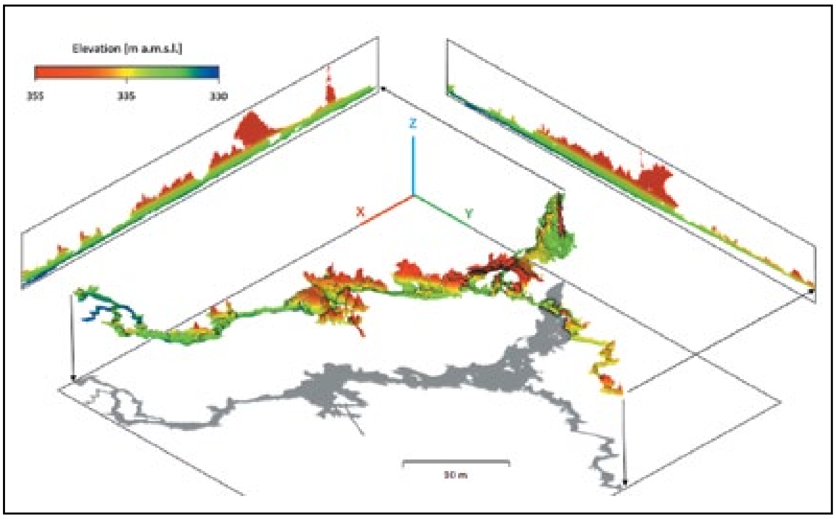
Research and documentation of the cave has been carried out by the Speleoklub UPJŠ under the leadership of Z. Hochmuth since 2014. At his invitation, we start research and documentation activities carried out in the cave. At the end of 2018 laser scanning of the entire cave system Čertova diera – Domica (Šupinský et al., 2019) began, which at the end of 2020 resulted in the mapping of approximately 95 % of the cave system. During the detailed documentation of the entire cave system, our knowledge of individual parts of the system increased, revealing potential avenues for further exploration even after almost 100 years since the initial discovery of the Domica cave.

The caverns of the Čertova diera cave, connect three underground streams from three known sinkzones in this area (namely: the Smradľavé Lake – *Smelly Lake*, Nová Domica – *New Domica* / Izolátor, and Hančina valley). The course of the caverns in the upstream direction was already known only in the direction of the sinkzone at Smradľavé Lake. The unknown course of the passages in the direction of the sinkzone with the main ponor of the Čertova diera cave (Izolátor – Z. Hochmuth, Nová Domica – G. Lešinský) and Hančina could be calculated to the order of several hundred meters (Fig. 1).

During a scanning of the remote parts of the cave behind the Nebezpečný dóm (*Dangerous dome*) at the end of 2020, a significant draft was observed around the cave-in near the end of the corridor, which was in line with the information from Z. Valenta. Apart from the draft, it was strange that the distinctive river corridor ended in a cave-in across the entire profile, where no exploration work had been carried out so far. Due to these facts, the first exploratory activity was carried out in February 2022 in the area behind the Nebezpečný dóm. One exploration was enough to breach the 5-meter-high cave-in, to the cavern above revealing significant sinter



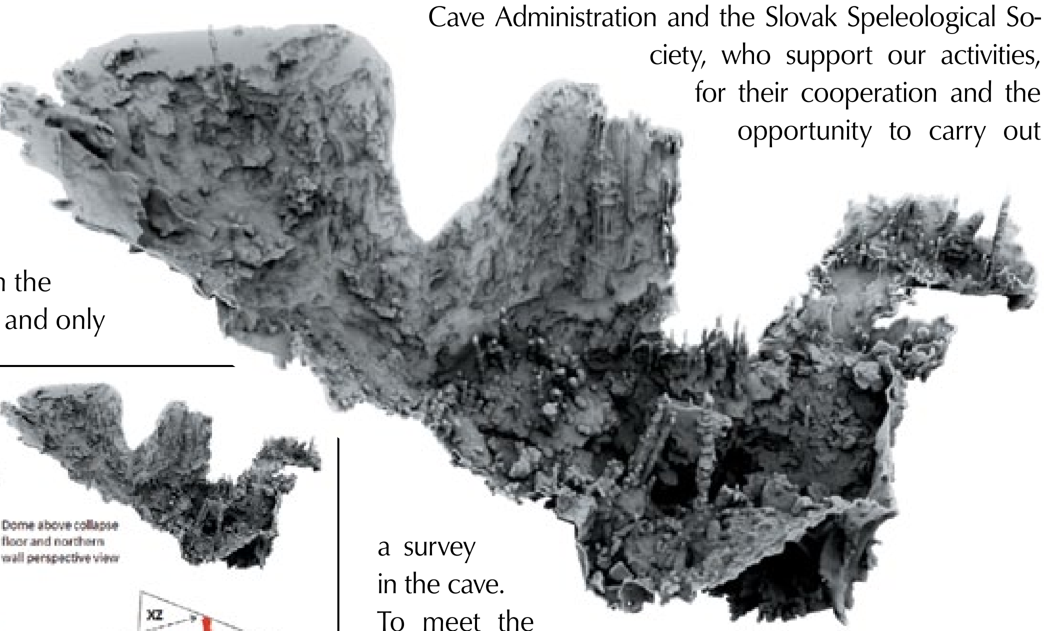


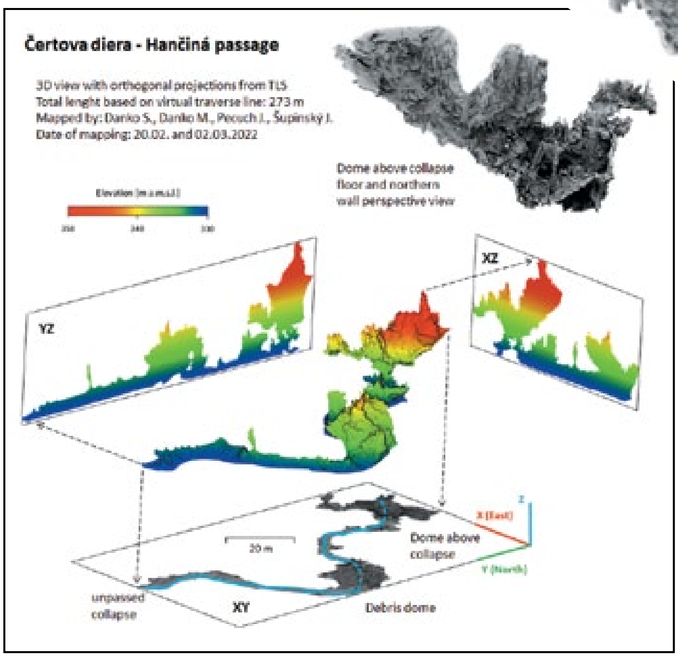


decoration. Two further explorations were required to scan the discovered parts and reach the riverbed behind the cave-in again. After breaching the cave-in and digging back to the river, the passage continued, ending again with another cave-inacross the entire profile of the corridor. Another three explorations were implemented at the ending cave-in without significant success. The total length of the discovered spaces in the direction of Hančiná corridor with 2 domes reaches 273 m, while the nearest ponor is still 200 m away.

Due to complications at the ending cave--in towards the ponor in Hančina valley, a change of location was proposed. A siphon section clogged to the ceiling in the direction of the Izolátor ponor was the second choice. To great surprise, flood waters washed away a critical section and the road ahead was clear without the need for digging. After approx. 10 meters of crawling, unexpectedly large spaces were discovered. During that exploration, at the end of the passage, a large flat stone bore the inscription of the previous discoverer, Mr. Hegedüs circa 1939. During the second exploration, the corridors were scanned, and an attempt was made to proceed further in the direction of the ponor. Under the inscription of Mr. Hegedüs rocks were cleared to reveal another 100 meters in dimensionally narrow corridors. After plotting the scanned data it was confirmed that the end spaces of the Hegedüs Corridor are a few meters away from known parts of the Izolátor ponor, but a connection is prevented by a large cave-in. For the cave spaces of the Hegedüs corridor, a floor map was derived according to the methodology for deriving a detailed map of the cave from laser scanning (Šupinský et al., 2022). The total length of the discovered spaces of the Hegedüs corridor with one dome and several branches extends to 525 m.

From the point of view of morphology, the areas of the Hegedüs corridor along the Balvanistý dóm (*Boulder dome*) are significantly larger than the well-known corridors leading to the Čertova diera Cave towards the Smradľavé Lake, in which the rocky bottom is visible filled primarily with gravel. This connecting corridor towards the ponor of Smradľavé Lake is younger in development with the similarities (filling, lateral notches) of the Meander and Discovery Corridor in Domica, while these marks also have the end parts of the Hegedüs Corridor. However, the corridors from Balvanistý dome approaching the entrance parts of the Čertova diera Cave are fossil spaces filled with clay in places up to the ceiling, similar to what can be observed in the Domica Cave. It is therefore possible to consider that it was Hegedüs corridor at a certain stage in the development of the Domica-Baradla Cave system that brought water from the Devil's Hole to the Domica, and only





later did the development of the current riverbed take place. Interesting to note is the end part of the Hegedüs corridor, has two height-differentiated branches similar to all other known corridors in the Domica-Čertova diera Cave system towards the ponor. The lower corridor is cleared up to the massif, with a lower altitude than the rest of the riverbed, which is further filled with clay or rubble. In the low-connecting parts of the Hegedüs corridor, there is also a lot of corroded and damaged decoration, similar to the corridors towards the Domica Cave. Flood lines are observable on the walls, indicating the previous water level, which, however, may have arisen not as a result of floods, but during the period when the Čertova diera cave was filled by a lake to subsidize enough water for tourist sailin the Domica Cave. The steep corridor connecting the Zrútený dome with the Hegedüs passages filled from the bottom to the top with red clay, which is located more than 20 m above the current river.

In total, as of May 2022, more than 800 meters of new cave spaces have been discovered. Jozef Šupinský, Ján Pecuch, Stanislav Danko and Michal Danko took part in the discoveries. We would like to thank Z. Hochmuth and other members from the Speleoklub UPJŠ as well as the Slovak Cave Administration and the Slovak Speleological Society, who support our activities, for their cooperation and the opportunity to carry out a survey in the cave. To meet the new challenges, we want to believe that overcoming the magical limit of 10 km is realistic and achievable in the near future.

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ON THE FUTURE OF CAVE MAPPING – WHAT ARE CAVE MAPS GOING TO LOOK LIKE?

Pavel Herich

Slovak Caves Administration; Demänovská Dolina Caving Club

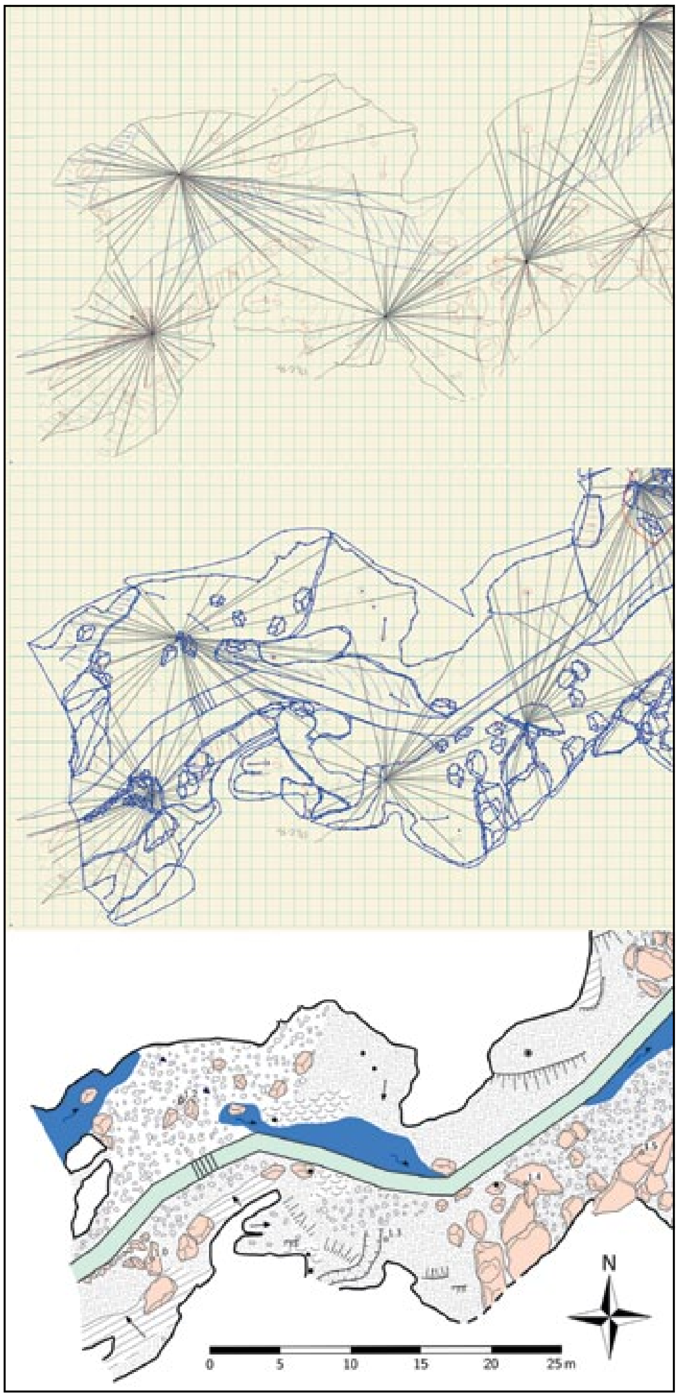
We can't omit the old survey technique using a mining compass and clinometer, along with measuring-tape. Since a major discovery of Štefanová Cave (18.3 km at present) in 2007, we have been using it even crawling in the mud or lying in the cold water to create a map. When the cave reached 7 km, Shetland Attack Ponny was introduced here, which made the surveying much easier. Instead of full caving pack of two wooden boxes there was a tiny plastic one along with measuring-tape in a pocket. And some years later, the DistoX and PocketTopo software took its place. This led to unprecedented precision of surveying (except for theodolite measurements in some caves elsewhere) and above all precise map creation. Fast measuring of the splayshots gives us exact positions of walls and fills. And the software Therion could create some rough 3D models out of it. But until now we didn't feel the need of reconsidering the way we survey and, before all, draw a cave map.

LIDAR ON TRIPOD (TLS)

Lidar-based technology at times of stationary devices didn't persuade us to reconsider this. Large and heavy, expensive scanners just weren't able to replace the compass methods in most important terms of effectivity and accessibility. There was some intensive scanning in Domica Cave in Slovakia as well (Hochmuth et al., 2017), partly with a map as result, but it involved large effort and was usable mostly in major and large passages. Nowadays, Leica BLK360 shows a certain progress in this technology. But still, if you must stand still and each scanning position takes minutes, that's not the way to cover the whole cave surface with data avoiding data-holes in it and create a full map and 3D effectively.

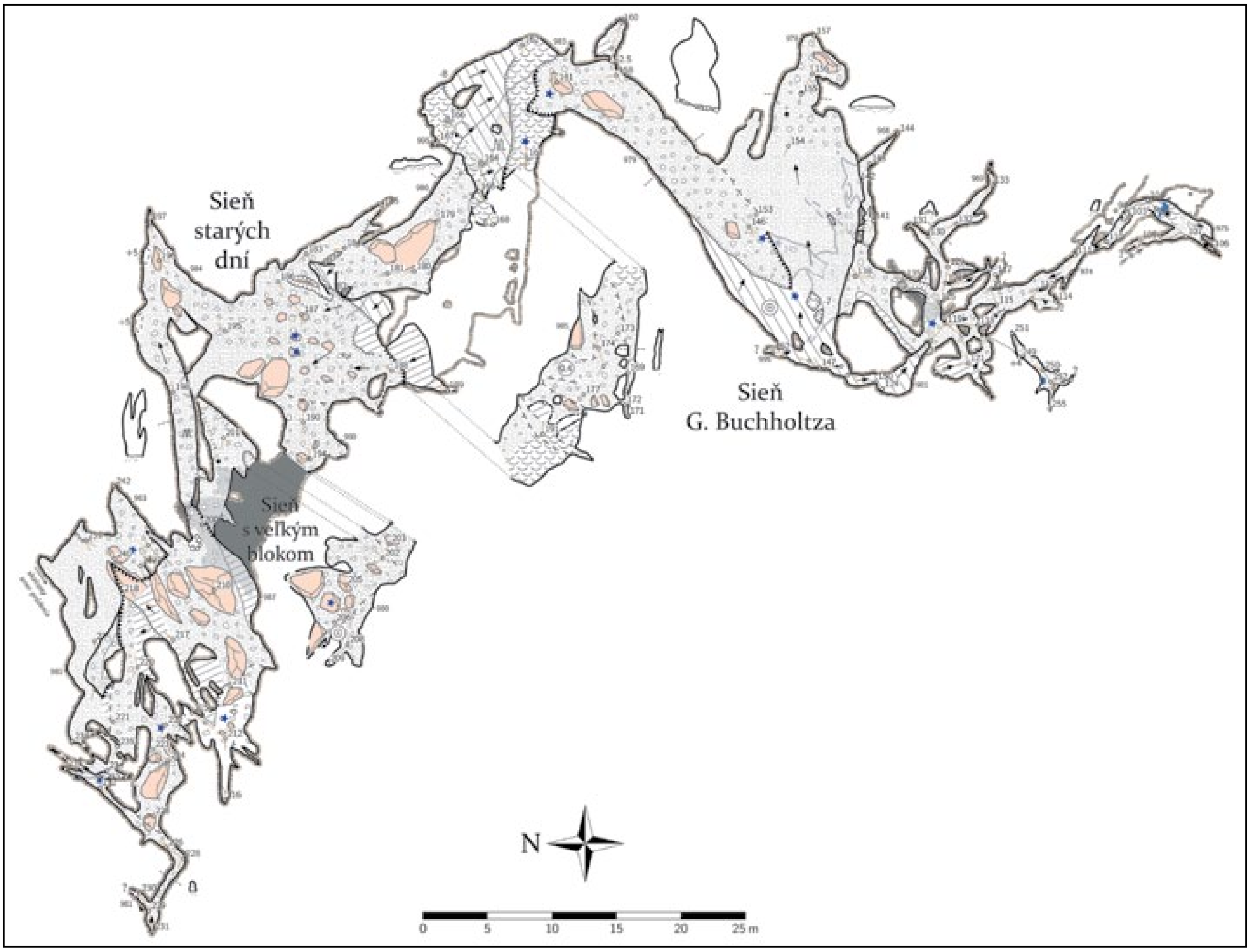
MOBILE LASER SCANNING (MLS)

Many of us have dreamed of automatic, aerial surveying of unknown spaces below the earth for a long time. This dream became partly real in the Csiro research agency (Bosse et al., 2012). In the beginning of 2017, we have already tested commercial product based on Csiro's Zebedee – ZEB1 in Demänová Cave of Peace. In just 15 minutes we've been able to scan 250 m of passages even with crawl ways, water, and domes. Scanning is done while walking, getting 40 000 points per second and max. range from 15 up to 30 meters. A model shaped out of point cloud convinced us to use this technology further



One of possible approaches of map creation using PocketTopo software + DistoX (in caves) and Therion software (PC). Upper picture is direct export from PocketTopo to Therion, in the middle the view of hand-made vectorisation in Therion and below a plan – pdf export form Therion. Author: P. Herich

to even draw a map. In 2021 we finally started to use Zeb Horizon with max. distance 100 m and 300k points



Final map, a precise plan of one part of Dragon Cave in Sokol Cliff in Demänovská Dolina Valley. Author: P. Herich

per second... These days a second step to autonomous aerial surveying was made by Hover map with similar parameters, but sophisticated algorithms to navigate UAVs (drones) through unknown places. Much must be done on this field, but the path seems to be set.

PHOTOGRAMMETRY

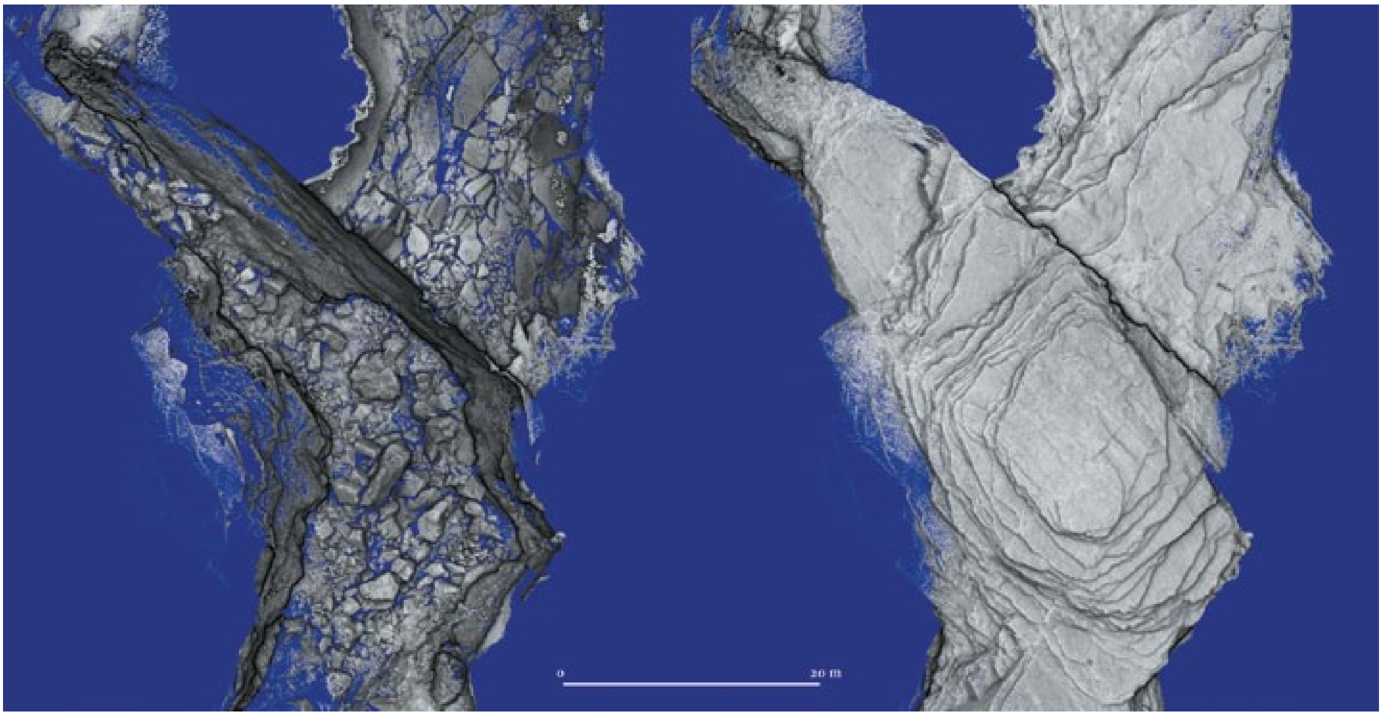
Much cheaper and simpler way even with better results of capturing a 3D object is photogrammetry. So why it's not used widely already? There are at least two main problems with it – lack of sufficient lighting, especially in larger underground spaces, which prevents creation of model correctly. A second one is still a huge demand on computing power. But again, it seems that there is a solution nearby (or present). It's really impressive, what can be done by iPhone 12/13 Pro (models or even point clouds created by using photogrammetry and lidar combined).

THE QUESTION OF DRAWING MAPS

If we can create a high-resolution model of a cave (based on lidar, photogrammetry technology or anything else), **do we still need a handmade map of the caves?** In Slovakian cartography it is a tradition to draw quite detailed maps full of various items (e.g., speleothems, sediments, morphology). Although not everyone went this way, we consider it as an ideal in general. It takes a lot of time spent in the cave and behind the computer (or laborious hand drawing). The question is, is this needed in times of precise, coloured 3D models?

When we talk with biospeleologists, they appreciate our precise work with maps, just because a brief look gives them an impression of possible (micro)biotopes present and very often there is no need to map specifically the biotopes. In Demänová Caves we use to distinguish between the sediments as a clay, sand, debris, pebbles etc., as well as between allochthonous and carbonate debris. Using Therion's exports you can get data for various spatial analyses. And don't forget aesthetics, this way of mapping can bring some beautiful results, as this could be one of the last remnants in field of handmade maps.

If we would ask cavers, who are not scientists or professionals, the first demand could be for an easy orientation inside the cave. The second may be the display of places of possible further continuation, unsolved ques-



3D scan from mobile laser scanner: cave floor (left) and ceiling (right) of the same part of the Cave of Peace. To cut the ground points out of whole point we could use CSF filter (Zhang et al., 2016). Author: P. Herich

tions, air-draughts, and other observations. To answer all of this, **isn't it enough to create a stabilised and labelled** (survey) **points at a crossroads in the caves, automatically generate walls** (outline of passages), create simple 2D maps **and put some interpretation directly into the 3D models** as a remark? And we would then need just to take this map and/or cell phone with us, with a simple 2D output and 3D flight through the model.

TRANSITION TIMES?

To be able to join older data with MLS data and draw a precise cave map (plans), we decided to follow these five steps:

- Measure a centreline of the cave with stabilised point stations. Simultaneously, draw sketches of small crawls or pits, muddy or wet passages where MLS can't go.
- Use MLS to scan the main passages not sketched in the previous step using stations as reference points. These two steps can be made during one surveying trip to certain parts of the cave.
- Process the MLS data, cut off the ceiling (or create a side view by cutting point cloud longitudinally), print them.
- Go back into the cave with these images of point clouds for an interpretation of sediments, speleothems, continuations etc. and draw them directly into these images as points, lines and areas.
- Scan these images and redraw sketched items in the same way as you would use exports from PocketTopo or another non vector paperless software.

The result is fully compatible with older maps, and it has a much better precision, as the cave items, lines and areas are in the exact position as they are.

AUTOMATICAL DETECTION

Is there any possibility to train AI to automatically detect cave items such as various speleothems, distinguish between sediments etc.? So far there have been some attempts, e.g. perfectly scanned stalagmites or stalactites can be detected by a simple algorithm looking for defined shapes. If we colorise point clouds and add intensity values, could we detect **all** we desire? It seems not likely, as an air-draught, continuations or even flat-shaped sediments covered with muddy film can't be detected and interpreted automatically. But automatization could save us a lot of precious time spending by surveying the caves and behind the computer. Which of course we could use to spend more time in caves again – digging, doing science or contemplating...

We would like to thank to Institute of Geography of P. J. Šafárik University in Košice (Slovakia), especially Jozef Šupinský, who showed us the processing of point clouds. And we thank also to creators of Cloud Compare free software, which we use on daily basis.

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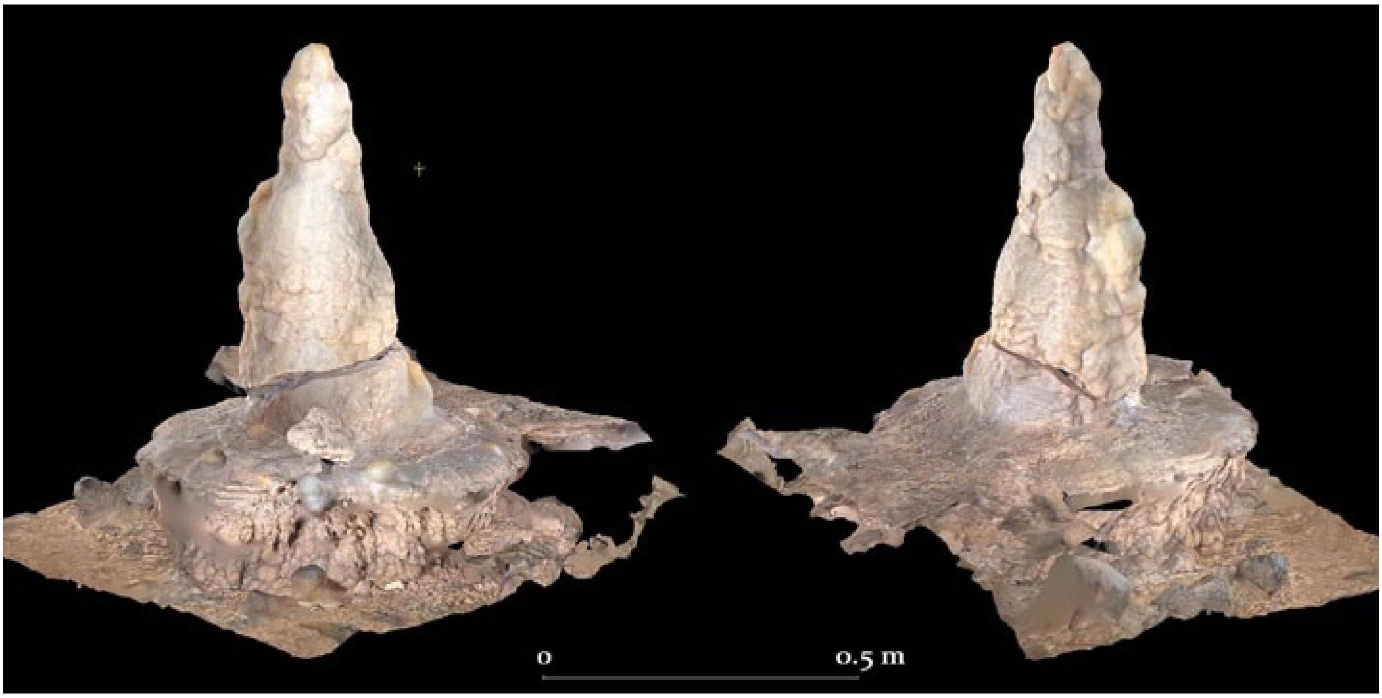

Model of a broken stalagmite made by iPhone 13 pro (photogrammetry and simple lidar) in 1 minute. Author: P. Herich

Side view of inner space of small cave made by iPhone 13 pro. Author: A. Galica

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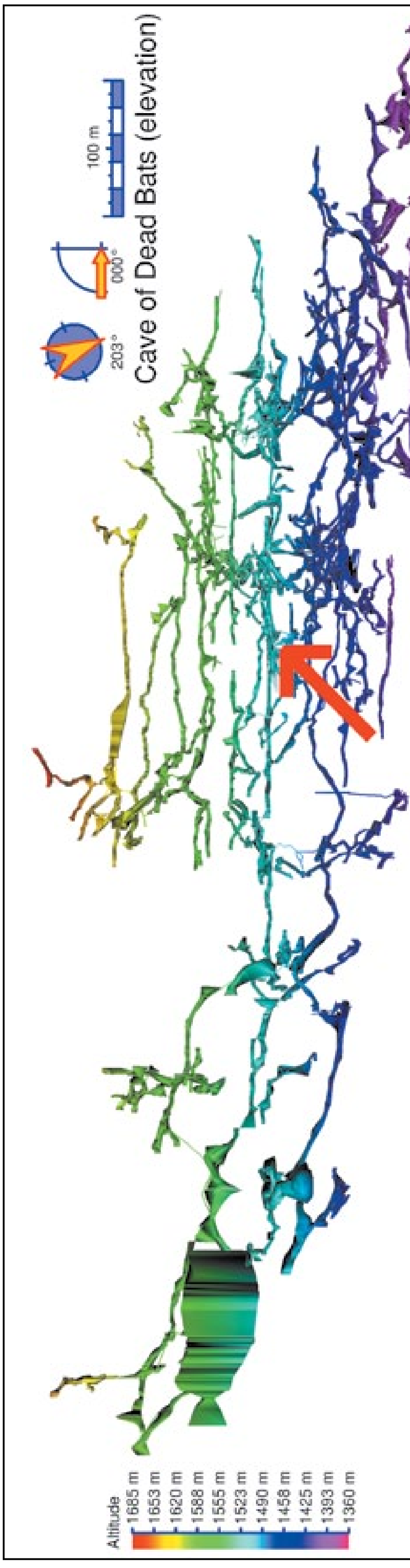
DIGGING THE EUROTUNNEL SUMP IN THE CAVE OF DEAD BATS

Stacho Mudrák
Speleoklub Ďumbier

Jaskyňa mŕtvych netopierov (Cave of Dead Bats) is more than 20 km long and 320 m deep cave system in central Slovakia discovered in the early 80s. It consists of several, mostly horizontal levels connected by steep passages, pitches and canyons based on the vertical rock bedding. The most developed cave level is situated at 1500 m a.s.l. altitude and is accessible by the main cave entrance at the bottom of a small steep valley. From this entrance, you can get relatively easily 500 m deep into the mountain by a series of stairways, bridges and horizontal passages with a diameter of several metres. This part of the cave was opened to the public in 1996. The main issue is that it ends with an 80 m long and 15 m deep sump completely filled with sediments. Behind this sump, cave passages continue to the series of halls, the biggest of which is Bystrický dóm Hall with a length of more than 100 m and largest diameter of 40 m. To get there, you need to bypass this sump by a complicated series of climbs, canyons and crawllways. Therefore, almost immediately after these big halls had been explored and surveyed, a decision to dig this sump was made. At that time, works on the The Channel Tunnel were in progress, therefore our sump was nicknamed the "Eurotunnel".



Eurotunnel location in the cave

THE FIRST YEARS OF DIGGING USING TRADITIONAL METHODS

During the first several years of digging, cavers reached the bottom of the sump basically without any major issues. The sediments were dry, progress was motivating and there were a lot of cavers willing to help. The dig was 40 m long and 15 m deep when we reached the bottom. The first issues emerged when the sump passage started to rise. After digging a few metres upwards, the lack of fresh air became apparent and digging started to be dangerous. We started to use candles to signal the high CO_2 level. When the candle started to flicker, we knew that "it's time". After digging more and more, the time we were able to work in the rising passagegradually reduced to about half an hour. But clearing the sediment choke from the sump had even more severe consequences. When a small pond appeared for the first time at the bottom, we were happy that the sump became active again and we were progressively getting closer to the end, where some active water streams exist. But the pond got bigger and bigger. After some time it reached the ceiling and we were able to dig only in winter when the pool dried up. But even this period was getting shorter due to climate changes causing very mild winters. Redirecting the water stream in the passages behind the sump helped a little bit, but during one intense spring snow melting a disaster came. Water level rose to about 10 m, the solid sediments turned into a liquid mud and some of the dig walls were destroyed. Several cubic metres of mud filled the bottom, it choked up even the tinyest water leakage and the bottom of the sump became permanently cloged up with about 3 m layer of sediments with

The flooded bottom of the Eurotunnel sump with the old cableway. Photo: S. Mudrák

1 m of water above it for almost the whole year. The last 20 m of the dig behind the bottom became inaccessible, our motivation was lost, a lot of the golden-era cavers got old and the Eurotunnel was abandoned. It was also problematic to organise a group of at least 5 cavers to make some progress because it was not clear whether the workplace will be flooded or not.

GETTING RID OF WATER – USING BATTERIES

After a few years and some more discoveries in the parts of the cave behind the sump, the temptation of an easy access route there became so big that we decided to resume the work on Eurotunnel. The first issue we had to solve was how to pump the water pond at the bottom of the sump. It was quite deep at times and there were very few cheap pumps available with the required head of 15 m. First we tried some generic 220 V 500 W pump we already had connected to a gasoline power generator on the surface. We used the existing cables used to light the cave for tourists. But the power losses on the line did not allow the pump to work properly. Bringing the generator in and out of the cave on every trip would also be too complicated, not to speak about the combustion gases in the cave. And working with a high voltage of 230 V in the wet conditions of the sump was a challenge by itself. We did not notice any major inflow to the sump so we decided to use a small $15 24 V 20 W garden pump from eBay with a nominal flow 800 l/h. Its effective head was only about 5 m, but using three of them in series worked surprisingly well. Obviously, the flow with a maximal head was much lower (around 300 l/h) but still enough to pump the pond out during the night. The pond had usually a volume of cca 2 m^3. To power the pumps, we calculated that our 7S8P 24 V 25 Ah 3.8 kg lithium-ion akkupack used with our cordless drill should be sufficient. To be more energy efficient, we placed the outflow hose end several metres below the entrance of the sump to the nearby canyon to achieve at least some siphon effect. All three pumps were needed just at the beginning of the pumping process to fill the hose with water. After several minutes, one pump could be switched off. We used a homemade automatic timer switch for this purpose. When the pond was empty, the rest of the pumps were turned off by a boat water level bilge pump switch to avoid overheating damage. With this setup we were finally able to come to the dry sump on Saturday morning or noon, if we turned the switch on on Friday evening.

GETTING RID OF SEDIMENTS – USING BATTERIES, TOO

When the problem of water was solved, we needed to find a way to transport the sand and mud from the 40 m long and 15 m deep dig. Originally, there was a cableway from the top to the bottom of the sump used for transport. The problem was, there were at least 5 or 6 people needed to operate it. The passage was not straight and the full bucket often fell down from the cable, so there were 2 persons needed on the top, 2 in the middle and 1, or ideally 2, at the bottom. Unfortunately, we were not able to organise so many cavers, because the progress of this way of work was very slow and demotivating. So we decided to switch from cableway to monorail (called alweg here), occasionally used for transport in the mines in former Czechoslovakia. In a few weeks the monorail was built and after some attempts also an electric winch was installed, powered by the same 24 V accupack as the water pumps. For the winch we used a 24 V 250 W DC motor running at 3000 RPM together with 1:8 mo-

The final setup of pumps with a water level switch at the bottom of the sump. Photo: S. Mudrák

Alweg transporting 3 buckets full of mud from the bottom of the sump. Photo: S. Mudrák

torbike chain gear. After several accidents we realised that also a very strong motor driver (70 A), limit switch, battery overcurrent protection circuit and a strong 16 kN 4mm dyneema tow rope are needed. Also the rail gradient changes should be as small as possible to avoid large changes in the towing force. When the mud was too sticky and it was hard to empty the bucket, we laid the buckets out with a custom-tailored polypropylene bags normally used for construction waste. With all these improvements, we were able to effectively dig the sediments from the bottom even with 2 or 3 cavers. After several trips, the choke at the bottom of the sump was cleared and the whole length of the dig became accessible again.

DROPLET-POWERED PERMANENT SIPHON PUMP

When the rising part of the sump was reopened, the old problem with missing fresh air reappeared. But this time we were prepared and the air turbopump from an old accu vacuum cleaner did its job. Although it was running on 7.2 V, a small DC-DC step down voltage regulator allowed us to attach it to the existing 24 V battery and regulate the power. Through the new 40 mm cable protection hose, we were able to suck the CO_2-rich air from the end of the sump over 60 m away and start to work there continuously. Well, almost. Apparently, the climate change caused the water inflow to be much stronger than a few years ago and all the sediments cleared from the bottom were replaced by water that was still keeping its level on the bottom. Therefore it took gradually longer to pump the sump out at the beginning of the trip. When it took almost 2 days, we definitely decided we needed a stronger pump. We again gave a chance to a 24 V eBay pump, but this time a $80 version with 250 W motor, 15 m head and 1″ hose diameter. We also upgraded the battery to 7S16P 52 Ah, more than a 1 kWh beast weighing just 7.5 kg. With this setup, pumping the sump dry took 2 to4 hours depending on the season. But it was still a complication. Immediately after the water was pumped out, the sediments in the sump were still wet and the digging was very difficult. And most of the year, there was a constant stream that was not very strong, but if you did not pay attention to it, you became completely wet very easily. We have calculated that if we can catch the water inflow at the end of the sump, we should be able to transport it out just using gravity and the siphon effect. The first half was relatively easy: to catch the water and bring it through the hose down to the bottom and then again to the same height, where a water tank was installed.

The second part was tricky. We planned to use a siphon pump over the head of 8 m. But at the altitude of 1500 m, the air pressure is about 0.85 atm so the whole setup was at the edge of the laws of physics. Nevertheless, when we tried it, it worked. Well, again almost. It worked for just 2-3 hours. The topmost part of the draining hose where the water is flowing in the near zero atmospheric pressure filled with bubbles quite quickly, the siphon effect disappeared and the water stopped flowing. The first idea was to use our good old 24 V mini pump to refill the water and resume the siphon effect. But it never worked for more than several days. The setup with a big lead-acid car battery charged from 220 V lighting cables protected by low voltage detection circuit, mechanical water level switch, safety timer and 40 m of cables had too many weak points. The battery capacity degraded, the charging was not sufficient, the charger stopped working, cables

The buffer water tank in the middle of the sump where inflow and outflow hoses connect. The bottle on the left serves for separating air and water from the shishi-odoshi fountain. Photo: S. Mudrák

Shishi-odoshi fountain (the grey tube). Water slowly fills the tube and when the centre of gravity passes the rotation point, 10 litres of water are released in one moment to the black tank connected to the outflow hose. Photo: S. Mudrák

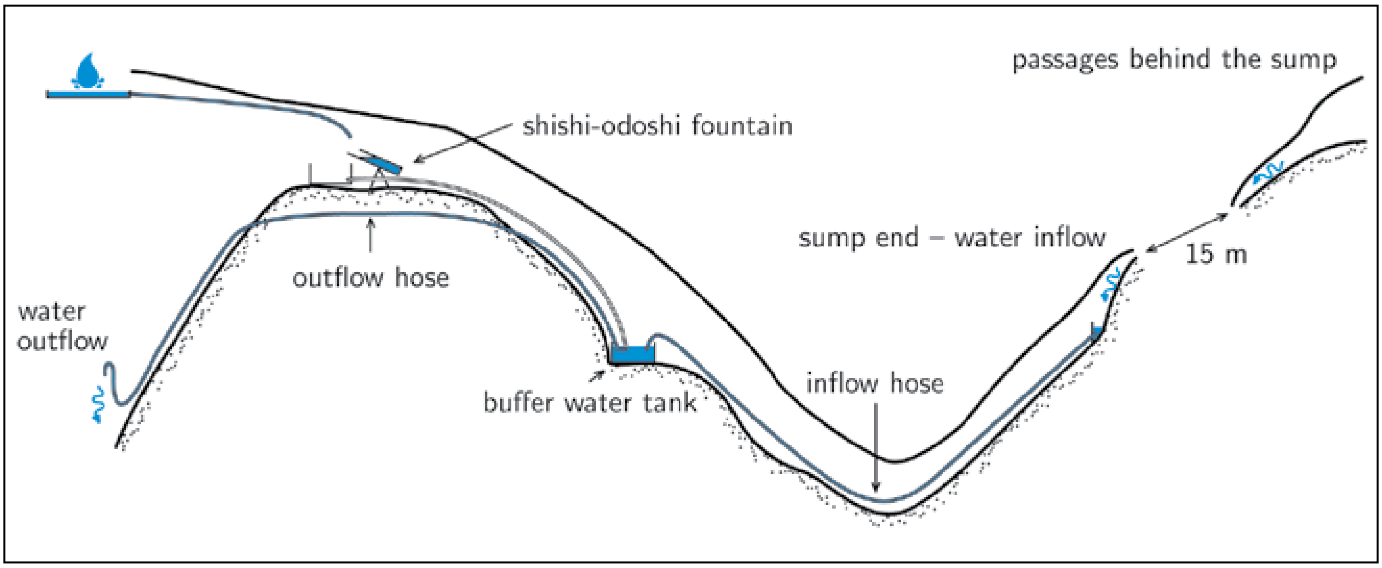
corroded, some water leaked into the sealing of circuits etc. Even though each of those problems was solvable, we decided to avoid pumps and electricity and make a more simple mechanical solution. We collected two water droplets sources near the entrance of the sump with a total flow of about 2 l per hour. They feed the shishi-odoshi fountain with a capacity of cca 10 l. When the fountain dumps out the water, it is led into the siphon hose equipped with a one way water valve on the inflow end. This waterflow takes the bubbles out of the hose, resumes the siphon effect and the water continues to flow from the sump. Every time the fountain is filled (depending on the season every 1–4 hours), the whole process repeats.

This sump draining setup finally seems to work and we are able to access the whole 60 metres of the dig without the need to use an electric water pump. As confirmed by the radio beacon location, there are remaining 15 m to dig. Let us hope, no other surprises are waiting there.

LESSONS LEARNED – ONE BATTERY PACK TO RULE THEM ALL

Using lithium-ion batteries simplifies the cave exploration a lot. With the small pump and 7S1P battery weighting together with the hose less than 1kg, we were able to dry small ponds in the cave which we normally were not able to cross without getting completely wet. With the strong pump, large battery and fire hose, everything still small enough to fit into and be transported in a backpack, we were able to pump 10–20 m^3 over the head of several metres even very deep in the cave. And without any toxic exhausts as a bonus. Having the same voltage on all of our equipment enables us to transport just one battery, and use it for everything. We have used our universal batteries also for drilling, transporting material with a winch, stale air ventilation and even to power the electric outboard motor of an inflatable boat. And with a small power inverter, we have also used it to charge all other devices we needed. Finally, if you do not succeed and the dried-up passage leads to nowhere, you have enough power to boil the water for a portable espresso machine.

This article was written with the purpose of sharing some innovative ideas we had and we are using. The author of this article is responsible just for a few of them. Many thanks to all other people who contributed with their ideas, materiel, equipment and time. If you have any questions or suggestions, feel free to contact us at info@speleo.sk.



Schema of the Eurotunnel permanent draining setup (extended elevation). Drawn by S. Mudrák

RECENT DISCOVERIES OF CAVE FAUNA IN SLOVAKIA

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Recently several undescribed cave animals have been discovered in the Western Carpathian caves. These species belong to the tiny wingless insects – springtails (Collembola), which represent the most diversified group of usual cave animals in Slovakia. *Megalothorax dobsinensis* Papáč, Raschmanová & Kováč, 2019, is species which survived from the last glacial period at cold entrance cave habitats, while *Deuteraphorura muranensis* Parimuchová & Kováč, 2020 is a representative of an old phylogenetic lineage obviously adapted to the cave environment showing highly troglomorphic characters.

A minute collembolan ***Megalothorax dobsinensis*** (Fig. 1) with the body length not exceeding 0.5 mm was

Fig. 1. Habitus of the genus *Megalothorax* sp. – electron microscopy image. Length of the body 0.5 mm. Photo: C. Schneider

discovered in the shallow rocky and soil profile at the entrance of Dobšinská Ice Cave, Slovak Paradise. It was subsequently recorded in Harmanecká Cave in the Veľká Fatra Mts which is another karst region of the central Western Carpathians. Both caves are seasonally open to public, with electric lighting and a guided path. Specimens were found in MSS that is a typical superficial subterranean habitat consisting of stony debris covered with soil and litter. At cave entrances the species is exclusively limited to the cold and wet parts of a microclimatic gradient. Inside the caves, specimens were collected on the surface of a water pool.

The genus *Megalothorax* includes 30 species worldwide, seven species have been found in Slovakia. The morphological features of *M. dobsinensis* (claws, antennae, chaetae) are less adapted to cave environment than in the highly specialized *M. hipmani* Papáč & Kováč, 2013, found in a few caves of central Western Carpathians, indicating its troglophilous mode of life. Inversed collapse doline at the entrance of Dobšinská Ice Cave hosts also other edaphic congeners, *M. minimus* Willem, 1900 and *M. willemi* Schneider & D'Haese, 2013 that are restricted to the upper, warmer part of the slope/gradient. The cave is occupied by another eutroglophilous species, *M. carpaticus* Papáč & Kováč, 2013 found on water surface of the pools in its deeper, unglaciated parts (Papáč et al., 2020).

M. dobsinensis is most likely a **glacial relict** since the absence of any well-developed morphological adaptations (troglomorphisms) and its preference for the cold subterranean habitats.

A high diversity of cave-adapted species in southern European mountains, with a decreasing trend towards northern regions, is a general pattern of distribution of troglobionts in Europe. The genus *Deuteraphorura* belongs to the most abundant in terms of troglobionts, including 83 species worldwide. Recently discovered ***Deuteraphorura muranensis*** (Fig. 2) was collected in two caves of the Muránska planina Plateau (central Slovakia) – Jelenia Abyss and Bobačka Cave – almost exclusively on the water surface of sinter pools, but also on bat guano and organic baits in the deeper parts of the caves. The new species has a 2.5 – 3.0 mm long body and

Fig. 2. *Deuteraphorura muranensis* – new troglobite species from caves of the Muránska planina Plateau. Length of the body 3 mm. Photo: Ľ. Kováč & A. Parimuchová

shows highly troglomorphic features, such as distinctly elongated claws and chaetae on the body. The other two species in the Western Carpathians caves are represented by troglomorphic *D. schoenviszkyi*, endemic to caves of the Slovak and Aggtelek Karst, and *D. kratochvili* that is the most widespread cave species with a distribution range covering the whole Western Carpathian Mts. The new species is endemic to the Muránska planina Plateau which is a small karst area in the central part of the Western Carpathians 213.2 km^2 in area with ~500 caves.

The discovery of *Deuteraphorura muranensis* supports the idea that the Western Carpathians are the northernmost distributional border of the **troglomorphic taxa** in Europe and an independent evolutionary centre of the usual cave dwellers.

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SLOVAK SPELEOLOGICAL LITERATURE

There are three periodical magazines representing the speleological library in Slovakia: **Spravodaj SSS, Slovenský kras** and **Aragonit**.

Since the 1970s, the **Spravodaj (Bulletin) of the Slovak Speleological Society** has been published by the *Slovak Speleological Society*; this year sees the 53rd volume. It is traditionally published in four issues a year. Once in four years one issue is published in English as a bulletin for the purpose of the UIS congresses. The journal is focused on the results of basic speleological exploration, survey, and research in Slovakia, as well as the work of Slovak cavers abroad.

The Museum of the Slovak Karst originally kept a yearbook, but this has been replaced today by a scientific magazine published by the *Slovak Museum of Nature Conservation and Caves*, and the *Slovak Caves Administration* – **Slovenský kras**, subtitled **Acta Carsologica Slovaca**. The magazine has been published since 1958 and contains hundreds of papers which constitute the main written contribution to the topic of caves and karstology in Slovakia. In 60 years of publishing 72 issues of the magazine published hundreds of papers of scientists and professionals as well as speleological and karstological reports. The publication was issued annually for a long time, but since 2008 Slovenský kras has been published as a magazine twice a year, with occasional supplements.

The third magazine of Slovak speleology is the **Aragonit**, which initially originated as a yearbook of the *Slovak Caves Administration*. In 2007 it became a peer-reviewed magazine, and since 2008 it has been published in two volumes each year.

Certain impacts on Slovak caves are attributed to the Slovak Museum of Nature Conservation and Caves' yearbook, the name of which suggests that it contains articles from speleology – **Sinter**. Its first volumes were devoted almost exclusively to the caves and karst protection. Useful information about local caving is included in the regional yearbooks **Jaskyniar** (Caver; 2007 – 2011) and **Hory a jaskyne** (Mountains and Caves; 2012 – 2022). The Society for the protection of bats in Slovakia (SON) publishes the peer-reviewed magazine **Vespertilio**, the 6th issue of which was conceived as a catalogue of hibernation sites of bats in Slovakia. In the last years many books and monographies with a speleological topic have been published in Slovakia.

Since 1996, at two-year intervals the *Slovak Caves Administration* has been organizing an international scientific conference called **Research, Use and Protection of Caves**. The papers from the conferences were initially published in the **Proceedings**, and since 2007 the contributions from the conferences in the *Slovenský kras* and *Aragonit* journals. In the past, Slovakia has held several conferences, symposia, colloquia, as well as speleologically oriented congresses of an international character. Papers from them, e. g. from the ISCA Congress (International Show Caves Association) can be found on the website of the Slovak Speleological Society.

In the Library section of the www.sss.sk website, we intend to include all available information from these magazines for the public as well as full access the Library of the Slovak Speleological Society for registered users.

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THE SLOVAK MUSEUM OF NATURE PROTECTION AND SPELEOLOGY 1930–2022

Karolína Balášková, Peter Holúbek

History

The discovery of the Demänovská Cave of Freedom in the Low Tatras Mountains in August 1921 led to great enthusiasm in speleological research in Slovakia, which has lasted practically to this day.

The town of Liptovský Mikuláš has become its centre. Here, on June 2, 1930, after more than a decade of efforts of Mr. Ján Volko-Starohorský, Ivan Stodola, Alois Lutonský and others, the Slovak Karst Museum was established. It is the oldest specialized institution in our country. Until 1970, when the Slovak Caves Administration was established, the **Museum of the Slovak Karst** in Liptovský Mikuláš had *de facto* been the main state administration body responsible for the caves of the whole of Slovakia.

In the 1980s, it became a part of the **State Nature Conservation**. Its name was changed to **the Museum of the Slovak Karst and Nature Conservation** and there was a tendency to deviate its purpose from its original purely caving mission. By the end of the century, its name and its operator had changed several times, until in 1990 it acquired the name **Slovak Museum of Nature Protection and Speleology**, under which it has operated ever since. Since January 1, 1999, it has been a specialized museum with nationwide competence in the field of nature and landscape protection in the scope of competency of the Ministry of the Environment of the Slovak Republic.

Today, the museum is a specialized research and education centre. It documents the development and current state of nature and caves protection, and it has given support to volunteer and professional cavers throughout the country, providing them with a scientific and research background. There are many important personalities who have worked at the museum since 1930, including the museum's founder, geologist, and naturalist Ján Volko-Starohorský (1880–1977), photographer and cave organizer Vojtech Benický (1907–1971), geographer and caver Anton Droppa (1920–2003) or geographer and caver Pavol Mitter (1941–1992). Currently (in 2022), there are 6 employees working in the cave department of the museum, out of which 5 are active cavers. Two of them work at an affiliated branch in city of Košice focusing on the Slovak Karst.

1. National Cave Database

National Cave Database is an information system designed to record and sort data on all known caves in Slovakia. The basic data in the database comprise of their: name, registration number, length, altitude, location (cadastre), geographical coordinates, genetic type etc. The database also contains data of a professional nature (occurrence of archaeological and paleontological finds, minerals, rare animals, etc.), photographs of entrances, the interior and surroundings of caves, maps, historical documents and materials published in literature. As of 7th December 2021, 7,723 caves with the total length of cave corridors of 447 kilometres have been registered in the database. The database has been filled with 4875 records on literature and 9,080 graphic records. Not only the museum's own professional speleologists and the Slovak Caves Administration, but also volunteer cavers from the Slovak Speleological Society contribute to the National Database under the administration of the museum.

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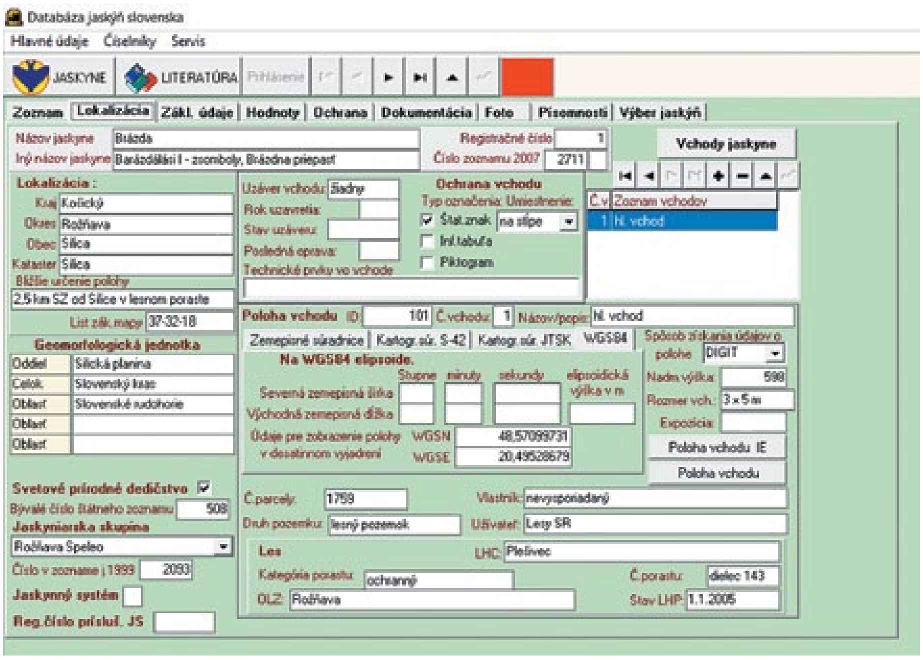

Introductory letter of the National Database of Slovakia

2. Library

The basis for the museum library was the private library of Ján Volko-Starohorský (1880–1977), who founded the museum. In 1949, a specialized speleological library began to be built systematically, mainly due to the exchange of literature. It has had 49 domestic and 113 foreign exchange partners. As of December 31, 2021, the library fund consisted of 26,257 library units, of which 638 date before 1918. The oldest published periodical in the fund is the French caving magazine Spelunca, which has been published since 1895. The museum has published the scientific journal **Slovak Karst** since 1957. In 2021, its fifty-nineth volume was published. In the '90s, the museum launched the publication of the magazine **Sinter**. It has also been dedicated to caving.

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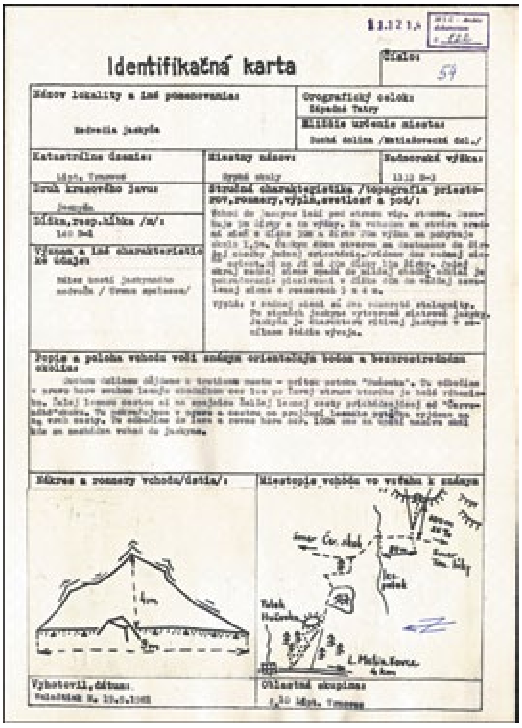
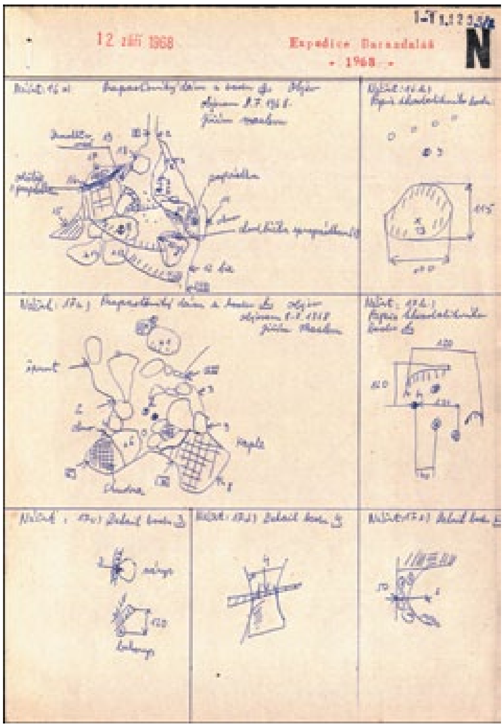


Cave identification card



Survey documentation of the Brázda abyss

3. Archive

The archive contains more than 250 running meters of archival documents from 1921–2018, which are divided into 23 archive funds of state bodies, institutions, and associations, 41 larger personal funds (almost 100 fragments of personal funds), 10 photo documentation collections (more than 100,000 pieces), collections of maps and 21 archival documentary collections. Important documents include diaries and notebooks from caves survey. In 2008, 700,000 archive funds were digitized.

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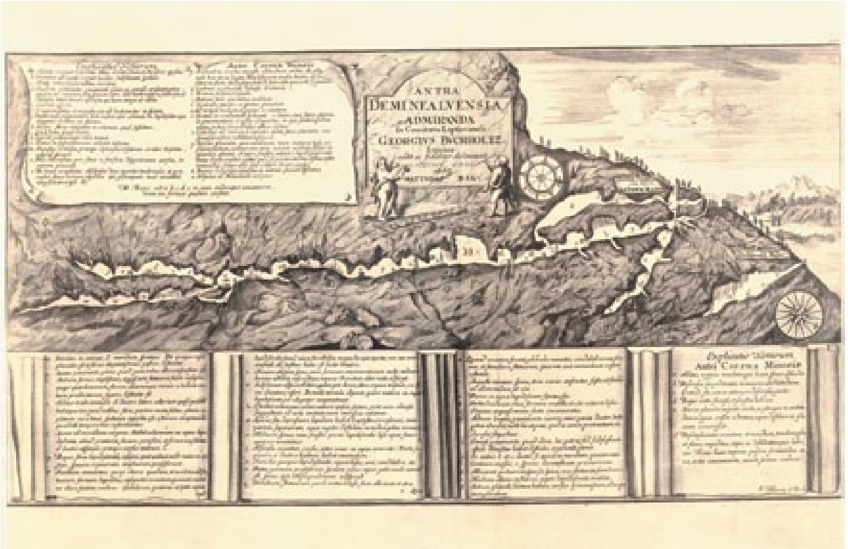
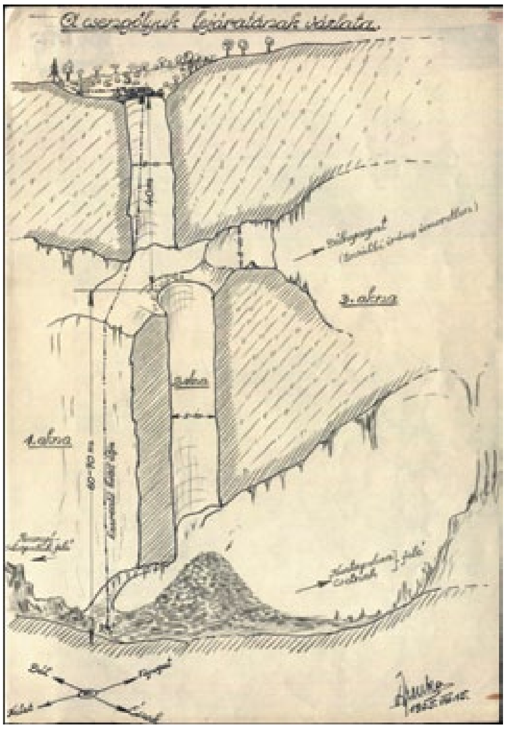
4. Collection of maps and measurement equipment and tools

The collection of graphic documentation of caves contains more than 3,000 cave maps, plans and sketches. It is divided into layouts of surface situations and a larger part of underground sites. The oldest map of a cave in Slovakia is a sketch of the Demänovská Ice Cave by the mining surveyor Samuel Mikovíni from 1719. At the time of its creation, it was a unique, though topographically very inaccurate depiction. Only a reproduction of this map, which was originally published in 1723 by Matej Bel in his travelogue in Hungary "Hungariae antiquae et novae prodromus", has been preserved in the collection. The oldest original cave maps of a Slovak cave in our collections are the plans of the Dobšinská Ice Cave by its discoverer Eugen Ruffiny from 1870–1895. In several versions of the cave map, Ruffiny gradually documented

Exploration of the Domica cave in 1931. Photo: V. Benický



Map by S. Mikovíni from 1719



Map of the Zvonica abyss from 1915 by Jozef Drenko

the development of the cave's glaciation, but also the process of making it available to the public. He captured the cave infrastructure under construction, such as stairs and sidewalks and lighting posts, as well as new corridors made in the ice to make further areas accessible.

The most important and the most numerous items of the collections of graphic documentation of caves are cave plans and maps, which were created after the discovery of the Demänovská Cave of Freedom. The gradual development of modern Slovak speleology is related to the adequate development of the speleological documentation. Unlike cave mining, there is still no generally binding regulation or technical standard establishing a uniform map form. Slovak speleology works mainly on an amateur platform. For this reason, the cave maps in our collections are unique in many ways and most of them are hand-drawn originals in various formats. They reflect the period methods of cave mapping and the personality of their author. They are often closer to a work of art than to a technical work. The maps are complemented by a collection of more than 200 pieces of equipment used to measure and map caves.

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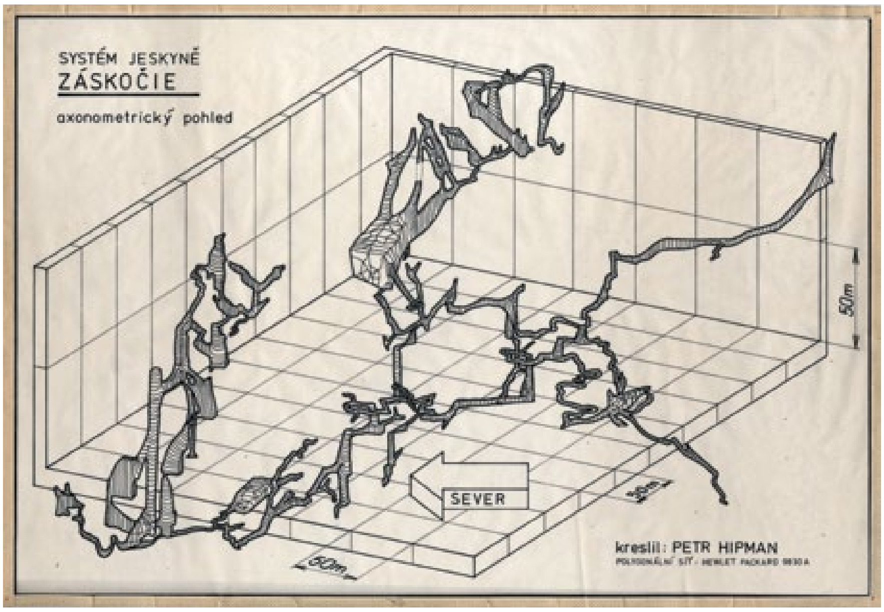
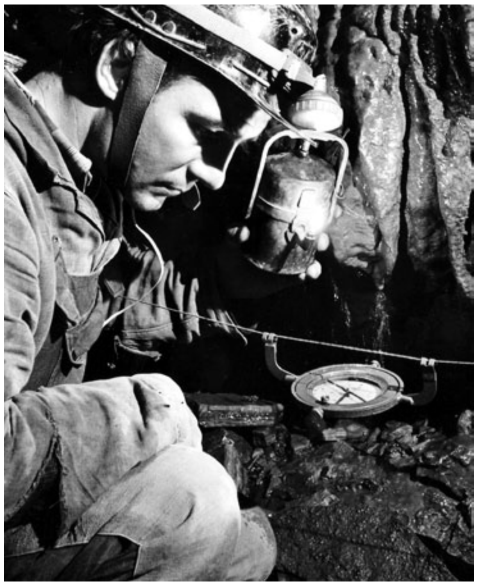
5. Collection of technical equipment and tools

The collection of lighting and technical equipment and tools used in speleological activities consists of more than 300 items. Equipment used to cross various chasms include ladders, winches and rope climbing equipment. The



Three-dimensional map of the Cave in Záskočie by P. Hipman



Survey of the Cave in Záskočie in 1970s. Photo: P. Hipman

Predmet: strmeň samovýstupný

Skup.: VEDKINA	Lokalita: Horná Štubňa	Múzeum: SMOPaJ Lipt. Mikuláš	č. evid.: 675
Podskup.: Pracovný výstroj	Okres: Martin	Umiestnenie:	č. prír.: 29/80
			č. neg.: 2102
		Cena:	hodnota: 200,-/ks
Spôsob nadob.: vlastný zber	Získal: Ing. Lalkovič	Získané od: sklad Slov. speleologickej spoločnosti	
Dátum: 1980	Opísal: J. Hlavák	Adresa:	

Opis:
1. Samovýstupný strmeň na prekonávanie vertikál po lane.
2. Osobitne formovaná duralová eloxovaná zliatina bordovej farby so západkou na pružinu s istiacim kolíkom. Rukoväť opatrená plastickou hmotou.
3. Plastická hmota má vylisované jemné protišmykové vrúbkovanie.
4. Rozmer 19,0x7,5x2,5 cm s otvorom lístom na uchytenie ruksu. Dva otvory ⌀ 1,0 cm na uchytenie karabínou.
6. Výroba VÚ Žiara Zvolen, Závod Horná Štubňa, podľa autorského návrhu P. Hipmana.
7. Výroba okolo roku 1976
8. Horná Štubňa
9. Konštrukcia prevzatá od švajčiarskeho Jümar, jaskyniarsko-horolezecká výstupová a istiaca pomôcka po lane.
10. Stav dobrý, nepoužívaný.
11. Literatúra: Spravodaj SSS 1/75, ročník VI.
Počet kusov: 2

TSNP LM 317000-86

Documentation of the Žiara rope ascender

oldest of them date from the second half of the 19th century, but the most valuable collections are original amateur constructions that originated in the 1970s and 1980s. Due to the "Iron Curtain", goods made in Western countries were not available to Czechoslovak cavers, and so various "gimmicks" and replacements were created, made in various, often domestic conditions. In 1974 the industrial production of the Žiara type climbing rope began and this supported the development of semi-professional rope climbing. However, the ropes ceased to be produced due to their low quality. In 1986 the LET Kunovice company began the industrial production of climbing ropes according to a foreign model which replaced amateur products. After the social changes of 1989, this production ceased and ropes as well as the lighting technology switched to professional products of Western European production.

Lighting technology includes torches, candles, candle lanterns, oil burners, petrol lamps, acetylene lamps and electric lamps. A part of the collection belongs to the classic mining equipment that cavers used without any modification until the 1970s. In 1975, the design of a lightweight acetylene aluminium lamp was created. It had a burner placed on the helmet, thus freeing the hands. More than 100 pieces of this lamp were produced. Other amateur designs followed, of which 8 types were created and more than 400 pieces were produced. Together with mining electric lamps, this was an essential equipment used for illuminating underground operations. After 1989, gradually professional products were preferred and amateur self-made items practically disappeared.

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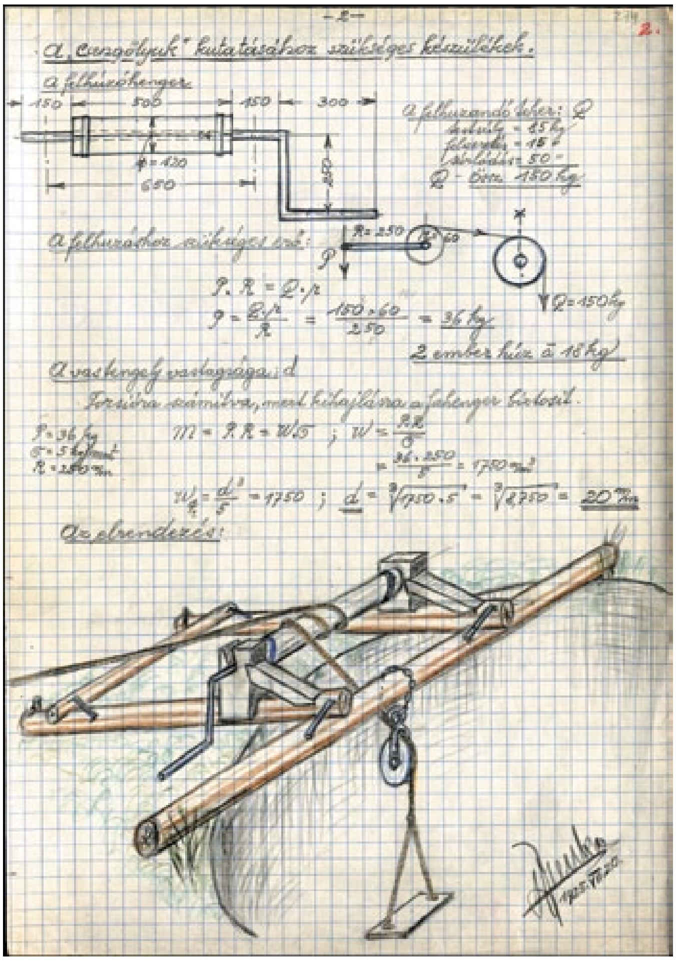

Technical documentation of the descent into the abyss Zvonica by J. Drenko from 1925

Climbing aids, Cave in Záskočie, 70s of the 20th century. Photo: P. Hipman

6. Geological Collection

The collection of speleothems was created at the same time as the museum was founded in 1930 and it was a part of the regional Liptov collection compiled on the initiative of Ján Volko-Starohorský in 1904. The collections contain all the basic forms of speleothems that can be found in Slovakia. These are unique specimens of solutional formation, a two-meter drum, fragile lake forms, acicular aragonite eccentrics, several shapes of cave pearls and clusters of calcite crystals. The collection is complemented by foreign collections from more than 30 countries around the world. Thanks to the field research made by the museum staff and numerous donations and purchases the collection of speleothems expanded, and its number gradually grew to more than 4,000 items with 1,321 registration numbers.

From the exposition of speleothems in the museum.
Photo: M. Orvošová

Cryogenic calcite crystals from Hačova Cave, Little Carpathians.
Photo: J. Česla

The speleothems collection is used in dealing with museum and grant scientific research tasks focused on paleoclimatic research, genesis and protection of the speleothems themselves, as well as related processes of karst development and caves formation / development. Moreover, the research activity also results in the description of new species of speleothems (cryogenic pearls, cryogenic cave carbonates) in Slovak caves which is one of their first descriptions in the world.

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7. Archaeological Collection

The archaeological collection of the museum includes mainly archaeological finds from Slovak caves, abysses, overhangs and karst areas from the Early Stone Age to the present. It currently contains more than 11,000 items. The oldest items in the collection include Palaeolithic stone and bone spikes from the caves Prepoštská, Kremenná, Deravá skala and Pec. There is a large number of finds from the Neolithic and Eneolithic periods, mainly ceramic vessels or their fragments belonging to the Bukova Hora and Baden cultures. The bearers of these two archaeological cultures used the underground spaces very often and the remnants of their stay form a substantial part of the collections. The typical engraved decoration on the surface of thin-walled vessels from the Domica cave is one of the most perfect ornaments on prehistoric ceramics in the region of Slovakia. Flat stone trapezoidal axes, highly arched spikes and chisels also enrich the collection. The bone tools mostly consist of crescent tools for rubbing of ceramics, needles and awls.

Anthropological findings are also a part of the collection. Among them, one of the most remarkable is a mask from the Majda-Hrašek Cave made of the facial part of a male skull. There was another one found, unfinished, with traces of processing, considered a semi-finished product and this one also comes from the skull of an adult man. They were discovered along with the remains of another ten people of different ages. The mask was apparently fastened to the head with a leather strap and is believed to have served in cult ceremonies in the Kyjatice culture (late Bronze Age / Early Hallstatt).

Counterfeit coins and semi-finished products for their production in the form of copper discs, flakes and clippings have proven money-counterfeiting activities in caves in the Middle Ages and the Modern Age in the archaeological collection. The first evidence of such use of cave spaces are flakes and coins, imitating the Hungarian denarii of Matej Korvín (1458–1490) from the Chvalovská Cave.

The latest collection items date from the Second World War, when the caves provided refuge for the persecuted, refugees, deserters and members of partisan groups. These items include not only weapons and ammunition, but also military equipment and daily necessities left here by the temporary inhabitants of the caves.

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Copper sculpture of an ox from Liskovská Cave, collection SMOPaJ

8. Collection of legends

Over the centuries, common people have invented a number of stories about mysterious, often inaccessible underground spaces. The legends were full of dragons, giants, witches and other mythical creatures, entwined with treasures, sleeping knights and other mysteries inside the caves. Because myths were initially passed on only orally, many of them have been lost to us. Since 2001, in connection with the foundation of a fund of written and literary artefacts about caves, they have been systematically collected. The first records include A. Medňanský's books Malerische Reise auf dem Waagflusse in Ungarn (1926), Sagen und Legenden aus Ungarns Vorzeit (1829). At the turn of the 19th and 20th centuries, thanks to Slovak nationalists, the first summaries of folklore traditions were gathered. Especially from these written sources, in the work *Processing of Myths and Legends about Caves in Relation to Individual Regions of Slovakia*, we managed to collect more than 200 legends about karst phenomena. We have been able to identify specific caves in about a quarter of them. Currently, we want to bring selected legends closer to the public in the form of podcasts.

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BIELA SKALA

Bolo ich vari sedem, čo sa o to pokúšali. Jednému sa prisnilo miesto, a to vraj celkom zreteľne, toľko a toľko siah vľavo od veľkej pukliny oproti nahnutému buku, ktorý práve jedným konárom ukazuje miesto, kde treba kopať; druhému sa zasa vraj prisnili číslice, ktoré akýmsi poskladaním dávali presný čas, v ktorý sa načim pustiť do roboty, a to iba v istý piatok na svitaní,

31

The Legend of the White Rock by Andrej Plávka (1907–1982) about treasures in the caves of Suchá dolina in the Western Tatras

Photo of skaters in Dobšinská Ice Cave before 1900, photo studio Divald

Glass negative from the filming of the documentary speleological film Demänová in 1928. Photo: J. Halaš

9. Collection of historical photos and films

Important cave collections include glass negatives and slides from the period up to 1945. There are about 2000 pieces with the theme of karst and caves registered in the museum collections, but with most of them it is not clear who the author is, or when they were taken and usually, the pictures lack any description.

From the period up to the 1970s, the museum archives 50 films on 8 and 16mm carriers. One of the most significant ones if the film **Demänová** from 1928, which is one of the oldest cave films in the world. It promoted the remarkable discovery of the vast cave Temple of Liberty with the participation of its discoverer Alois Král (1877–1972). It is a 16 mm black and white film and its official premiere took place on July 5, 1928 at the Exhibition of Contemporary Culture 1928 in Brno. Until 1930, it was screened several times in France, Austria and Germany. The original negative and copies burned in a fire at the University of Brno, but the copy, stored in France at the time, was saved.

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10. Guest books of caves

Cave guestbook entries have different forms and contents. They provide unique historical information about visitors to the underground and different periods of the past. The oldest book with records of visitors in the collections is from the Dobšinská Ice Cave and dates from July 7, 1871 to November 5, 1879. It begins with a record of the discovery of the cave on June 15, 1870 and contains 515 pages. It is followed by books from 1871–1894. The cave was also popular due to the possibility of skating in the summer. The collection also includes other books from well-known caves from the first half of the 20th century.

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11. Collection of postcards

Cave postcards document mainly the accessible caves of Slovakia, but there are also postcards from abroad in the collection. Postcards reveal the history of discoveries, cave decorations, the history of making caves accessible and illuminated, transport to or inside the caves, tourist shelters and entrance areas or cave fauna. There are also postcards of discoverers and cavers.

The richest part of the collection are postcards depicting individual areas of the Demänovská Cave System. In addition, the collection of postcards of the Dobšinská Ice Cave from the turn of the 19th and 20th centuries from the major publishers and printers of Austria-Hungary stands out for its historical, documentary and collector's value. The cave was a very popular place for tourists at the end of the 19th century also thanks to the already mentioned summer skating in the Great Hall. A rare item of the collection is a postcard issued around 1914, which shows the modified entrance to the Swimming Cave. This cave, which is not accessible today, was opened at the beginning of the 19th century.

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12. Collection of the works of art

The collection of the works of art consists of about 120 collection items including paintings, sculptures and even caricatures. The oldest artistic collections include paintings by Július Sándy (1827–1894) dating from 1850–1860. The cycle of oil paintings on canvas presents the Hungarian Baradla Cave in Aggtelek.

Front and back of a postcard from the Belianska Cave from 1905

Postcard of the Plavecká Cave

The painting of the Dobšinská Ice Cave by Ignaz Spöttl (1836–1892), an important Viennese painter, is also remarkable. The charcoal-drawn work features an ice fill and a wooden walkway with a standing figure holding a lighted torch.

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13. Collection of objects with a cave motif

Philately, calendars, posters, badges, stickers, patches, phillumeny, numismatics, brochures, souvenirs, utility items etc. are collected by a collection fund of cave souvenirs. The oldest objects date from the times of Austria-Hungary, their collection continues up to

Painting of the Dobšinská Ice Cave by Ignaz Spöttl

Metal stick label, Dobšinská Ice Cave stickers and the Italian Cave Club sticker

the present. This museum fund contains about 9000 items.

Metal tags from alpine cottages, castles, spas, or caves reminded tourists of the places they had visited in person, because they could only be purchased at that particular place. Very often they nailed them to their tourist sticks and the number of items on a stick showed the activities and interests of their owner. A label with the motif of the Domica Cave was created in the years 1929–1938. It shows the sinter decoration in the part of the cave called the Roman Baths in the Majko's Dome and the logo of the Czechoslovak Tourist Club, which was its owner at the time. The stickers from the Dobšinská Ice Cave, which were issued and could only be purchased at the Dobšinská Ice Cave Post Office in Stratená in the years 1888–1918 during the summer tourist season, are also unique. The stickers were placed on letters, postcards or luggage.

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14. Fossil finds from Slovak caves

The paleontological collection of the museum consists of remains of plants and animals dating from the Archean to the Quaternary, as well as fossil finds from Slovak caves. There are more than 2,000 items in our collection and more than 2,500 items in the auxiliary materials from the cave localities. They are fossils of invertebrates - ammonites (*Acanthopleuroceras* sp.), brachiopods, nummulites (*Discocyclina* sp.) and crustaceans (*Ophiomorphai* sp.), but especially osteological material. The most numerous are the fossil remains of cave bears (*Ursus ex gr. Spelaeus*), which are supplemented by fossils of the so-called Pleistocene megafauna – cave lion (*Panthera spelaea*), cave hyena (*Crocuta crocuta spelaea*), polar reindeer (*Rangifer tarandus*), giant deer (*Megaloceros giganteus*), wild aurochs (*Bos primigenius*), wild horse (*Equus ex gr. ferus*), woolly rhinoceros (*Coelodonta antiquitatis*) and woolly mammoth (*Mammuthus primigenius*). These osteological findings date mainly to the period of the last

The bones of a cave bear from a cave in the Western Tatras in 1953. Photo: A. Droppa glaciation (115,000 to 11,650 years ago) and come from Slovak caves. There is the unique finding of the skull of an adult male cave lion (*Panthera spelaea*), which, together with the rest of the skeleton, got into the collections thanks to the enthusiasm of cavers from Liptovský Trnovec.

Exceptional finds come from older geological periods – the tooth of a Miocene shark (*Odontaspis* sp.) from the Cave at Holý vrch (Revúca highlands) and the fossil remains of the Pliocene mastodont (*Anancusarvernensis*) from the karst cavern in Včeláre (Slovak Karst).

Skeleton of a reptile from the Štefanová Cave. Photo: J. Šurka

The 245-million-year-old part of a reptile skeleton (*Pachypleurosauris*), found in the Štefanová Cave (Low Tatras) in 2016, is also a unique find of global importance. It is the first skeleton of a tetrapod from the Mesozoic period and of the oldest known vertebrate from the territory of Slovakia.

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15. Biospeleological Collection


Thanatocenosis from a cave. Photo: P. Holúbek

The biospeleological collection contains 150 registered collection items and more than 700 specimens. The purpose of this collection is to obtain data on the species composition of cave invertebrates in individual karst areas and their distribution. The result is new knowledge about trogloxene and troglophile species. The most important collection items include preparations of the genus *Duvalius* and *Duvaliopsis* (Coleopterta, Carabidae), a troglophile beetle *Duvalius microphthalmus*, found in the Slovak caves. Of the stygobiontic invertebrates, there are mainly the species of wellworms – *Niphargus tatrensis* and *Niphargus aggtelekiensis* (Crustacea, Amphipoda) or the findings of the troglobiont water scorpion *Neobisium slovacum* (Pseudoscorpionida). The museum collections also include invertebrates from the Balkans (Dinaric Karst) obtained during several expeditions to these areas. The aquatic salamander (*Proteus anguinus*) represents cave amphibians in the collections.

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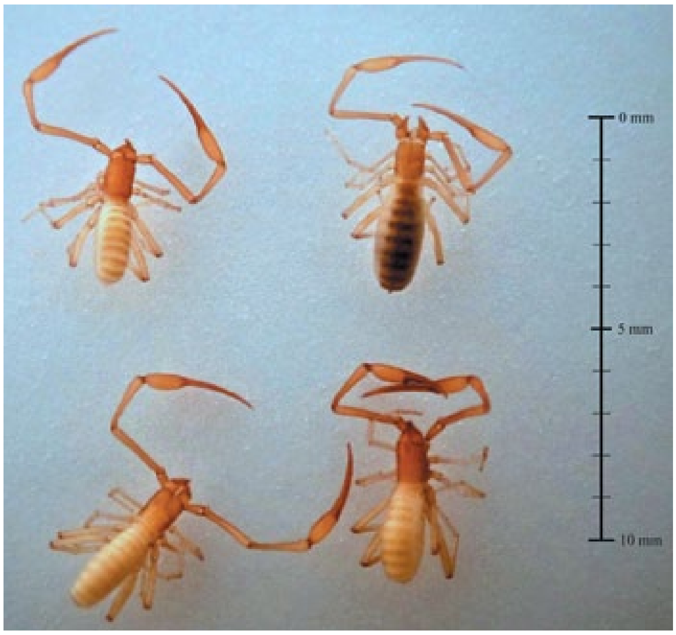


Neobisium slovacum. Photo: J. Lakota

FIVE YEARS OF EXPLORATION BY SLOVAK CAVERS IN THE BĂIȚA KARST AREA (BIHOR MTS., ROMANIA)

Jozef Psotka – Vladimír Papáč
Speleoklub Drienka, Clubul de Speologie Speodava

Introduction

In this paper, we present the results of speleological exploration of the two major caves on the right side of the Corlatului Valley in the karst area of Băița Bihor, in the western part of the Bihor Mts. This karst area represents a well-developed contact karst with a small surface area (less than 2 km^2), situated below the southern slopes of Țapu peak (1475 m). After few years of exploration almost 3 km of underground spaces were successfully discovered.

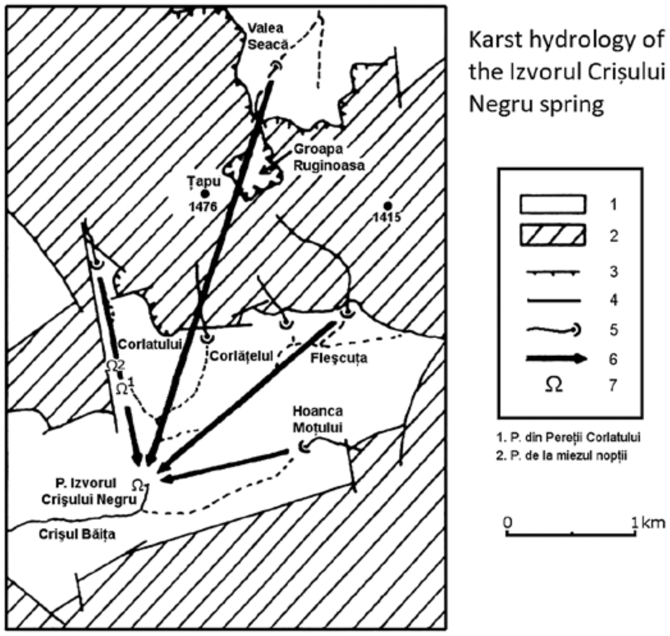


Fig. 1. Catchment area of the Izvorul Crişului Negru spring (according Orăşeanu et al., 1991). 1. carbonate rocks, 2. non-carbonate rocks, 3. nappe boundary, 4. faults, 5. ponors, 6. direction of underground drainage, 7. cave

Geology

Băița Bihor is an important mining district known by its skarn polymetallic deposits (Mo, W, Bi, Cu, Pb, Zn, B, Au, Ag). It has a long mining history since medieval times up to the present (Stoici, 1983). Many caves were encountered during mining works and some of them are formed in skarn host rocks and their mineralogy suggests their hydrothermal or combined origin (Onac, 2002). The area of the Corlatului Valley is built mostly by non-metamorphosed Lower Cretaceous (Barremian) massive white limestones of the Bihor Unit (Bleahu et al., 1985). From W they are separated by NNW–SSE Corlatului fault (Stoici, 1974) from siliciclastic sedimentary rocks: quartzites and hornfels (Coşuri Beds) of the Valani Nappe of the Codru Nappe System (Bordea et al., 1975). From SE the Lower Cretaceous limestones are delimited by overthrust of quarzitic sandstones and conglomerates of the Arieşeni Nappe, which build higher parts of the Țapu peak. Lower Cretaceous magmatic rocks -– andesitic dikes (banatites) pierce the limestones in the central parts of the karst area.

Karst hydrology and speleology

There are not many published works dealing with the speleology of this area. The renowned Czech geologist František Pošepný was the first one who recognized and described karst phenomena and hydrology, he was here in the second half of the 19th century. In his monograph about Rézbánya (Baița) mining district (Pošepný, 1874) he devoted a lot of space to the description of the local karst phenomena, hydrology and speleogenesis. He recognized the contact karst as he wrote: "The Corlat stream springs below the Tzap ridge and sinks into large, partially open caves, on the border of the Werksthal limestone complex." The main karst spring draining this area is Izvorul Crişului Negru with an entrance to a 1155 m long cave terminated by sumps (Damm, 2000). Results of several tracer tests (Orăşeanu et al., 1991; Orăşeanu, 1996) proved the groundwater flow paths of sinking streams in several side valleys (Valea Seacă, Corlatului, Corlațelul, Fleşcuța) to this spring. These allogenic streams originate on sandstones and conglomerates of the Țapu peak. According to the tracer test of Gaşpar and Orăşeanu (1987), the drainage area of the Crişului Negru spring extends to the opposite side of the Țapu massif to the Galbena stream catchment, which proves the continuity of Lower Cretaceous limestones of the Bihor Unit under the siliciclastic rocks of the Arieşeni Nappe on the Țapu peak. Corlatului Valley was never in the spotlight of speleological research but still from time to time, from the '70s to the '90s, it attracted explorers mainly from Speodava and Speo"Z" clubs. Only few papers have been published (Vălenaş et al., 1977; Damm, 1998; 2000).

Fig. 2. Corlatului Cave, Galeria Petru Brijan. Photo: P. Kočiš

Peştera de la Pereții Corlatului

(Cave in the Corlatului walls)

After few surface trips we chose the former ponor cave Peştera din Pereții Corlatului as our workplace. This meandering descending cave has been known for a long time due to its location at the bottom of the Corlatului Valley. In the past the cave was explored and described by biospeleologists from the Speleological Institute in Cluj: P. Chappuis, R. Jeannel and the Austrian beetle specialist A. Winkler, who also published its schematic drawing (Jeannel and Racovitza, 1929). Decades later, the cave was explored and mapped by Romanian speleologists from Speodava and Speo"Z" clubs. After their survey, the cave reached a length of 266 m (L. Vălenaş) or 247 m (P. Damm), and depth of 32 m. However, they didn't continue to work systematically here, even though they got entry into the underground system of the Crişului Negru spring (Vălenaş et al. 1977, Damm 1998). In 2017 we started enlarging the upper part of a very narrow meandering drain; few meters above the bottom of the cave (Psotka, 2020). After few trips it looked like a long work will be necessary there because it was still visible ahead but in a very narrow profile. The work here took us 12 actions and then we penetrated a 12 m high meandering passage, which after 30 meters finished in another narrow point. There was another shaft below us, so it was only a matter of time before we get there. During the next two actions, we passed the narrow and descended to another shorter meander which was ended again by another narrow after 30 m. We passed this place after a few hours of work and advanced 50 m forward. We stopped at the next narrow in the ceiling of the meander, but this was the last one before the discovery of a free continuation up to the underground stream. After this penetration, we discovered a continuation of more than 500 m of passages. Gradually we discovered the *Bear's Teeth* corridors or the *Pendulum Shaft*, behind which the *Gypsum meander* continued unobstructed to a huge corridor with an active water course. We named the corridor with the stream after the deceased caver from the Speodava club *Galeria Petru Brijan*. It is about 300 m long spacious corridor ended at both ends by siphons. Other possibilities were offered to us upon entering the *P. Brijan Gallery*, where we were looking for a continuation in the ascending branch with the air draught and flying bats. So far, however, unsuccessfully. During the years 2017–2021, 13

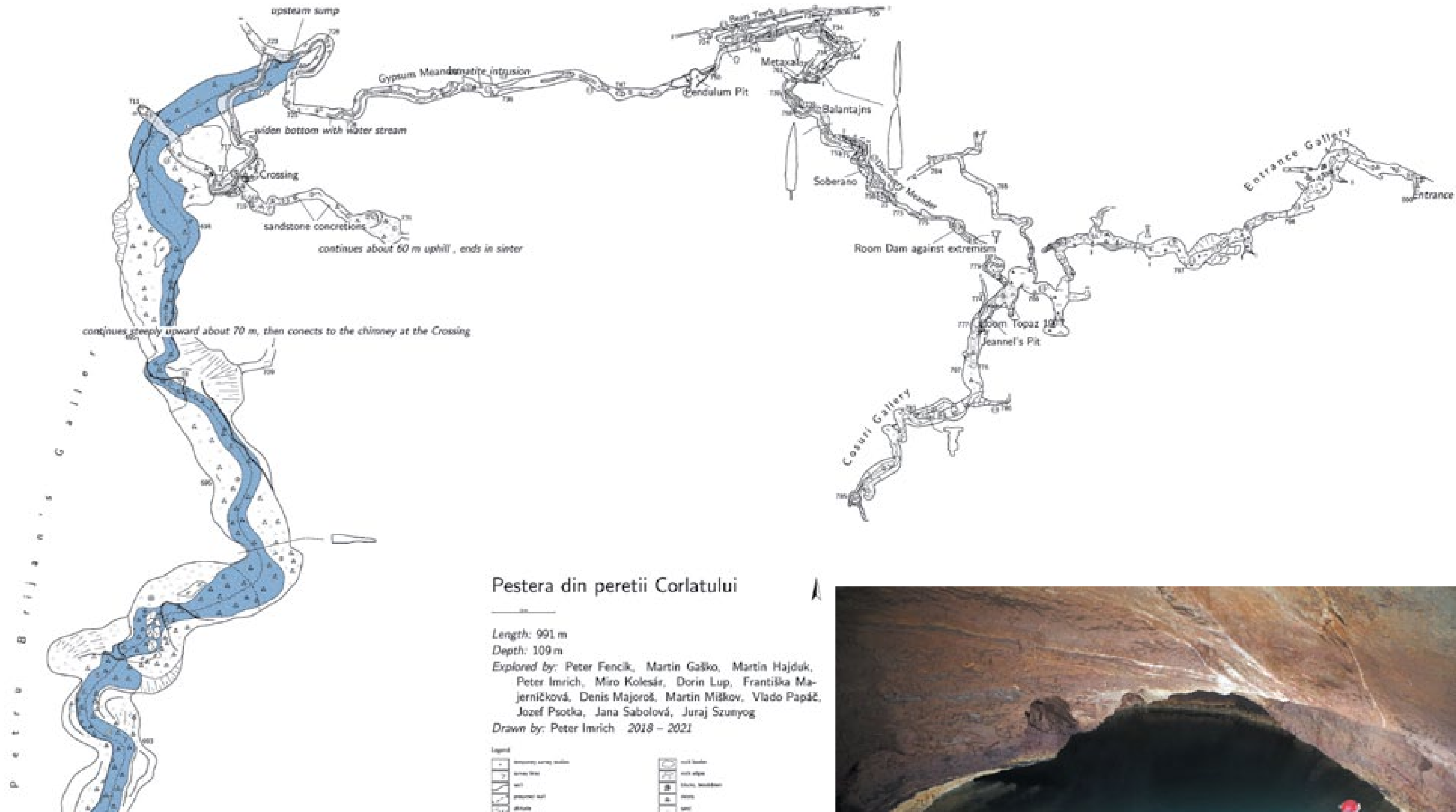


Fig. 3. Corlatului Cave, downstream sump. Photo: P. Kočiš

cavers carried out a total of 24 actions. The total surveyed length of the cave is 991 m with a vertical span of 109 m. Around 150 m of passages remain to be surveyed.

Cavers participating in the exploration of the Cave in the Corlatului walls during this period (in bracket number of actions): P. Fencik (6), M. Gaško (23), M. Hajduk (4), P. Imrich (20), P. Kočiš (1), M. Kolesár (2), Š. Kyšela (1), D. Lup (2), T. Majerníčková (18), D. Majoroš (6), M. Miškov (6), V. Papáč (17), J. Psotka (23), J. Szunyog (1),

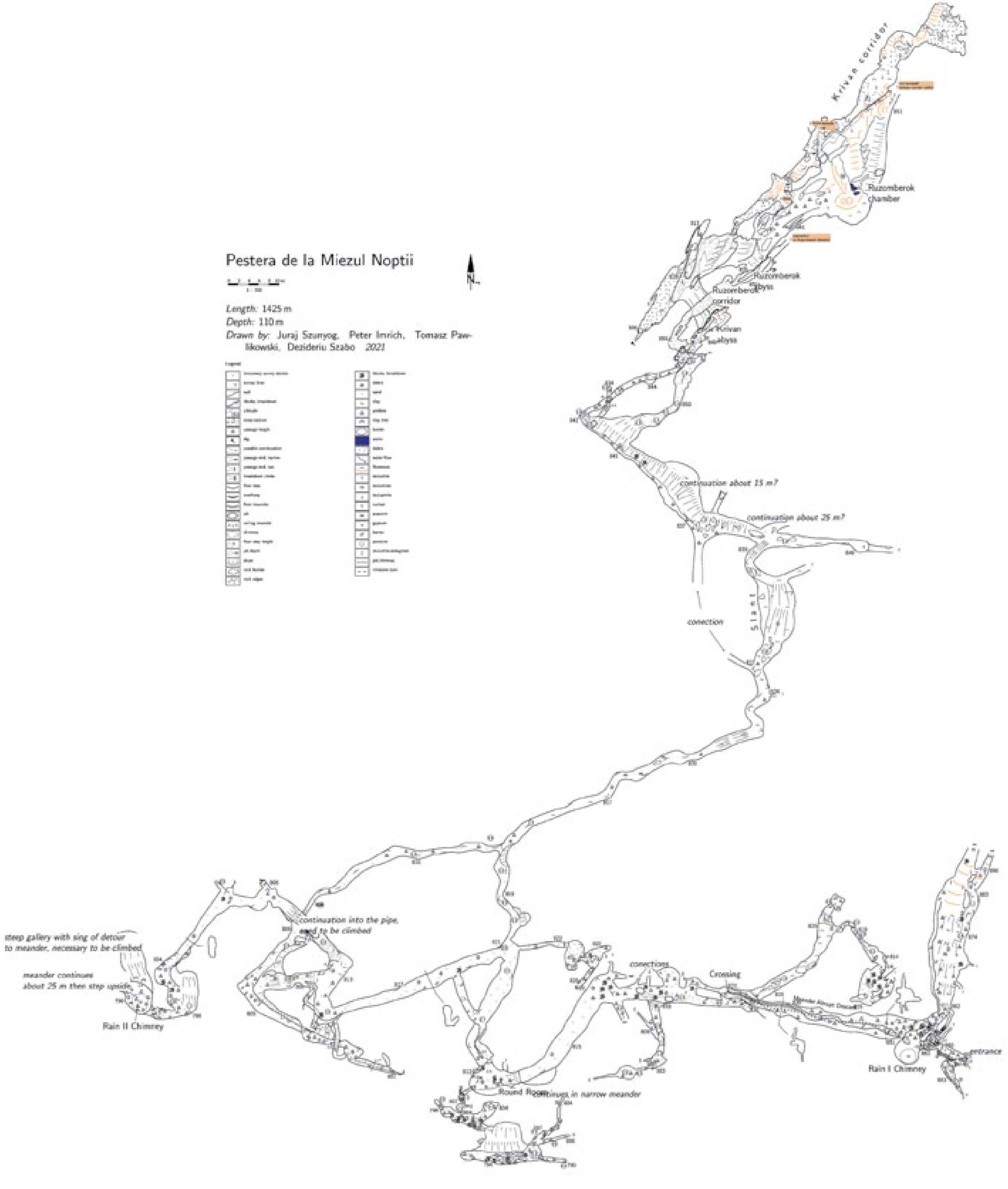
Peştera de la miezul noptii
(Midnight Cave)

Inconspicuous impassable entrance to this cave was discovered accidentally at night on 20 June 2021 by P. Imrich, on the way from the Corlatului Cave (Psotka and Papáč, 2021). After some work on enlarging the hole, we descended to the depth of 15 m and stopped at a short impassable narrow. After a short enlarging, we came out into a huge shaft with a vertical span of 45 m. It continued in the form of a significantly descending corridor *Strmina*, ended by a 5 m deep shaft. After overcoming it, we found the *Crossroads* at the depth of 80 m, from where we continued freely in 3 different directions. The first was the *Western branch*, where large corridors with gypsum speleothems open. By a more detailed exploration, we discovered a continuation into beautifully decorated parts of the *Krivánska*

Fig. 4. Midnight Cave, Meander Scarp. Photo: V. Papáč

Fig. 5. Midnight Cave, Western branch. Photo: T. Rus

Fig. 6. Midnight Cave, gypsum blisters. Photo: T. Rus



Passage and the *Ružomberský Hall*. The *Western branch* ended with a half-siphon and more than 20 m high chimney. The second, *Deep branch* continued from the *Crossroad* through a system of pits and horizontal sections up to a depth of −172 m, where it ends with *Siphon I*. In the middle of *Deep branch* another descending, not yet sufficiently explored corridor ends with *Siphon II*. The third *Southern branch* is a young outflow meander that is ended by a narrowing on which we plan to work. The cave was explored during 10 trips in 2021 by 22 cavers. The measured length reached 1641 m with a vertical span of 172 m. Some parts, of about 200–300 m have not yet been surveyed (Fig. model). Due to the close location of the caves and their similar speleogenesis, we assume their possible connection. The nearest passages are about 120 m apart, at an elevation difference of about 100 m.

Fig. 7. Midnight Cave, Deep branch. Photo: V. Papáč

Cavers participating in the exploration of the Midnight Cave during this period (in brackets the number of actions): I. Barabási (4), P. Fencik (2), M. Gaško (7), M. P. Imrich (7), M. Kolesár (3), M. Kudla (2), R. Kovács (5), Š. Kyšela (4), D. Lup (2), A. Manta (1), M. Miškov (2), V. Papáč (10), T. Pawlovski (4), A. Peterfi (1), J. Psotka (9), R. Rotaru (1), T. Rus (1), C. Rus-Herdea (1), J. Sabolová (2), P. Sliačan (2), D. Szabo (2), J. Szunyog (2).

Acknowledgment

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Fig. 8. Midnight Cave, Deep branch. Photo: V. Papáč

Fig. 9. Midnight Cave, Siphon I. Photo: V. Papáč

Fig. 11. Entrance to Ružomberok Hall. Photo: V. Papáč

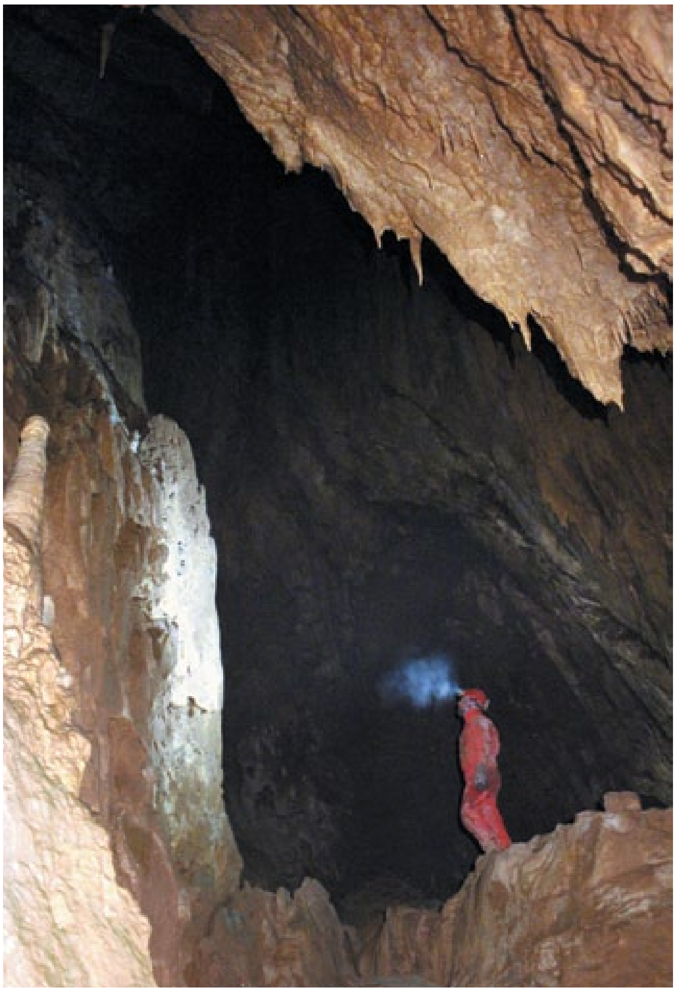

Fig. 10. Ružomberok Hall. Photo: V. Papáč

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SPELEOEXPLORATION IN SARDINIA: THE BUE MARINO – SU MOLENTE CAVES

Karol Kýška[1] – Daniel Hutňan[2] – Leo Fancello[3] – Roberto Loru[4]

[1] Spelodiver, [2] Speleoaquanaut, [3] Gruppo Ricerche Ambientali-Dorgali,
[4] Gruppo Speleologico Sassarese

Caves in the Gulf of Orosei

The **Gulf of Orosei** (central-eastern Sardinia) is an important coastal karst area of Italy. More than 37 km of coastline consist of Jurassic dolomites and limestones with a total thickness of up to 800 m, situated above Paleozoic granites and phyllites, interspersed with faults in the NNE-SSW direction. The valleys of Codula Fuili, Codula Ilune and Codula Sisine are developed on these fault structures. The karst of the Gulf of Orosei is a typical fluviokarst with the mentioned valleys active during high rainfall. The valleys extend deep into the shelf, which corresponds to the minimum level of the Mediterranean Sea during the maximum Glacial 22,000 years ago (Andreucci et al., 2012) There are about 400 known caves in the area. The total development of cave passages reaches almost 100 km. The genesis of caves is from the alpine type to

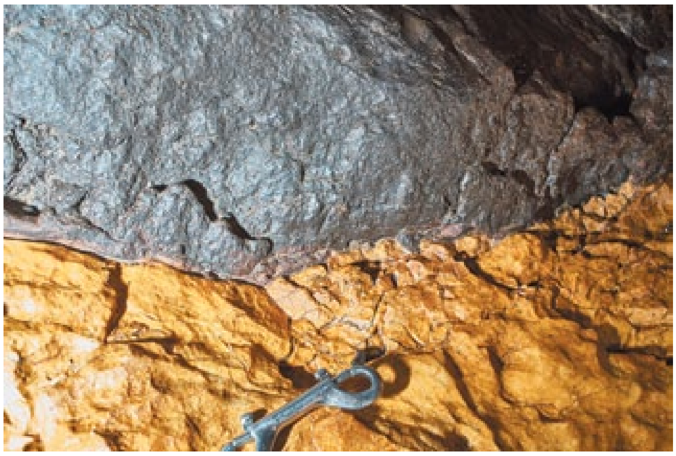
The **Bue Marino** and **Su Molente** caves are a part of more than 75 km long system, which includes Su Spiria and Su Palu. Speleologists and speleo-divers from the Czech Republic and Slovakia have been involved in the surveying of the first two caves for almost 30 years.

Bue Marino (sea ox – literal translation) got its name from a seal that lived in this cave until the mid-1970s. It is located on the shores of the **Gulf of Orosei**, about 4 km south of the town of Cala Gonone. The entrance has a morphology significantly shaped by the sea. It is divided into 3 branches, named South (**Ramo Sud**), Middle (**Ramo Mezzo**) and North (**Ramo Norte**).

Relic of lava flow (right wall). Photo: K. Kýška

the coastal caves. Interestingly, Jurassic limestones were flooded with Quaternary basaltic currents from local volcanic centers. These lava flows also penetrated underground and filled the already formed caves (Beccaluva et al., 1985). Relics of lava flows can be found in the whole Bue Marino system.

The **Bue Marino cave** itself or specifically the entrance has been known since ancient times. But the first historical maps, including a serious survey, date from 1954. A more detailed mapping of Ramo Sud and the arid part of Ramo Nord began in 1987. The caver groups Gruppo Ricerche Ambientali-Dorgali and Gruppo Speleologico Sassarese collaborated on the mapping until 2007. The result was a detailed map of Ramo Sud up to the Terminal Sump and the dry sections of Ramo Norte. Only divers could perform further surveys. Since 2001, we have been systematically mapping the spaces behind the sumps and in the sumps of all three branches of the cave. Previous measurements were mostly only indicative, be it the maps of Czech divers Benýšek, Bílek, Slezák, Hovorka or sketches of Jochen Hasenmayer, and we must not forget the pair of French Penez-Le Guen. In 1977 the mentioned Hasenmayer explored the 600 m long and 30 m deep Terminal Sump in Ramo Sud. For illustration his support team consisted only of his wife. We can still find fragments of stainless-steel wire, which he used instead of a guideline. In 1982, a pair of the mentioned French explored behind this long sump, and their sketches helped us a lot in the exploration in the new millennium.



Contact of limestone and lava flow. Photo: K. Kýška

Ramo Norte is an infinitely long part of the cave, which stretches next to the distinctive fault structure of Codula Fuilli. Its research requires very demanding logistical preparation, not to mention the process itself

in its most remote parts. Superhuman performance in endless actions is worth admiring. Names such as Slezák, Benýšek, Hutňan, Manhart, Honeš, Čermák, Chmel and many others will forever be written into the history of the discovery of Ramo Norte. To illustrate, one trip takes about 20 hours. Three days before, the support team begins to equip the way for the explorers. It is necessary to use a sufficient supply of air to the individual sumps on the way there and back. The public perceives success always associated only with the name of the discoverer, but caving is not about individuals, caving is about a teamwork. In recent years, we had been researching the last parts of Ramo Norte and the continuation is still ahead of us. Eyes must be kept everywhere during transports and mapping. Thus, the Neverending Chimney appeared behind the twentieth sump, which is 270 m high, reached by helium balloon. About in the middle of this height there is a large gallery, which they try to reach (Malík, Kýška) by climbing from the bottom. Now they are at height of 85 m. Between the nineteenth and twentieth sumps, we found an outflow of salty mineralized water, which is lost in a corridor in the sump, unfortunately filled with sediment. Behind the eighteen sumps we managed to climb (P. Malík, D. Hutňan) to the fossil floor with breathtaking decoration. In this way, meters of passages, either in the main direction or in the side branches, are gradually discovered and mapped. I must also mention P. Nakládal, who with his

◄ 700 m of sumps in the northern branch of cave. Photo: K. Kýška

Corridor behind the 19th sump. Photo: K. Kýška team dug in the dry part of the northern branch behind the twelfth sump, which allowed a more detailed survey of the dry parts between the flooded passages and simplified the transport of material during expeditions to distant parts of the cave.

Ramo Mezzo – it is a purely diving problem. It was a forgotten corridor from a part of Lago Esmeralde, through which the boys from Speleoaquanaut got inside in 2005. In 1972, the already mentioned Hassenmayer dived here and, according to a memory sketch, swam up to 1 km. Respectable performance for that time. We are overtaken by Tody (Thorsten Waelde) – a German living in Cala Gonone. He mapped the survey line to 1200 m. This is followed by a gradual penetration by Czech-Moravian-Slovak cavers, which culminated in 2011 when the couple Husák, Žilina reached 4 km. They reached the distance with an open circuit, the classic diving technique. The number of sumps is 40; it is possible to constantly dive here without having to carry the equipment through long dry parts, which greatly facilitates the survey. But don't underestimate the difficulty: the achieved depth was also 50 m, and it is not an easy dive, especially when you are constantly changing the depth of the dive. When using the open circuit, many stage bottles and underwater scooters were needed to allow a safe dive of the two divers. The trip there and back took them 5 and a half hours and they dived a total of 8 km. Our activities in this part of the cave continue.

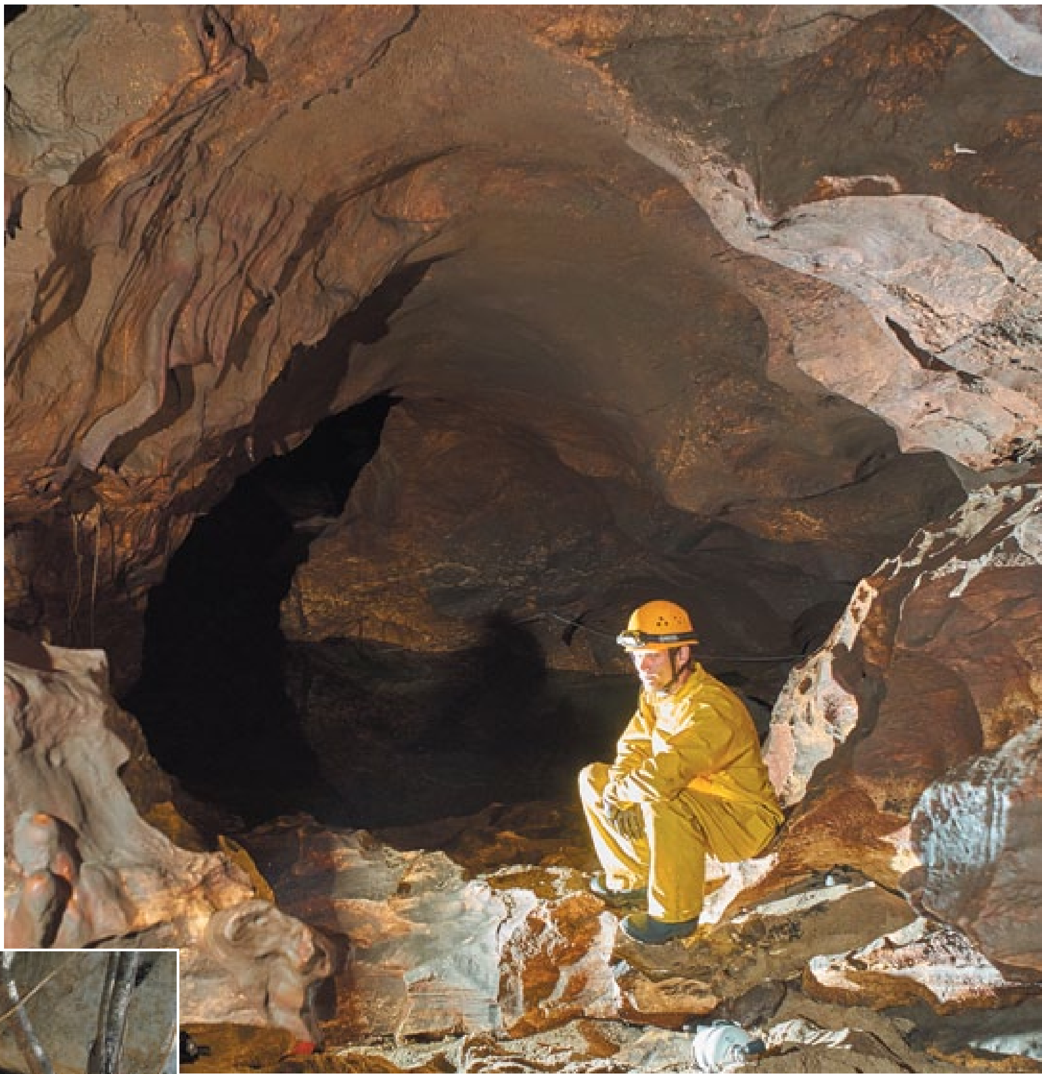
Giant chambers of southern branch of cave. Photo: K. Kýška

Ramo Sud – is an important branch of discovery. When Dano Hutňan first took me to Sardinia in 2011, I didn't know then that it would be for a long run. Before my first dive in the long Terminal Sump (Hassenmayer's sump) there were already many serious cave-divers there. Facts and history say that the first was Jochen Hasenmayer (1977), followed by the duo Penez – Le Guen (1982). These discoverers were followed by a Czech-Slovak group of cave-divers (1993) gradually exploring and mapping the spaces behind this long siphon. The southern branch is formed by a dry, partially accessible part of the cave, which passes through gigantic corridors with amazing decoration till the Hassenmayer siphon. After overcoming this obstacle, a very similar morphology of the cave awaits us as before the siphon, which, however, changes after 300 m and the corridors are much smaller. Behind the siphon, we discovered and mapped more than 1 km of corridors. In cooperation with the Sardinian cavers, we checked with a radio-beacon the place where a dry entrance to this part of the cave from the Codula di Ilune valley could be made. In part, this is working well, and the Sardinian cavers are starting to work on the Buko entrance. In 2012, Hutňan Jr. found a siphon in rear parts. Daniel Hutňan dived this sump and reached the other side of the valley Codula Ilune closer to the Su Molente cave. This was a serious breakthrough in the Ramo Sud survey. In 2013, the couple D. Hutňan and M. Manhart, with the support of the divers, connected the Bue Marino and Su Molente caves.

Su Molente – Roberto Loru and Leo Fancello – two of our very good Sardinian friends in 2009 got to the right side of the Codula Ilune valley, a short distance from where we checked the beacon area in the South Branch of Bue Marino, to the underground cave they called Su Molente. After crossing a pair of sumps, they found the main

Riverbed behind the Hasenmayer's Sump. Photo: K. Kýška

Sardinian cavers in front of Su Molente Cave. Photo: B. Kýšková corridor of the cave running from the northwest to the southeast, which copies the right side of the valley. It is clear to all of us, this is the way to connect the Bue Marino, Su Molente, Su Spira and Su Palu system – more than 74 km – it sounds very good. Roberto and Leo with the group of Sardinian cavers continually explore parts of Su Molente. In 2014, Roberto, who dived through three long sumps, in direction of Su Spiria asked us for help, in the rear parts the depth reaches over 40 m. It was a great honor for us, and we have immediately taken the survey. In autumn 2014 we were camping on Codula Iluna beach. The couple Hutňan, Manhart with the support of Kýška, Chmel went two times to explore the sump near Su Spiria. However, they have not found the connection. In 2015



The 1st sump of Su Molente Cave. Photo: K. Kýška

The probe Buko. Photo: B. Kýšková

we returned here again, but the exploration was complicated by weather. Previous rains have heavily muddied water in the cave and the current was very strong. Failure again. Before leaving, we compared the data with Leo Office and found out that it must be connected. In June 2016 we organized a short easy expedition of 7 cavers for the purpose of connecting. But the Sardinians were ahead of us, and a week before our arrival, they connected Su Spiria with Su Molente. The disappointment was huge, but we did not interrupt the action and we focused on the connection. Sardinians "won" – but

In corridors of Su Molente Cave. Photo: K. Kýška it is not a competition. We are happy for this success. In the Su Molente cave, however, the exploration continues. Our activities continue in close collaboration with Roberto Loru. In the last two years we have been exploring and mapping parts, which are directly ahead Cala Luna Cave.

We are a team. Without the great support of many great people, it would not be possible to explore in such a gigantic system Bue Marino – Su Molente. I would like to say them: Thank you.

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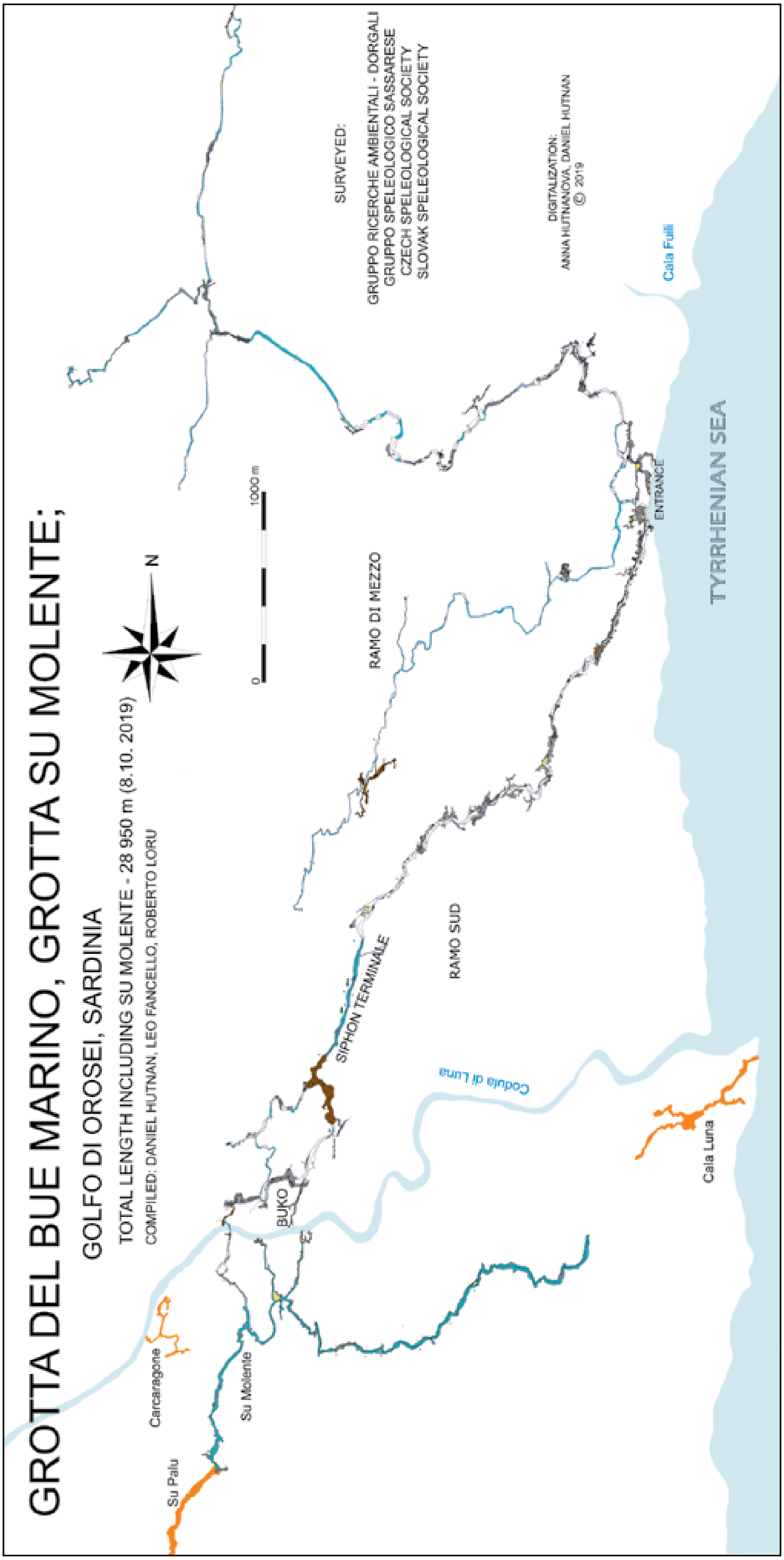
In memory of Daniel Hutňan, who left us in June 2020.



MEXICO – EXPLORATION OF FLOODED CAVES

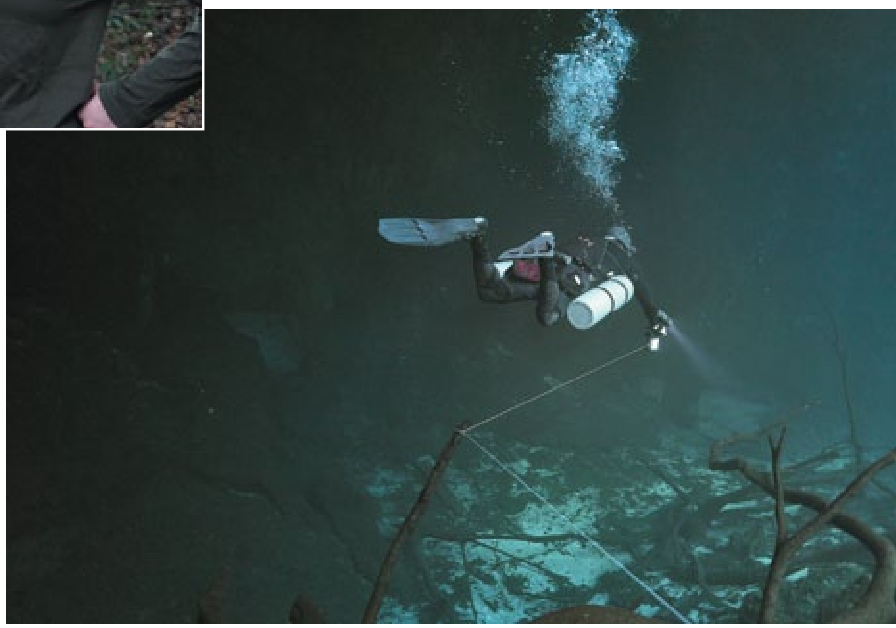
Karol Kýška
Speleodiver

The bottles need to be transported to the cave entrance. Photo: L. Kubičina

Daniel Hutňan explains how to map flooded caves. Photo: B. Kýšková

Each one of you knows about cenotes – caves flooded by water on the Yucatan peninsula in the heart of the Mayan jungle. The photos of crystal-clear water and kilometres of discovered caves. Somebody may say that it is an easy exploration. Well, although the statement isn't wrong, it isn't right either. In this article, I'll explain what we do underwater and briefly summarize the history of Czech and Slovak discoveries of the cave divers.

The peninsula is a part of a bigger whole of the Yucatan platform. The geological history of Yucatan is not entirely known, mostly because of the lack of information from boreholes and the inaccessible terrain in the central part of Yucatan. The upmost interest of the cave exploration is situated in the eastern part, where are the Cretaceous limestones of Carrillo Puerto formation with an average thickness of 1,300 m. The other sedimentary rocks were formed mostly by the transgression and regression of the Caribbean Sea, caused by the changes of glacial epoch. The changes in the height of sea levels are noticeable directly in the environment of the caves. The regression of sea caused a significant base drop of the lower level of water and the corrosion of limestones, amplified by rich vegetation and humid environment. In the period approximately 18,000 years ago the sea level began to rise and flood the existing caves with salt water. Salt water penetrates exponentially into the inland and it is found in deeper dives above 20–30 meters. In the area of interest, we recognise in a karst relief, interwoven with significant depressions (cenotes). Yucatan lays in subtropical area. The average



Training dive in cenote Carwash. Photo: K. Kýška

Descent into the Cenote Yoni using the old wooden ladder. Photo: B. Kýšková

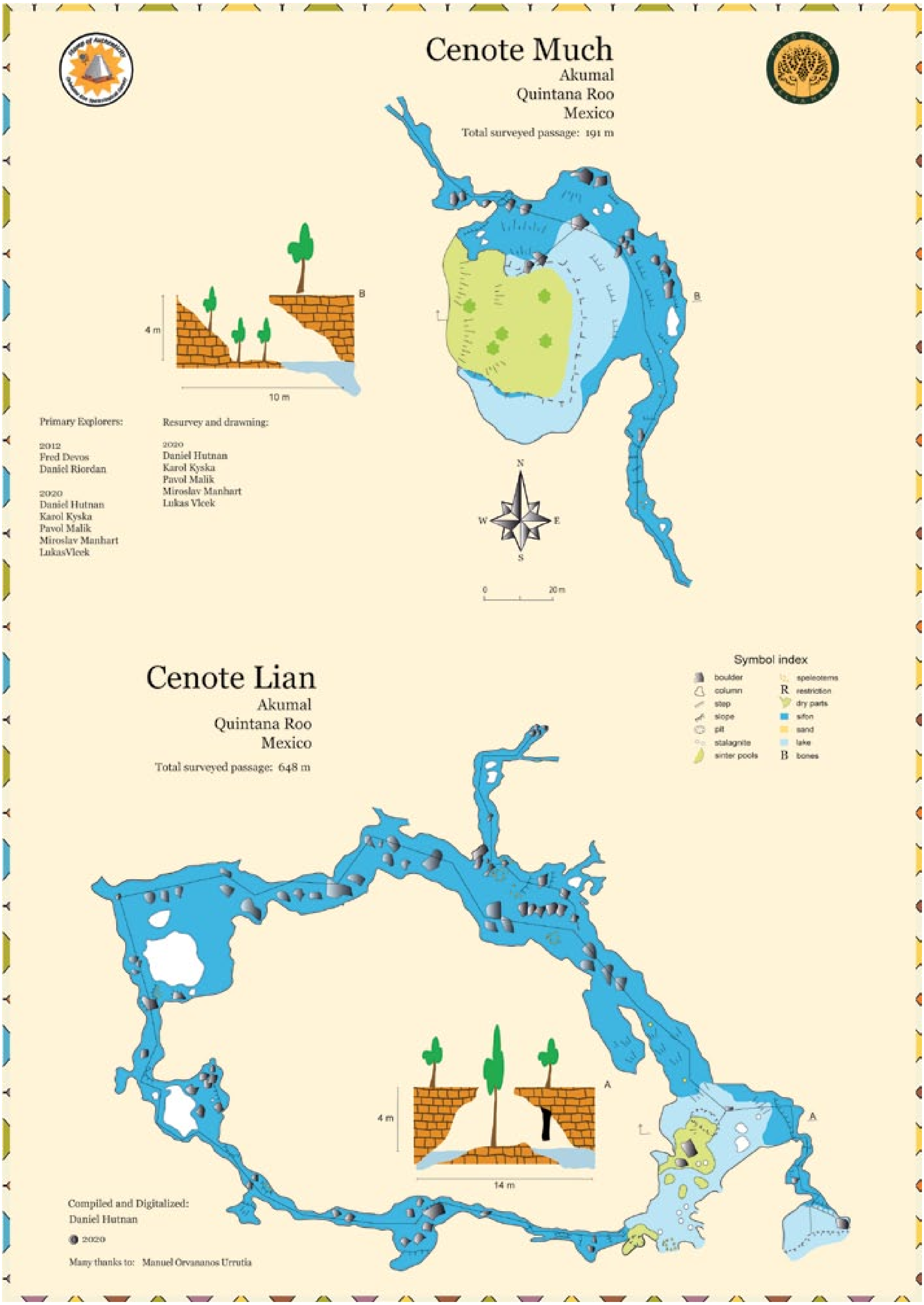
hand, I was pleasantly surprised that in the rest of the country (not the famous touristic resorts) there are very kind Mexican people.

Exploration of flooded caves begins on the surface. If you do not have a known cenote, you must find it. This is not easy at all at 35 °C and 100 % humidity. Chopping through the vegetation with a machete to the GPS coordinates, that you have found on Google and hoping that no snake in a bad mood is passing nearby. Not to mention insects, mosquitos, or forest wasps. With Palo Malík we had the luck to knock down a wasp nest that landed on our necks – to this day I am proud of the sprinting performance in a dense vegetation. Do not dare to enter the jungle without a compass or a GPS, in just mere moments you would be doomed to walk in circles and a way out would be just a prayer unanswered by God. The jungle is very dense, and the cenotes are hardly visible. Many times, you can be standing just a meter away from the entrance, and you wouldn't even know it. When you find a cenote, it's important to try it, I mean to look inside with a diving mask and a light if it is even possible. If it is, the next day you can drag your diving equipment to the entrance. Many times, cenotes are located more than 1 km away from the main path, where your car is parked. It may seem close by, but with 40 kg on your back in already mentioned conditions, it is a workout to be sure. When you finally get into your gear and hope you didn't forget anything in your car, you start the dive with your buddy. For somebody who has never been in Mexico, this is a marvellous experience, diving into horizontal beautiful hallways and flying between the formations. The time of a dive depends on various conditions including the depth, length, number of bottles. Reasonable time underwater is 4 hours. Even though water temperature is around 24 °C, after four hours in the 7 mm wet suit the diver is bound to get extremely cold. The more you explore, the colder

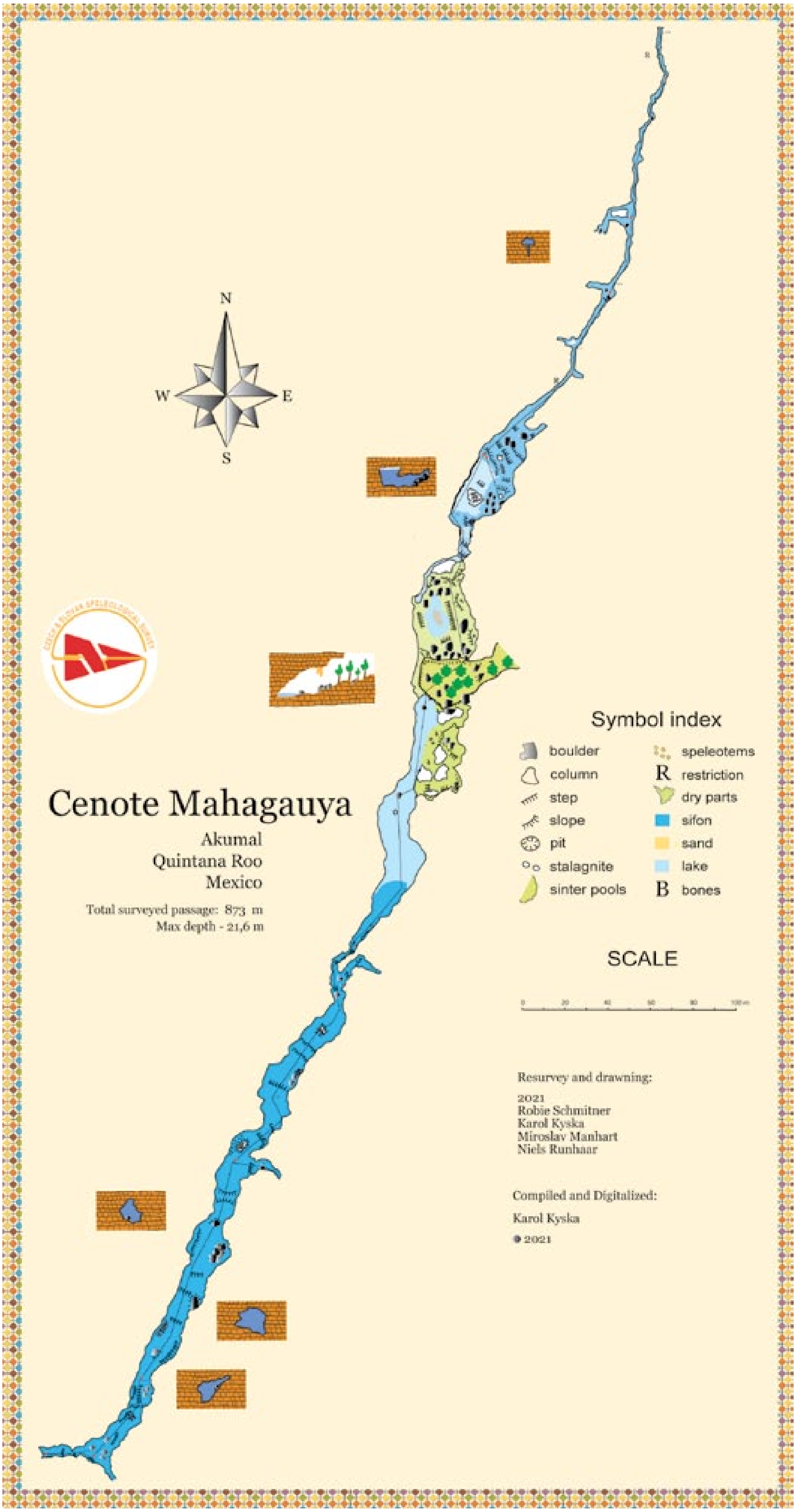
yearly temperature is 24 °C, a very humid environment is influenced by hurricanes.

The Czech and Slovak divers first ventured to explore Yucatan in 1980s. It was a group of Moravian cavers in 1982, during the CUBA 82 expedition. After nearly 20 years of nothing, in 2003 a group of four Czech and Slovak cavers arrived on Yucatan. They came to a small city named Tulum, situated on the eastern cost of the Caribbean Sea. Until this day nearly 1396 km of flooded caves and 291 km of dry caves have been discovered. Since 2003 each year expeditions are coming to this region.

We have completely solved the logistic problems from the beginning, like filling of diving bottles, where to sleep and how to transport. Some diving centres, which were established in the meantime, provide sufficient logistical resources for diving expeditions. Winter months are the best for the stay in the jungle, ideally from November to March. Most expeditions took place in January–February. We stay in local hotels or hostels. Sleeping in the jungle during the night is not a pleasant experience and moreover, after each dive we need to fill up the bottles, so logically in the evening we return to Tulum. We use rented cars for the transport to cenotes. After some not very good experiences it was clear that to buy such a vehicle is not recommended. I'm the owner of such a vehicle, and I don't even know where it ended up. To get the whole picture of the situation in this part of Mexico, it is important to understand that you are just an ordinary gringo, who can be robbed of the clothes on his body. On the other


Cenote Much
Akumal
Quintana Roo
Mexico
Total surveyed passage: 191 m
4 m
10 m
B
Primary Explorers:
2012
Fred Devos
Daniel Riordan
2020
Daniel Hutnan
Karol Kyska
Pavol Malik
Miroslav Manhart
LukasVlcek
Resurvey and drawning:
2020
Daniel Hutnan
Karol Kyska
Pavol Malik
Miroslav Manhart
Lukas Vlcek
N
W
E
S
0
20 m
Cenote Lian
Akumal
Quintana Roo
Mexico
Total surveyed passage: 648 m
Symbol index
boulder
column
step
slope
pit
stalagmite
sinter pools
speleotems
R restriction
dry parts
sifon
sand
lake
B bones
4 m
14 m
A
Compiled and Digitalized:
Daniel Hutnan
2020
Many thanks to: Manuel Orvananos Urrutia


Sistema Tatich
Akumal
Quintana Roo
Mexico
Total surveyed passage: 15 924 m
N
W
E
S
Sistema Tatich West
Total surveyed passage: 1 637 m
Cenote Tatich
Symbol index
Cenote Dos Ojos Tatich
Cenote Gatitos
Cenote Koos
Caverna Grande
Cenote Yoni
Cenote Christian 1
Cenote Veladoras
Cenote Tatich Antonio
Primary Explorers:
1999 - 2002
Christian Thomas
2010-2012
Fred Devos
Daniel Riordan
MCEP
Natalie Lynn Gibb
Vincent Ronquette-Cathala
Anders Knudsen
2019
Daniel Hutnan
Frantisek Srnec
Jiri Skuhrovec
Karol Kyska
Zdenek Motycka
Radek Jancar
Tomas Lehman
Jan Sirotek
2020
Daniel Hutnan
Karol Kyska
Miroslav Manhart
Pavol Malik
Lukas Vlcek
Radek Jancar
Jan Sirotek
Resurvey and drawning:
2019, 2020
Daniel Hutnan
Jan Sirotek
Tomas Lehmann
Karol Kyska
Zdenek Motycka
Radek Jancar
Frantisek Srnec
Jiri Skuhrovec
Barbora Kyskova
Many thanks to: Manuel Orvananos Urrutia
Compiled and Digitalized:
Daniel Hutnan & Karol Kyska
2021



you're. After several days you get deep into the cave, and you do not want to use underwater scooters and many bottles, so it's necessary to find another entrance, from which later dives will be done. If you're lucky it's possible to find one from the inside of the cave, if not you can repeat the surface exploration. All these areas where the caves are located belong to someone. That's why it is important to contact the landowner and establish a friendly relationship. Sometimes it happens that the owner catches you on his property. In that scenario, relationships are established quickly, and you are able to promise everything, you know the jungle is deep.

Mapping of each cave should go hand in hand with its exploration. Underwater mapping is much easier than in dry caves. The polygon is already marked by the line and we're floating, so everything is easier. One of us always measures the polygon and the other draws the map. The line serves to measure the length, direction is captured by a compass and the angle by a depth gauge. Mapping is always done when returning from the cave. If the cave continues, it's possible to explore and map 500–600 m in one dive. The processing of data and drawing of the map is discussed in the evening after the dive. The name of the cave must be authentic, we don't apply patriotism, so the names are

One of the ceiling windows of Cenote Tatich. Photo: B. Kýšková

in the Mayan language and are usually connected with the story of how the cave was found. Since 2003 we mapped over 149 km of caves.

The photo-documentation of the cave layout along with the mapping are a vital part of the documentation fund and an inseparable part of the cave research. Taking photos underground is a very specific and difficult task. It is even more difficult under water. The use of appropriate lighting drastically changes the quality of the photo. Underwater photographer in an environment completely devoid of light is at the mercy of illuminators, who are an inseparable part of photo excursions. Obtaining perfect photos not only depends on the level of the equipment you work with, but on a larger scale it's about the experience obtained in the field and the already mentioned team of illuminators. Mexican caves are photogenic, the best underwater cave photos came from this place. During our photo shooting, we experienced many situations that just put a smile on your face. The most complicated part is the communication underwater because you can't shout at your illuminators. You have to set up the rules before the dive.

The equipment that we use underwater has changed over the years. From the configuration of bottles on the back, we gradually changed to the side-mount configuration, which is especially suitable for overcoming narrow passages. The classic basic equipment of an explorer is made up of two S80 bottles secured on the side to a side-mount harness with a buoyancy compensator, two diving regulators, the main light, three backup lights, fins, helmet, main reel, backup reels, knife,

Mapping in practise. Photo: K. Kýška

direction arrows, mapping table and a wet note. For longer dives we gradually add more stage bottles to the two bottles. Direction arrows serve to mark pathways out of the cave and are installed on the marked line.

As I already mentioned, since 2003 we found and explored more than 100 km underwater caves. We worked in the K'oox Baal system about 10 km west of the village Che Muil, where we have discovered 65 km of pathways. To the system K'oox Baal we can add the cenotes Jolis, Cangrejo and Zebra – approximately 15 km of discoveries, they are in the same hydrological zone as K'oox Baal, and it is just a matter of time until they join. K'oox Baal with the length of 102 km (source: https://caves.org/project/qrss/qrlong.htm) is currently the third-longest underwater cave in the world. At the same time, it's the first longest mapped cave on Yucatan. Because we're not the only team that is working on this site, I can't say that the map is complete. The most intense research in this site took place before 2014. After 2014 we turned our attention to the exploration of caves west of the village Akumal – Sistema Sak Kay (13,3 km) – working title of Slovak cenotes. In this part of the jungle, we found together 18 km of "dry and wet caves" in total. Almost nobody, before us, worked in this location. But now it is no longer true. Forget about the rule of priority or some caving decency. When I publish a map, other explorers immediately run there. It's sad, but that's just my opinion that on Yucatan there is a "factory" for cave divers. Since 2019 we turned our attention to mapping the cave system Tatich. Between the years 1999 and 2002 French divers worked there and stretched several lines at different entrances. Later, in 2010 until 2012, Fred Devos and Natalie Lyn Gibb worked on this site. We had the opportunity to continue exploring, but we also promised that we would map the cenotes. After two years of detail work, the map is born with the total length of 15,924 m.

Exploration in corridors of Cenote Veladora. Photo: K. Kýška

The expeditions were attended by:

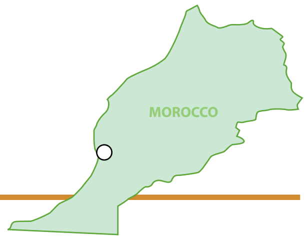
ČSS: Zdeněk Motyčka, Radoslav Husák, Jan Sirotek, Miroslav Dvořáček, Radek Jančar, Jan Žilina, Tomáš Mokrý, Vít Kaman, Libor Matuška, Roman Šebela, Jiří Huráb †, Martin Honeš †, Kamila Svobodová, Martin Hutňan, Miroslav Manhart, Petr Chmel, Radoslav Teichman, Šárka Štepánková, Rafal Krzewiski

SSS: Daniel Hutňan †, Michal Megela, Karol Kýška, Zdenko Hochmuth, Pavol Malík, Martin Vrábel, Barbora Kýšková, Erik Kapucian †, Zoltán Ágh, Tomáš Urban, Lukáš Kubičina, Martin Vacek, Michal Plankenbuchler, Ivan Poláček, Lukáš Vlček, Dušan Hablovič.

Thanks for the translation to Lenka Kýšková.

Cenote Yuum Kaax. Photo: K. Kýška

TWO SPELEOLOGICAL EXPEDITIONS TO THE HIGH ATLAS MTS. (NORTHERN AFRICA, MOROCCO)



Lukáš Vlček – Robert Pest – Jerzy Zygmunt – Krzystof Papuga – Mariusz Miedziński – Abderrahmane Wanaim – Abdelhamid Bahebaze

Slovak Speleological Society – Exploromania Poland – ASAN Agadir, Morocco

In 2017 and 2018, two international expeditions took place to the High Atlas region in the North African state of Morocco. Cavers from several Polish and Slovak clubs participated under the guidance of Moroccan cavers from the ASAN Agadir speleogroup. The aim of both expeditions was to explore the karst areas of the southwestern part of the High Atlas (north of the city of Agadir), to find and explore new caves, as well as to document caves known to the local inhabitants of the mountains – the Berbers (Amazighs). The vast limestone plains area between the Atlantic Ocean and the Sahara Desert is still very little explored.

Karst landscape in surroundings of the cave Tigmi n Dou Akal. Photo: R. Pest

Location and climate

Morocco is a coastal country in north-western Africa, whose west coast is washed by the Atlantic Ocean and the north coast is adjacent to the Mediterranean Sea. The northernmost point of Morocco is the Strait of Gibraltar, from where you can see the shores of Spain. Much of the country is mountainous. From the Atlantic coast, the country continuously passes into the Atlas Mts. and to the east there is a large desert area of the Sahara. The shape of Antiatlas, High Atlas and Central Atlas Mts. is elongated in a northeast-southwest direction. In High Atlas there is located the highest peak of the country and the whole Atlas area – Djebel Tubkal (4167 m a. s. l.). North of them lies the mountains of northwest-southeast orientation – the Rif. A fertile coastal plain lies below, in its adjacent area. In the southeast, the country runs into the vast Sahara Desert. The Atlantic coast is flat and rises inland to the table-like Moroccan meseta (about 800 m a. s. l.). The Atlas Mts. prevent the penetration of warm winds from the Sahara Desert, so most of the country has a subtropical climate. In addition, the cold coast of Morocco is drawn by the cold Canary Islands Stream, which humidifies the arid sub-Saharan climate throughout the year.

Transport of cave gear to the most distant sites. Photo: K. Papuga

Geology

Geologically, the country is divided into four areas, from south to north: Antiatlas, Meseta, Atlas and Rif. These areas represent a part of Mauritanides, the Trans-Saharan zone and, in the north, the Tethys region. In addition, there are basins filled with Mesozoic sediments along the Atlantic coast. Due to the significant uplift of the territory of Morocco, pre-Mesozoic rocks also abound. The oldest crystalline rocks, fold-shaped during the Pan-African orogeny, occur mainly in the Antiatlas region

Entrance schaft to the deepest cave of Tinftah plateau.
Photo: L. Vlček

(= Trans-Saharan zone; West-African kraton). Precambrian rocks were re-folded during the Mauritanian folding (equivalent to the Hercynian orogeny). Sandstones, shales, and limestones with abundant fossils, especially trilobites and graptolites, sedimented in the Cambrian and Carboniferous, when ended the tectogenesis of the Moroccan meseta platform, which is covered with large thicknesses of Mesozoic and Tertiary sediments. The elevated and detailed folded zone of the High Atlas is directly affected by the expansion of the Atlantic Ocean and the emergence of sedimentary basins of Argana, Essaouira and Doukkala. Carbonate rocks, suitable for the formation of caves, can be found mainly on the periphery zones – in the cover sequences of Atlas Mts. The northernmost zone Rif is part of the Mediterranean branch of the Alpine-Himalayan zone and is closely connected with the Spanish Baetic Cordillera. The Rif is built of carbonate sediments from the Triassic to the Paleogene, which predetermines it to become a "land of caves".

Karst and caves

Africa is generally very poor in limestone massifs. However, the karst is best represented in the area of Maghreb, between Tunisia and Morocco, and Morocco can be considered the most important country in Africa from a speleological point of view. Algeria had the longest cave on the continent for the log time – Rhar Bou Maza (Tafna; 18.6 km); only recently overtaken in length by the Moroccan cave Wintimdouine (reported to be more than 19 to 20 km); and the third longest African cave is the Ethiopian Sof Omar Holluca with a length of 15.1 km. Morocco had the deepest cave in Africa – Kef Toghobeit (−722 m); today the deepest caves are located in Algeria – Anou Ifflis (−1170 m) and Anou Boussouil (−805 m), which was also visited by Slovak cavers in the 1980s (Mitter, 1982). Both countries still have great speleological potential; while Tunisia has only a few karst massifs, in Libya, despite the vast area of limestone, the karst landscape is little occurred, and, finally, Egypt is extremely poor in caves.

Karst rocks cover about 100,000 km^2 in Morocco and, so far, we know a little more than 1,000 caves. However, cracks and small rock holes are not considered to be caves, as is the case in Slovakia. The richest districts in caves are the alpine Rif (Kef Toghobeit Cave), the one best explored for its proximity to Europe; the mountains of Atlas and the Antiatlas. In the Antiatlas Mts., the thickness of the Paleozoic limestones reaches more than 300 m, but despite the beautifully developed surface karst on an area of about 18,000 km^2, the caves are very rare. In the Atlas Mts. There is different story – 30,000 km^2 of mountain karst with an annual total rainfall of up to 1000 mm and Jurassic limestone thicknesses exceeding 500 m represent for cavers a fairytale-terrain. There are abundant karren fields, caves, ponors, springs, blind valleys, poljes and paleokarstic features. The thickness of Jurassic carbonates of up to 5 km (!) is evident in the Argana sedimentation basin. The caves are also rich in 20,000 km^2 large terrain in the east of the Atlas, built of Middle- and Upper Jurassic limestones, which are, however, less homogeneous. The dating of cave sediments revealed the

Abderrahmane Wanaim descending to the Igui Ogare Cave, Imouzzer Ida Ou Tanane plateau. Photo: K. Papuga

Entrance part of Tigmi n Dou Akal Cave. Photo. K. Papuga

research were presented mainly in the journals Spelunca, Spéleo, Karstologia, Écho des Vulcains, Bulletin I.F.R.I. and in others, hardly available materials in our country. However, scientific reports have also been published in the International Journal of Speleology, Acta Carsologica and other prestigious journals, which are now available on the web. The "Cave Cadastre" from 1981 (Camus & Lamouroux, 1981) is a fundamental work leading to the understanding of the karst and caves of Morocco. Several caving clubs with around a hundred members are currently exploring caves in this country. Today, in Morocco,

age of flowstones from 3,200 to more than 400,000 yrs BP. Almost all of Morocco's springs are associated with thick deposits of travertine rocks.

Cave expeditions

Cave expeditions to Morocco have been organized since the 1930s, mainly by French cavers. Later, Spanish, and German expeditions joined, and Lebanese and Poles also played a role in the caves survey. The results of the

there lies the longest cave of Africa, Wintimdouine (20 km), which has been intensively explored since the 1950s. Exploration and research of the cave has attracted dozens of serious cavers from around the world. Research tasks were performed not only from university projects, but also within the UNESCO program. Occurrence of more than 200 species of cave fauna we mention just for example. We moved in vicinity of this great cave as part of the Spéleo Maroc 2017 and 2018 expeditions as well.

Tigmi n Dou Akal Cave – main corridor. Photo: K. Papuga

Side passage of Tigmi n Dou Akal Cave. Photo: K. Papuga

Canyon on the Amsdnass plateau

In the previous period, Polish cavers visited the famous Wintimduine Cave under the Tasroukht plateau (2006). As part of the Spéleo Maroc 2017 and 2018 expeditions, we explored the abysses on the Telms plateau and the canyon on the Amsdnass plateau, north of the town of Tiguert. We were taking an excursion to an interesting archeological site, which the researchers found only recently. For short periods of time, we only documented cave openings, at a height of 20 m above the valley surface, from below. The age and the true significance of rock dwellings can thus only be debated. However, they can be hundreds, thousands, or tens of thousands of years old. Most likely, they come from the Neolithic, when the level of the canyon bottom was significantly higher, the landscape was green, full of moisture, flora and fauna; a permanent river flowed through the valley and not just seasonally from torrential rains.

Changes in North Africa in recent millennia

The world is full of paradoxes. Nowhere in the world can one see as much evidence of a humid climate as in the Sahara Desert. Dry riverbeds and ruins of former rich cities covered by sand... How has North Africa changed over the last millennium? A brief cross-section of the transformations of the Sahara and sub-Saharan regions brings e.g. V. Cílek (2009) or famous Egyptologist M. Bárta in his books on the collapse of civilizations (e.g. Bárta & Kovář, 2011). The Sahara is characterized by the operation of a climate mechanism called the Saharan Pump. Every few thousand to tens of thousands of years, the area turns into a green savannah with large lakes, which dries up relatively quickly, displacing flora and fauna, as well as its inhabitants, to the coast and to the Nile Valley. The mechanism worked most characteristically between 6,000 to 11,000 yrs BP, when precipitation was two- to several times higher than today. The lakes of that time in East Africa filled to a level more than 100 m above today's level and gradually began to flow over. Thus, was created the modern Nile, which is the youngest great river in the world; in the shape of a 2000 km long river with a catchment area of 2.9 mil. sq. km we have known it for only 11,000 years. According to climatologist J. E. Kutzbach, the humidity was caused by an increased amount of energy falling on a unit of area – he found that when the amount of energy is just 10% higher, precipitation increases by one third! However, the Green Sahara began to dry up very soon. The first stage of drying started by climatic event 8200 yrs BP, when the entire northern hemisphere began to cool. In the drying Sahara, animals and humans migrated to water sources, where the first domestication of animals took place on the shores of large lakes. The climate collapse 6,000 years ago caused, that several thousand of Nomads migrated from the drying Sahara to the fertile Nile Valley, where they formed the first Egyptian pharaonic dynasties, after a demographic explosion. We are still not talking about the desert – the Sahara became this shape in the dynastic period – between the end of the 21st century and the 18th century BC. Gradual drying of the area and water fluctuations of the rivers (especially the Nile) led to a number of large trans-Saharan migrations, ending with the so-called Coptic drought in the 5th century, which also caused the end of Roman Empire in Africa...

Bouligua Cave

Local adventurers from Imouzzer showed us the entrance to a spring cave in the nearby Dued Bouligua valley near the village of Tiqi. In the almond grove under the rock wall in the depression of 10 × 5 m, at a depth of about five meters, a narrow cave corridor full of sticky clay sinks. The locals say that it is an occasional spring that pours water during the heaviest rainfalls. After 300 m, the cave ends with a sump; on the wall you can see the inscriptions of domestic explorers. We registered the cave as Ifri Bouligua.

Zachodni Atlas Wysoki

Plateau Imouzzer Ida Ou Tanane

Tigmi n Dou Akal

Jaskinia „Dom pod ziemią"

ⵜⵉⴳⵎⵉ ⵏ ⴷⴷⵓ ⴰⴽⴰⵍ

Współrzędne (otwór S):
30°45'34,14" N; 9°25'6,84" W

Wys. otworów: 1258 (S) i 1235 (N) m n.p.m.

Ekspozycja otworów: do góry

Długość: ok. 700 m

Deniwelacja: 110,5 (+1,5; -109) m

Plan (IV 2019): Jerzy Zygmunt

Pomiary (XI 2018): Zbigniew Wiśniewski, Damian Sprycha

System pomiarowy: Cave Sniper (PL)

Topo: UIS (zmodyfikowany)

Otwór jaskini

Próg z podaną wysokością S (?)

Studnia z pod. głębokością P (?)

Obniżony strop

Pochyła ścianka

Poziomice, kierunek nachylenia dna

Strumień, ponor

Stalagmity, stalagnaty

Stalaktyty

Polewa naciekowa

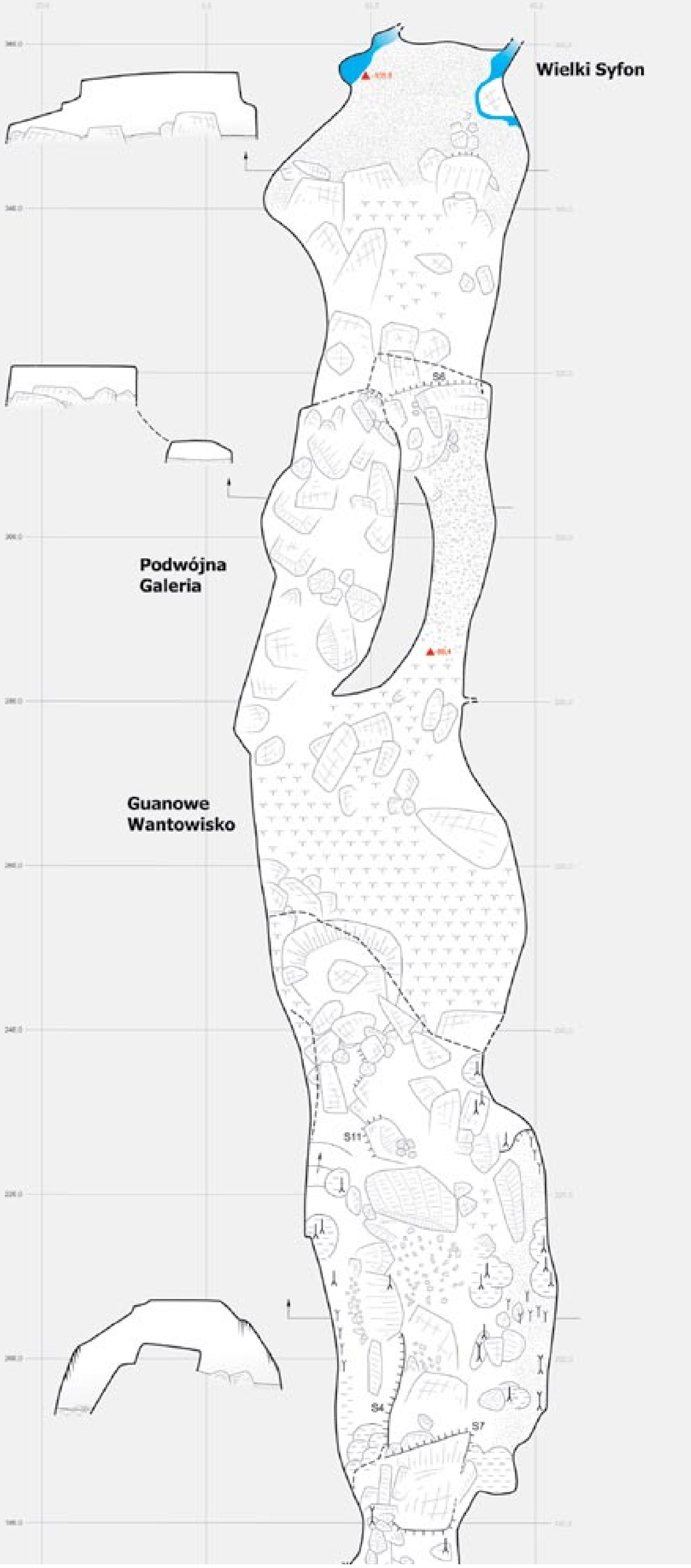
Osady klastyczne

Guano

Punkt wysokościowy

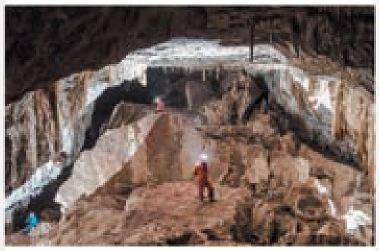
Wanty, gruz

Drzewo



Otwór południowy, tzw. Brama pod Drzewem Oliwnym,
fot. Jerzy Zygmunt

Pod otworem południowym, fot. Krzysztof Papuga

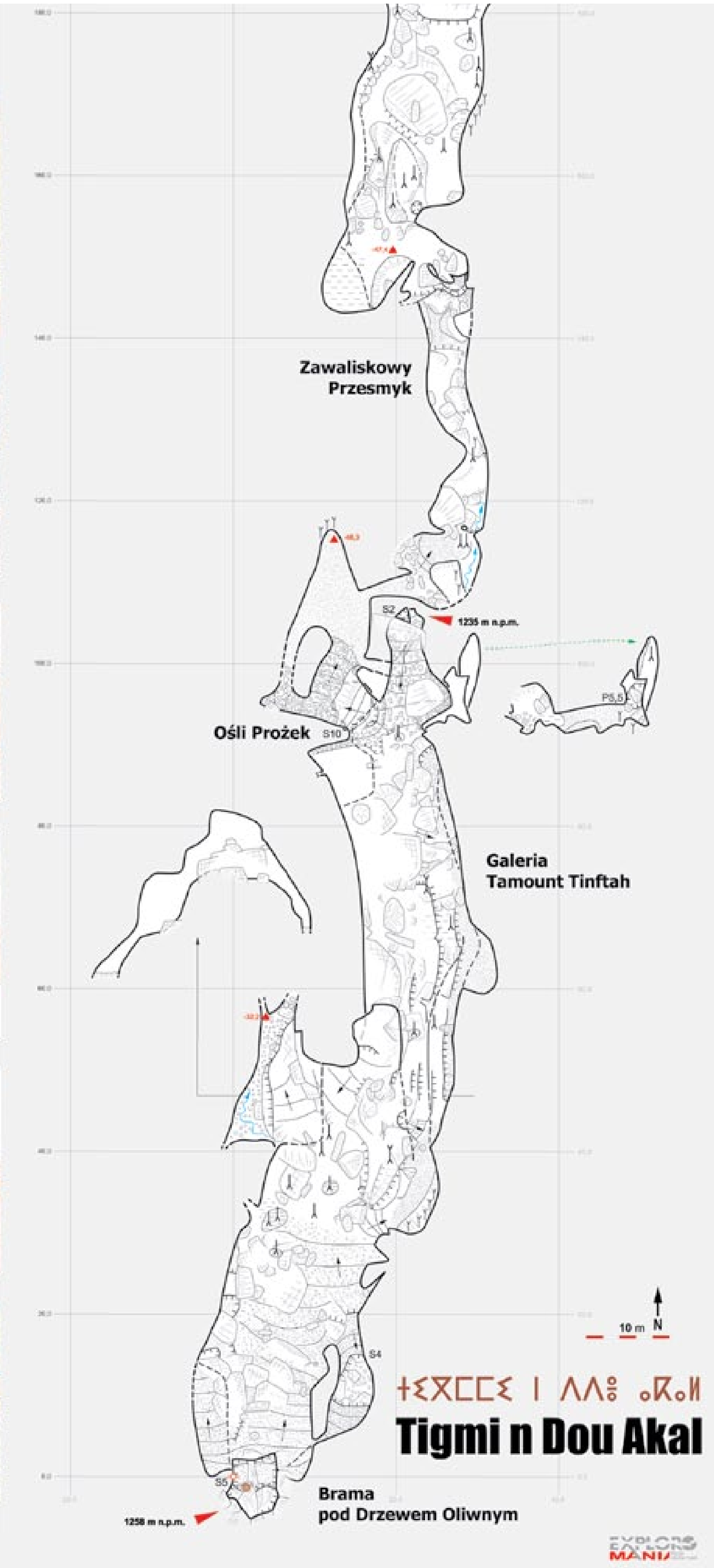


W Galerii Tamount Tinftah, fot. Krzysztof Papuga

Pokryte naciekami ściany Guanowego Wantowiska,
fot. Krzysztof Papuga

Wielki Syfon (część lewa) w sali końcowej,
fot. Krzysztof Papuga

Ekipa polskich i marokańskich grotołazów wraz z mieszkańcami wioski Tinftah, fot. Krzysztof Papuga



Plateau du Tinftah

At the settlement of Douar Tinftah, the vegetation is sparse, and the surface is mostly covered with rocky outcrops and rubble. At first sight, we can identify the area of karst and the boundaries between the more massive limestones and the slightly crumbling variegated shales. When exploring the rock walls (*falaises*), we get to the labyrinths of stone towers, between which grow inaccessible prickly vegetation. It is a little more difficult for us to know that the limestones are rich in quartz and sandy, and what's more, the sedimentary sequences are interspersed with layers of pink quartz sandstones, so in some places we feel like explorers of the Venezuelan table mountains. Pseudokarst is developed excellently. But the caves we are looking for? We will rely on local people again. They promised that they will take us to the largest cave in the area. Maybe it would be suitable for opening for public in the future. Organized cavers did not know it, so far only the locals have visited its underground.

Underground dwelling

And really! The cave is really huge! Exploration took us all day. The corridors are large, tens of meters long polygons could be realized during the survey. Rich dripstones along the sides of the corridors remind us Slovak Demänová Caves, except that all formations are alabaster white – and completely dry. The name of the cave is in the language of Amazigh **Tigmi n Dou Akal – Underground dwelling** – because, if necessary, it would be suitable as a refuge for hundreds of people. The corridor descends and continues to increase in cross-section as well as in depth. At the cave bottom we were stopped by a meandering silent stream of water, ending in a muddy sump. The cave is truly huge, even one of the largest caves in South Atlas. The cave was surveyed during the second expedition in the length of over 700 m with a vertical span of 110.5 m. In the rock walls, about 50 m from the entrance to the Underground Dwelling, there are several other entrances of parallel caves several tens of meters long.

Abysses in the region of argan trees

In the marginal zone of the plateau of Tinftah, we explored several abysses in argan groves. The argan tree (*Argania spinosa*) is a very special and extremely rare tree that grows naturally only on the western tip of the Atlas, just around Agadir. And even though people have tried to plant it elsewhere on the planet, it grows only rarely, and interestingly, it does not give fruits at all. Thanks to this mysterious phenomenon, Morocco today boasts the traditional production and export of the highly sought-after argan oil, which is so expensive in the world, that it is used almost exclusively for cosmetic purposes. Here, in the "land of argan trees", we all prefer to consume it – it is delicious!

The abysses on the Tinftah plateau have been created following tectonic lines and reach a depth of up to 32 m. In some cases, they drain the terrain depressions, which visibly concentrate the runoff of surface water from rainfalls. In the area there is a rocky maze, made of a detailed corroded plateau surface, karren fields, with several significant corrosive holes and few massive but shallow light hole abysses.

Southern Morocco, Antiatlas and the Central High Atlas

South of the mouth of the Oued Souss River and the Souss-Massa National Park, famous for its tropical birds and livestock, behind the town of Tiznit (= jewel) lies the town of Mirleft. On the recommendation of local cavers, we went on a speleological-geological excursion to its surroundings. The helpful companion made us friend of caves Hafid Akhchan, whom we thank for their hospitality and care.

We visited the cliffs of Legzira, where reality exceeded our expectations! Originally three bridges were created here in carbonate breccia by sea abrasion. In September 2006, one of them collapsed into the sea, leaving behind only an impressive hill of rocks. The fate of others will be the same, but no one knows whether they will last for years or centuries. We also visit the karst areas of the Anti-Atlas Mts. near the town of Tafraoute, close to the Sahara Desert. The country has changed rapidly and the mountains, which we thought would be something like our Low Tatras, someplaces resemble the rugged Italian Dolomites. We visited the Central High Atlas Mts. only very quickly (*Tizi n 'Test* pass), but we were impressed.

Summary

Two international speleological expeditions to the southwestern part of the High Atlas Mts. in Morocco were organized in 2017 and 2018. Both were focused on karst areas in the southwestern part of the mountains, north of the city of Agadir. In addition to Moroccan cavers, speleologists from Poland and Slovakia participated in exploration and survey. The expeditions brought the discovery of more than 30 new caves and abysses, and the caves already known to the local population were also examined and documented. The longest explored cave is **Tigmi n Dou Akal** with a length of more than 700 m and a depth of more than 100 m, which is one of the longest caves in Morocco and it has

the potential for opening for public in the future. Smaller caves and abysses were explored on the plateaus of Telms, Imouzzer, Amsdnass and Tinftah. During the expeditions, were established the effective contacts with members of the ASAN Agadir caving club, and further successful cooperation is expected in the future.

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The terminal sump of Tigmi n Dou Akal Cave. Photo: K. Papuga

SPELEOFOTOGRAFIA: INTERNATIONAL CONTEST WITH THE THEME OF CAVES AND SPELEOLOGY

Pavol Kočiš – Lukáš Vlček – Mária Ošková – Michal Danko
Slovak Speleological Society – Slovak Museum of Nature Protection and Speleology

Although the first cave photography was made already in the 19th century, taking pictures underground is still anything but piece of cake. Complex planning and preparation are just the beginning.

In addition to a special equipment taking pictures underground requires a considerable amount of courage, caving experiences, skills in lighting, but especially well-coordinated team of cavers.

Speleophotography means a teamwork. The photographer usually needs the assistance in transportation, arranging the scene and lighting.

Sometimes the cavers usually wait underground in the dark few minutes, sometimes even a few hours for the moment of pressing the shutter release button. Flash! Well, this one is extraordinary!

In 1982 the idea of Speleofotografia Contest was born in Slovakia – a contest meant to represent pictures which showed different caving activities. For the first two years that event was held only among Czecho-Slovak cave photographers, and in 1984 it started to be international.

Most of the Speleofotografia participants belong among the world elite in caving. Their masterpieces are increasingly moving towards capturing the dynamics of speleological activities.

Speleomoment

All sorts of difficulties of discovery and exploration of caves show us, that caving belongs among the most demanding, but also challenging and stimulating human activities.

The photographers have taken pictures of discoveries, which represent the fruits of their voluntary, often dangerous and exhausting labour.

Pictures also show ways to caves, mysterious creatures living in such unusual environment, breath-taking magnificence of underground kingdom where the human-being disappears in comparison with the size of the world of stone, flowstone formations and cave rivers.

Underground activities of cavers sometimes balance on the edge of human possibilities.

Beauty of caves

Theme of static cave decorations – clusters of crystals, cave pearls, dripstone formations, shiny castles of ice... What surprises are still waiting in caves?

Another miracle has been created. Nature means Art. Caves are keys to perfect feeling of it.

This year is the 21st anniversary of Speleofotografia. You can also participate in the contest, by sending your photos to speleof@gmail.com. You can find the contest conditions as well as the gallery of the pictures on the website https://speleofotografia.sss.sk.

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