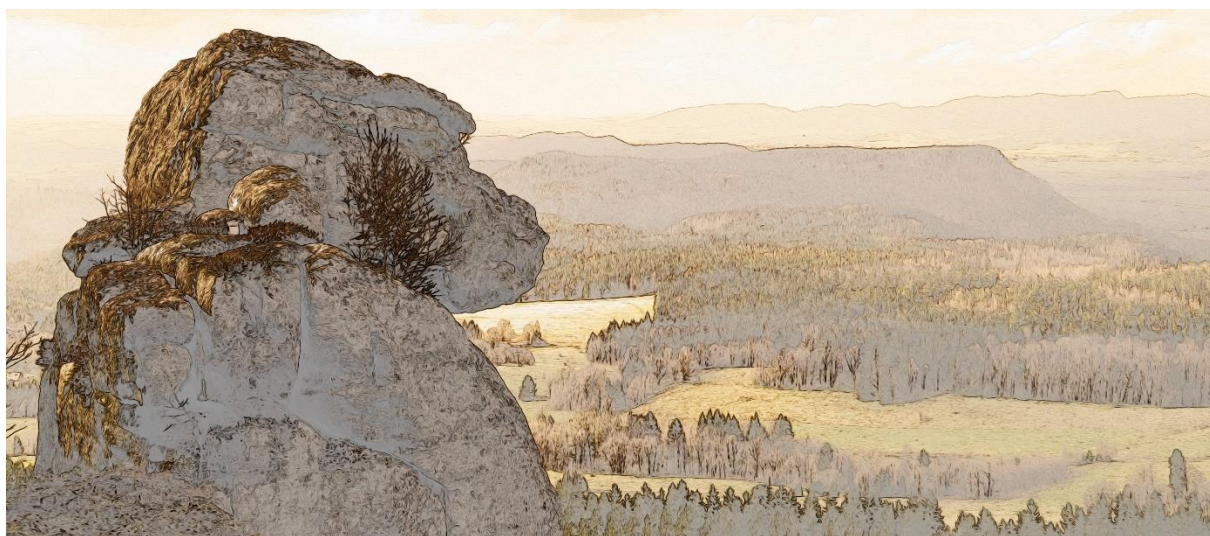




Union Internationale
de Spéléologie

14th International Symposium on Pseudokarst

GUIDEBOOK



FIELD SESSIONS May 25th & May 26th

Crags and caves of the Stołowe Mountains sandstone tableland

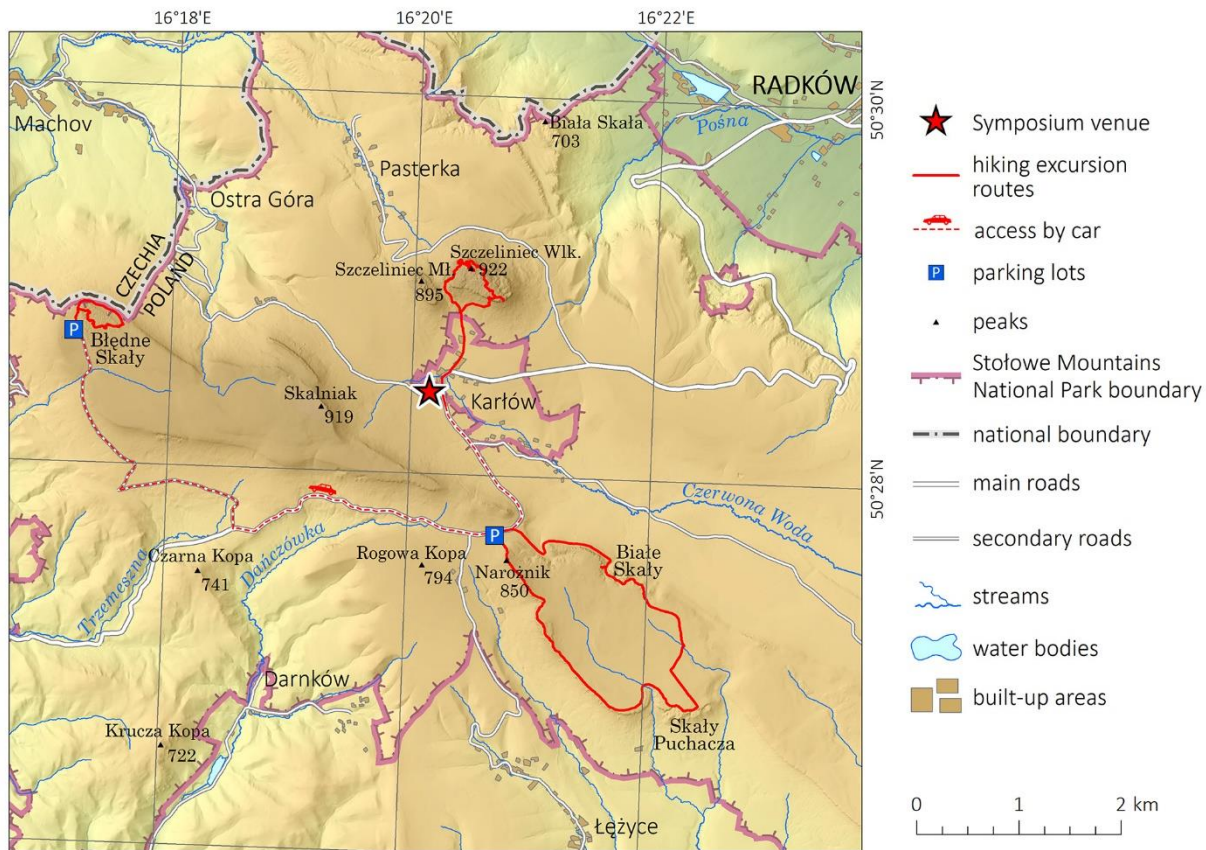


Figure 1. An overview of excursion routes in the Stołowe Mts.



Photo 1. Twin mesa of Szczeliniec Mały (to the left) and Szczeliniec Wielki (to the right) (photo K. Jancewicz).

Part 1: Mt Szczeliniec Wielki May 25th, Thursday afternoon

Filip Duszyński, Wioleta Porębna, Kacper Jancewicz,
Institute of Geography and Regional Development, University of Wrocław, pl. Uniwersytecki 1, 50-137 Wrocław, Poland; e-mail addresses: filip.duszynski@uwr.edu.pl, wioleta.porebna@uwr.edu.pl, kacper.jancewicz@uwr.edu.pl

Excursion route

The village of Karlów – Franz Pabel Tourist Route entrance – Pass between Szczeliniec Mały and Szczeliniec Wielki – North Terraces and the ‘Na Szczelińcu’ mountain hut – Fotel Pradziada sandstone pillar – Piekielko open cleft – South-Eastern Terraces – Franz Pabel Tourist Route exit – The village of Karlów

- Total walking distance: ca. 4 km.
- Gear needed: comfortable shoes with non-slip soles
- Duration: ca. 4 h
- Character of passage: tourist trail; numerous stairs, slippery in rainy weather

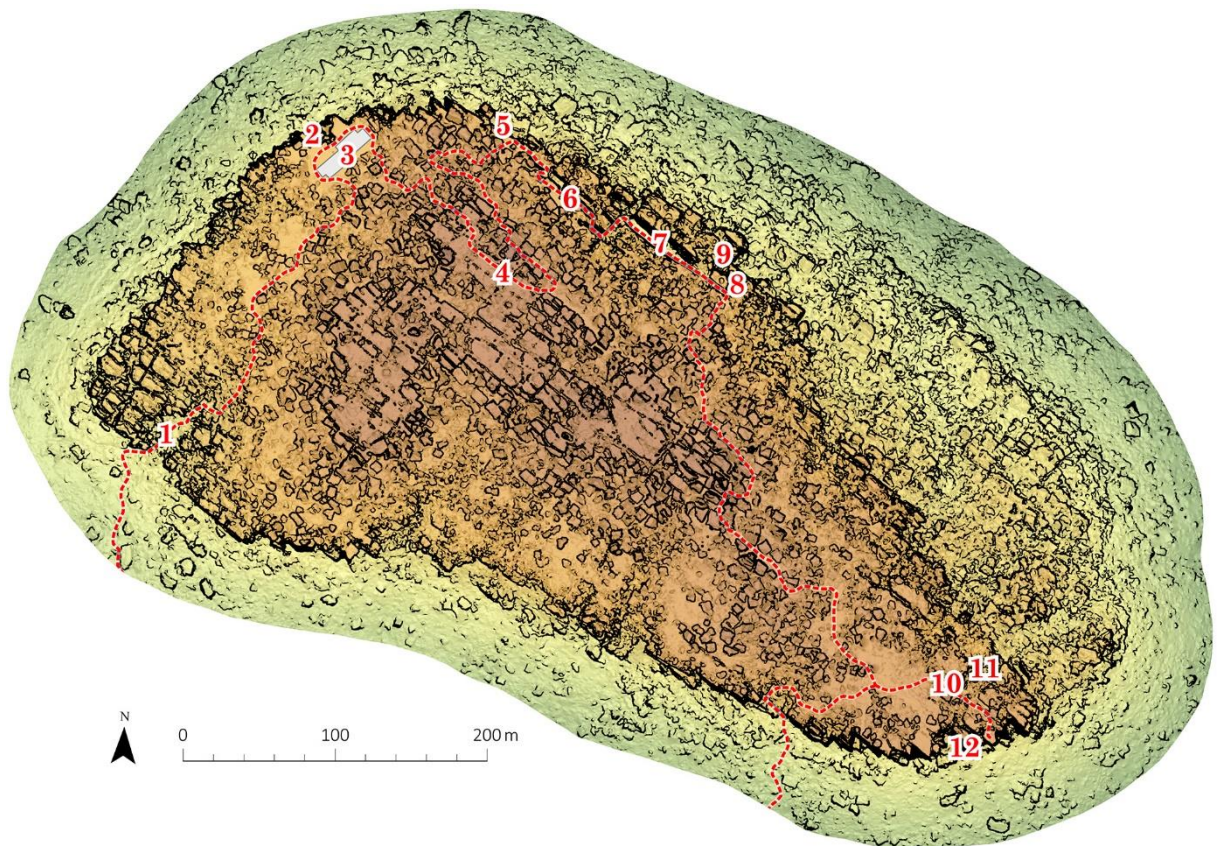


Figure 2. Szczeliniec Wielki – excursion route: 1 – main entrance (boulder caves), 2 – Northern Terraces, 3 – “Na Szczelińcu” mountain lodge, 4 – Fotel Pradziada (Forefather’s Chair), 5 – Malpolud (Ape Man), 6 – Diabelska Kuchnia (Devils Kitchen), 7 – Piekielko (Little Hell), 8 – Niebo (Heaven), 9 – Jedyńka Cave, 10 – Tunnel Cave, 11 – W Jagodowym Wąwozie Cave, 12 – South-Eastern Terraces.

After lunch we leave the conference venue and walk on foot towards Mt. Szczeliniec Wielki. The tourist trail leading to the top of the mesa, with c. 700 stairs carved in stone, was originally constructed as early as the beginning of the 19th century by the head of the village of Karlów (Carlsberg at that time) – Franz Pabel (1773-1861). To provide good accessibility for tourists, some of the narrow passages were blown

up, whereas the others were partially filled in. Generally, however, the great majority of the mesa's top surface has remained in its original, natural state.

Szczeliniec Wielki (ger. *Große Heuscheuer* / cz. *Velká Hejšovina*, 922 m) is an isolated tabular hill, rising some 150 m above the gently undulating surface of the main plateau of the Stołowe Mountains. The Upper Turonian quartzose sandstone, characterized by regular orthogonal jointing (vertical joints striking at 30° and 120°), acts as a caprock which overlies the complex of finer-grained rocks. Sandstone is more resistant and hence supports precipitous cliff lines, which are up to 40 m high and follow a zig-zag, joint-adjusted course. The summit surface of the mesa, c. 630 m long and 320 m wide, is almost entirely occupied by ruiniform relief and rock city topography, with spectacular examples of wide, joint-guided corridors, isolated tor-like sandstone compartments as well as chaotic boulder accumulations. Deep open clefts close to the northern rim of the mesa – Piekiełko and Diabelska Kuchnia – are among the top tourist attractions and, in particular, the sites of special scientific interest.

We follow the trail across the mid-slope section of Szczeliniec Wielki, densely forested and littered with huge sandstone boulders. Once we reach the cliff lines we can clearly see that the marginal part of the mesa, through which the trail guides us towards the top of the mesa, is highly disintegrated, with chaotic piles of boulders lying one upon another and a number of *in situ* bedrock compartments tilted in various directions. In this zone some of the boulder caves were identified. In fact, 40 out of 105 caves that have been mapped in the Stołowe Mountains so far are located at Szczeliniec Wielki. During the stop we will see a few of them, located in the south-western part of the mesa's margin. The stop will also serve as an opportunity to discuss the evidence for and geomorphic role of removal of mass at depth.

After a short walk across the top of the mesa we stop near the famous '**Na Szczelińcu**' mountain lodge, in the vicinity of the **Tarasy Północne** (*North Terraces*, 905 m). The history of the lodge is almost 200 years long. Soon after Franz Pabel provided access to the top surface of Szczeliniec Wielki in 1814, a small shelter was constructed. In 1845, with constantly increasing number of visitors, a large mountain lodge in the Alpine style was established, operating till the present-day. Tarasy Północne situated nearby serve as one of the best viewpoints in the tableland. In good weather conditions one could appreciate the view towards the Karkonosze Mountains, the mesa of Ostaš and the Broumovské stěny, the Rudawy Janowickie mountains, the Kamienne Mountains as well as the Sowie Mountains. During the stop regional geological and geomorphological context will be discussed.

We follow the tourist trail across the top surface of the mesa and stop at **Fotel Pradziada** (*Forefather's Chair*, 922 m). This sandstone tor is the highest spot in the mountain range, providing an excellent 360° panoramic view. While enjoying the landscape, a discussion will be conducted on the morphological patterns of ruiniform relief and rock city topography.

The tourist trail leads us towards the northern margin of Szczeliniec Wielki. Here, a series of open clefts have developed, with the most famous **Piekiełko** (*Little Hell*) and **Diabelska Kuchnia** (*Devil's Kitchen*). The former is c. 100 m long and 17 m deep, whereas the latter extends at a distance of c. 40 m and attains the depth of 15 m. In fact, the system of open clefts in this locality is much more extensive and involves other landforms of this type, which are outside the tourist trail. The open clefts – with courses parallel to the mesa rim – have been formed due to gravity-induced outward movement of large sandstone slabs. In some instances, however, selective weathering has also played a role. During the stop the likely processes standing behind the development of these landforms will be discussed, and the information on the current geophysical and geochronological studies will be presented (projects no. 2020/39/D/ST10/00861 and 2021/43/B/ST10/00297 of the National Science Centre, Poland). Depending on the number of tourists, some of the open clefts not accessible for ordinary visitors will be shown.

After leaving the system of near-margin open clefts, we reach the viewpoint known as **Niebo** (*Heaven*). Here, the effects of large-scale block tilting are very well visible. Next to this locality the biggest cave in Szczeliniec Wielki – **the Jedyńska cave** – was discovered, of the total length of 230 m. It remains inaccessible to tourists.

While heading towards the end of the tourist trail on top of the mesa, we go across a typical rock city topography. Finally, we reach the so called **Tarasy Południowo-Wschodnie** (*South-Eastern Terraces*) – an excellent viewpoint towards the Śnieżnik Massif, the Bystrzyckie Mountains, the Orlickie Mountains, the Narożnik Plateau and the Skalniak Plateau. The terraces are separated by a partly-roofed slot called **Tunel** (*Tunnel*). There is also a cave in this part of the massif, called **W Jagodowym Wąwozie** (*In Berry Gorge Cave*). It is 96 m long.

We leave the top surface of the mesa by stairs. Similarly as in the case of the entrance route, the trail guides us via highly disintegrated zone, with huge boulder accumulation replacing the cliff line. At the foot of the rock walls we stop near a group of sandy cones, which are currently subject of a detailed investigation in the frameworks of the Q-MESA project of the National Science Centre, Poland (project no. 2020/39/D/ST10/00861). The research programme involves monthly measurements of contemporary sand removal, and, in particular, soil study and dating work. The results acquired so far will be presented and discussed.

We follow the tourist trail down to the foot of Szczeliniec Wielki and go for dinner at the conference venue.



Photo 2. The upper part of Małpolud (Ape Man) – one of the highest free-standing sandstone pillars in the Stołowe Mountains (photo W. Porębna).



Photos 3 and 4. Partly roofed slots within the top surface of Szczeliniec Wielki (photos W. Porębna).



Photos 5 and 6. Left: Descent to the Diabelska Kuchnia (Devils Kitchen). Right: Piekielko (Little Hell) Gorge (photos W. Porębna).



Photo 7. Partly roofed slot in the SE Terraces area (photo W. Porębna).

Part 2: Narożnik Plateau – Białe Skały **May 26th, Friday morning**

Piotr Migoń, Filip Duszyński, Kacper Jancewicz, Wioleta Porębna

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Excursion route

The village of Karlów – Lisia Pass – Kacper’s cave – Skały Puchacza – Skalna Czaszka – Narożnik – Lisia Pass – The village of Karlów

- Total walking distance: ca. 7 km
- Gear needed: comfortable shoes with non-slip soles; headlamp/torch
- Duration: 4.5 h
- Character of passage: tourist trail; small caves and slots (roofed and unroofed); wooden planks might be slippery in rainy weather

After breakfast we travel by cars along the main road crossing the plateau in the south-easterly direction. We stop at the car park at the Lisia Pass. From this point we walk for c. 30 minutes along the hiking trail in the easterly direction, parallelly to the cliff lines of the Białe Skały escarpment.

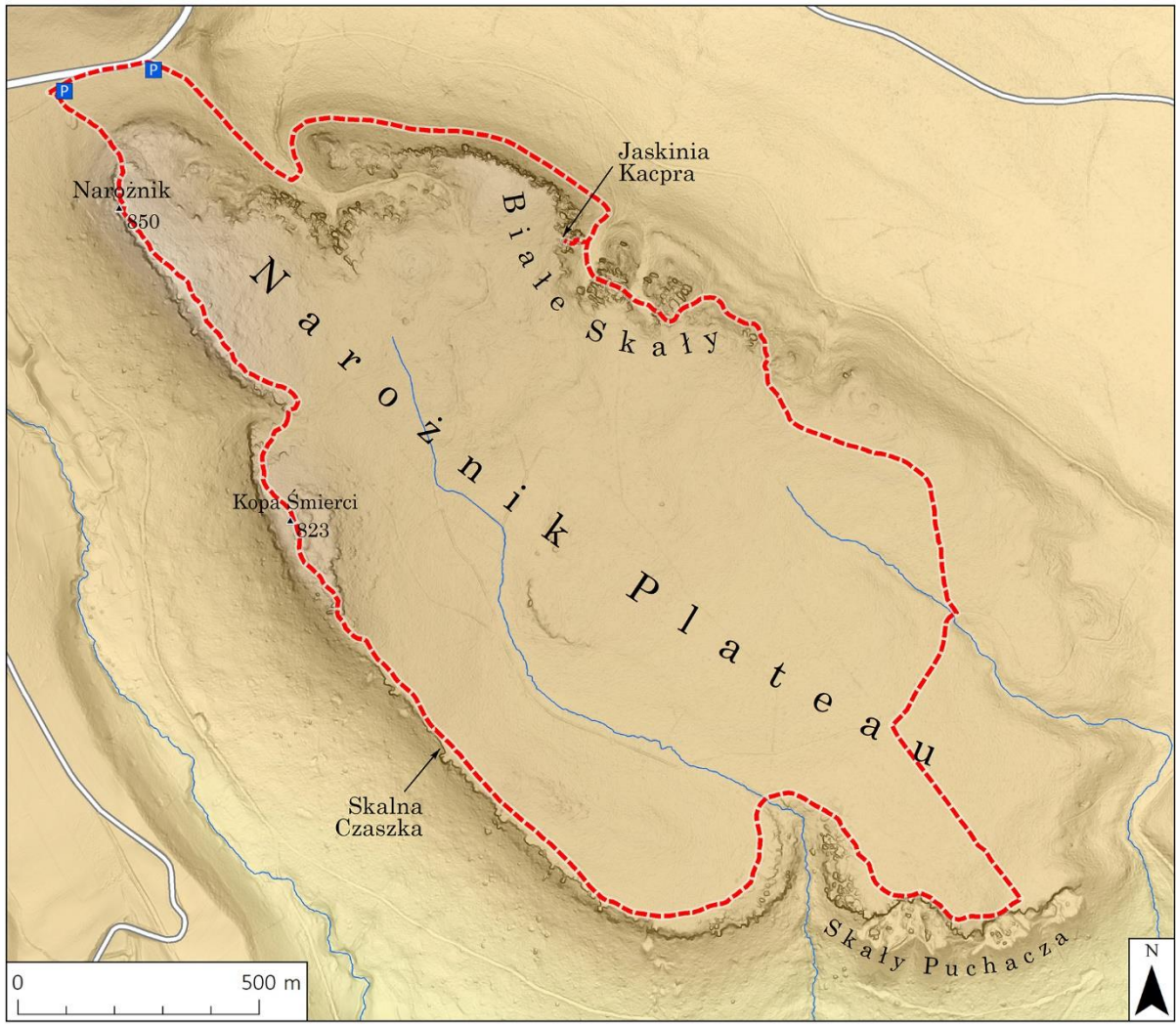


Figure 3. Narożnik Plateau – excursion route.



Photo 8. Ruiniform relief section of the Białe Skąły massif (photo A. Michniewicz).

Biale Skaly (*White Rocks*) is a name given to the north-western section of an escarpment bounding the Narożnik plateau. It is derived from the whitish colour of the cliff-forming sandstone, which is an almost pure quartz arenite of Upper Turonian age. The escarpment section named as such begins immediately after crossing a small creek. Here, within a small spur, the rock walls are highly disintegrated and appear as isolated sandstone compartments with chaotically resting sandstone boulders. Further to the east, the cliff lines become continuous, extending at a distance of c. 250 m in the WNW-ESE direction. Locally, they attain the height of up to 20 m and show zig-zag outlines reflecting local jointing pattern. Afterwards the landscape changes dramatically. The escarpment is cut by two valleys, c. 30 m deep, indenting the plateau by c. 150 m. Both within the spur separating the valleys and the escarpment sections to the east and west a great number of rock towers and pinnacles occur, forming ruiniform relief.

We follow the tourist trail heading to the western valley. Here, we stop near the geotouristic panel 'Podmorskie Tarasy' discussing the sedimentary environment of the observed sandstones and the origin of large-scale cross-bedding structures. We leave the trail and walk some 50 m to a small courtyard, where an interesting cave and a roofed slot were discovered last year.

Jaskinia Kacpra (*Kacper's cave*) is a small cave which has been subject of our detailed investigation. The cave, together with a roofed slot nearby, is situated within a small rocky courtyard, opened towards the valley axis by an almost 10 m long trough. The rock walls are up to 7-8 m high and host various weathering features, such as tubes and arcades. The southern cave, with the main chamber c. 3 m long and 2 m wide, is connected with a narrow roofed slot, 9 m long, with active water flow after large rainfall and snow melting episodes. The floor of the cave and the slot is littered with sandy detritus, whereas the roof, abounding with small arcades and arches, is deteriorated to the degree it breaks into pieces by delicate touch. During and after rainfall and snow melting episodes the water percolating through the sandstone appears on the ceiling as drip water. Similar features were observed in the cave on the opposite side of the courtyard, with roof deteriorated *en masse* and amber-coloured drip waters appearing soon after the beginning of the rainfall. The slot to the north is roofed by a huge sandstone boulder in between intact bedrock compartments. During the stop in the courtyard the results of our work will be presented, which involved petrographical, hydrological, geomorphological, geophysical, bioweathering and soil study. Our ideas about the controls and processes of ruiniform relief development will be discussed (the research team involved Filip Duszyński, Wojciech Bartz, Kacper Jancewicz, Andrzej Kacprzak, Anna Potysz, Marek Kasprzak, Wioleta Porębną, Aleksandra Michniewicz and Barbara Woronko; the study is financially supported *via* research project no. 2020/39/D/ST10/00861 of the National Science Centre, Poland).

In fact, the area abounds in more caves, the majority of which are boulder caves. They will be demonstrated during a short walk to the top of the plateau. After that, we go in the south-easterly direction. After a walk across flat terrain of the upper plateau, partly waterlogged (wooden planks help to get through), we reach the southern cliffs of the plateau at the locality of Skały Puchacza.

Skały Puchacza (*Eagle Owl Rocks*) are actually a landform of anthropic origin and represent one of many old quarries in the Stołowe Mountains, inset into the sandstone-capped marginal escarpments. The sandstone cliffs were undercut along a distance of 500 m and the zig-zagging quarry walls are locally more than 20 m high. The floor of the former quarry is littered with boulders and debris, which is partly a leftover, but subsequent falls from the cliffs also contributed to the origin of the boulder piles. Local curiosities are unfinished dressed sandstone columns and a stone ramp going downslope, which used to be a transport route of blocks retrieved from the quarry. From the rim of the quarry one can see wide panoramic views of the Bystrzyckie-Orlickie Mountains (Velká Deštná, 1115 m) located further south.

The trail then circumnavigates a small natural rock labyrinth developed within the slopes of a small hanging valley (left of the trail) and continues along the edge of the upper plateau. The terrain is mostly forested, but occasional sandstone spurs projecting from the edge are good viewing points.



Photo 9. The rim of Narożnik Plateau at Skaly Puchacza (photo W. Porębna).

Skalna Czaszka (*Rock Skull*) is another point of interest along the trail, accessible via newly installed steps down the cliffs. The name is given to a peculiar section of the sandstone cliff face, where two large spherical cavities of regular shape (c. 70 cm across) occur side by side. The origin of these cavities in the Stołowe Mountains, long recognized, is a subject of debate. They are rather unlikely to be produced by surface weathering and clearly differ in shape and setting from common arcades and horizontal slots developed along bedding planes. One hypothesis holds that they are primary features of the sandstone and indicate the presence of gas bubbles in the original sediment. In the adjacent cliffs one can see various surface weathering phenomena (arcades, crusted surfaces), as well as short slots along vertical joints. However, they are all short and have not developed into any extensive underground systems.

The following part of the trail goes first across the flat section of the plateau, but then manoeuvres across a tract of ruiniform relief, developed above the rim of the cliffs. Individual massive sandstone compartments are up to 10 m long and 4 m high, separated by corridors and passages of variable width, including roofed slots and tunnels. Their shapes and spatial patterns indicate that they have evolved from a thick bed of massive sandstone, cross-cut by vertical joints running in two principal directions. Notable are tilted blocks, distinguishable by anomalously high dips of sandstone beds. These are interpreted as the evidence of rock mass disintegration and removal in the subsurface, via underground flows. Massive compartments then slowly subside into newly created accommodation spaces, as has also been observed on the mesa of Szczeliniec Wielki. The trail finally reaches the summit boulders and platforms of Narożnik.



Photo 10. Skalna Czaszka (Rock Skull) (photo P. Migoń).



Photo 11. A ruiniform relief section in the marginal part of the Narożnik Plateau (photo W. Porębna).

Narożnik (850 m) is the most elevated spot on the tilted part of the upper plateau, located to the east from the Lisia Pass. Sandstone beds are inclined both to the south and east, resulting in a asymmetric shape of

the elevation. Its western side is a cliff line more than 20 m high, whereas the eastern side slopes gently towards the cliffs of Białe Skały at lower elevation. The summit platforms are excellent vantage points towards the sandstone-capped mesa of Szczeliniec Wielki, the main plateau of the Stołowe Mountains, and the meadows at Rogowa Kopa (790 m), with peculiar scattered sandstone boulders resting upon mudstone bedrock.

A short steep section of the trail takes us back to the Lisia Pass and the main road across the plateau. We travel back to Karlów for a lunch break.



Photo 12. A ruiniform relief section in the marginal part of the Narożnik Plateau (photo P. Migoń).

Part 3: Skalniak Plateau – Błędne Skały **May 26th, Friday afternoon**

Filip Duszyński, Kacper Jancewicz

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Excursion route

The village of Karlów – Błędne Skały rock labyrinth – The village of Karlów

- Total walking distance: ca. 2 km
- Gear needed: comfortable shoes with non-slip soles; headlamp/torch
- Duration: 3.5 h
- Character of passage: tourist trail; slots (roofed and unroofed); wooden planks might be slippery in rainy weather

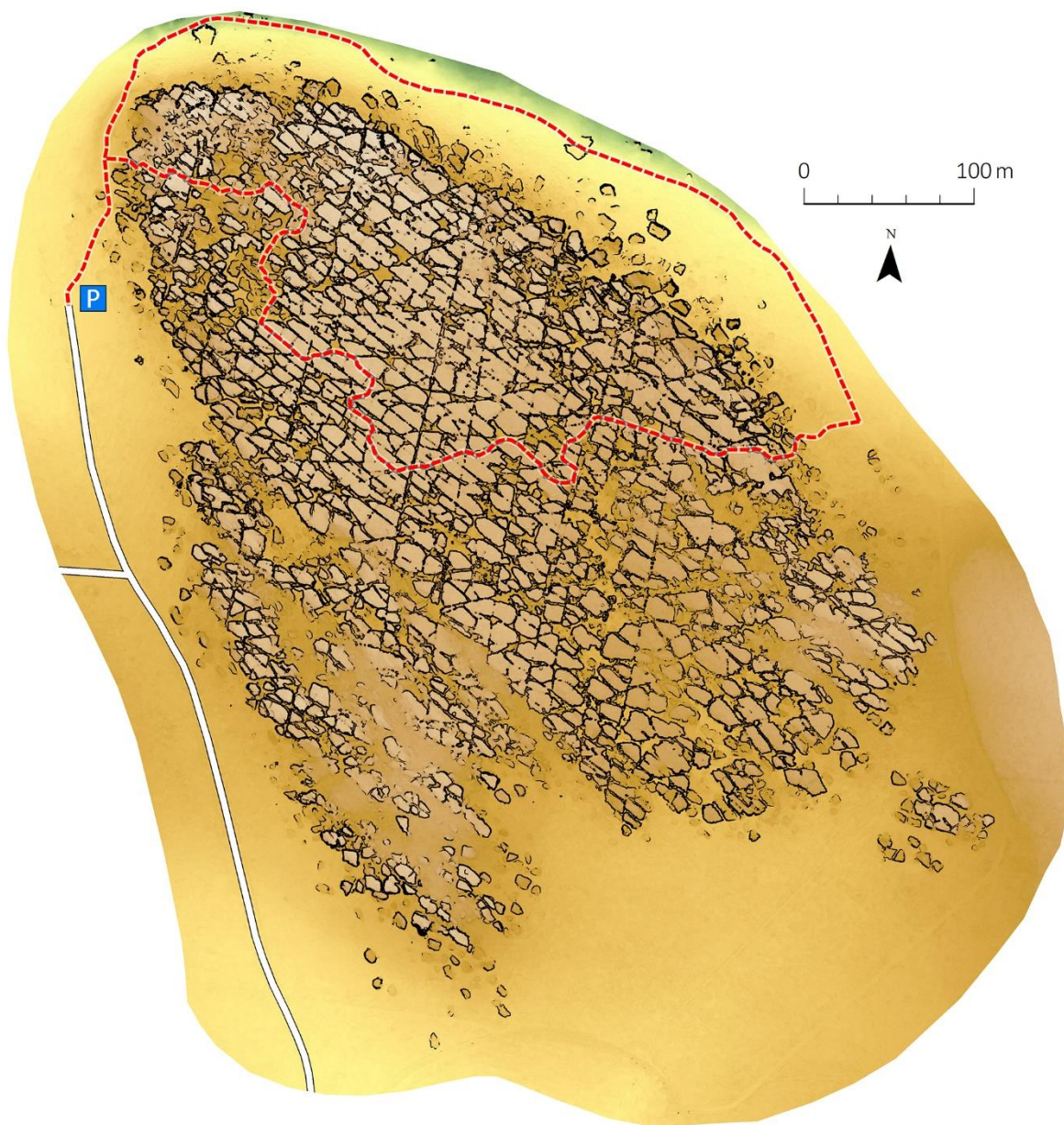


Figure 4. *Błędne Skály* – excursion route.

After lunch, we travel by cars to the south-west, crossing again the main plateau of the Stołowe Mountains and the southern escarpment of the Skalniak plateau, moulded by shallow landslides responsible for long-distance passive transport of sandstone boulders derived from the caprock. We pass a large car park and turn to the north onto a small road, leading directly to the car park situated on the plateau surface of Mt. Skalniak. From here, we start our walk across the Błędne Skály rock labyrinth.

Błędne Skály (Errant Rocks), the second most popular tourist destination in the Polish Stołowe Mountains (after the mesa of Szczeliniec Wielki), is a textbook example of a rock city. Being a maze of interconnected narrow slots and corridors, with isolated sandstone compartments in between, it is often referred to as a ‘rock labyrinth’. The Błędne Skály are limited to the western extremity of the Skalniak plateau, occupying the area of c. 400 m x 200 m. Although relatively small in terms of spatial extent, the rock labyrinth hosts passages of the cumulative length of c. 20 km. They are clearly structurally-controlled, following three sets of vertical joints striking 15-20°, 85-90° and 130-135°. At the

intersections of corridors, distinctive plazas and courtyards are often developed, giving the landscape a truly urban appearance.

The morphogenesis of the Błędne Skały is yet to be studied in detail. However, it is commonly assumed that vertical discontinuities in the rock mass have been the zones of enhanced chemical and physical weathering. There, the disintegration of sandstone has been the most efficient, which, over the time span, has led to the formation of slots and corridors, with more massive bedrock compartments left between them. Pervasive control exerted by internal rock architecture is evident not only in the layout of the rock city. Isolated sandstone compartments – some of which attain the height of up to 6 m – are often characterized by distinctive, bipartite morphology in vertical profile, which reflects the density of horizontal discontinuities. The upper sections, cut in massive, homogenous sandstone, are wider and form overhangs, locally roofing or partly roofing the corridors. The sandstone counterpart below is densely-bedded, less resistant and hence abounding with basal niches. Faster rate of sandstone deterioration in the lowermost parts is also associated with low permeability of the underlying bedrock, which results in permanently damp conditions within the corridors' floors. In these circumstances, the corridors are thought to develop via upward propagation of voids and the evacuation of sandy detritus at depth. These proposals are consistent with observations from other localities presented earlier.

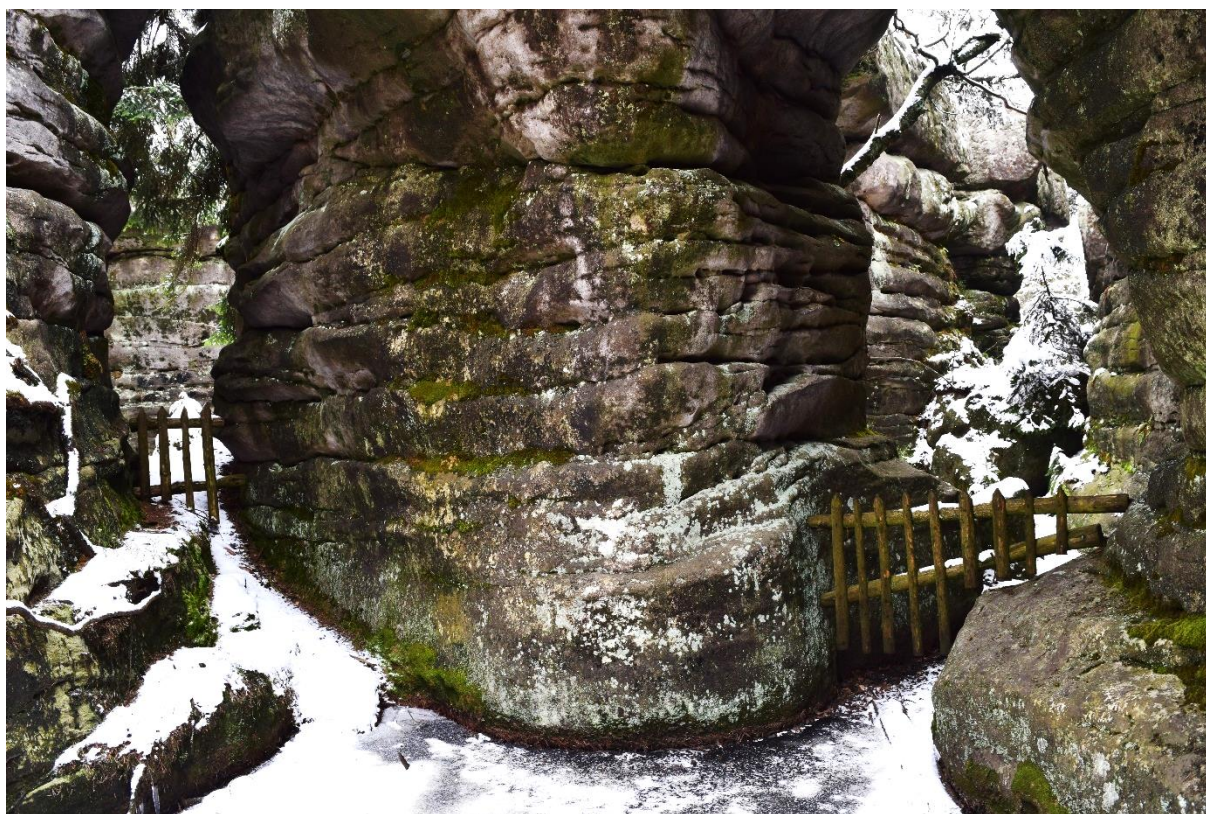


Photo 13. Criss-crossing corridors within the Błędne Skały rock labyrinth (photo F. Duszyński).

While heading to the eastern part of the rock city, we will recognize that the morphology progressively changes. *In situ* sandstone compartments become more scattered, the corridors follow more chaotic courses and the amount of larger boulders resting on the plateau surface is growing. Further east, the rock city disappears, giving way to the regolith-covered surface of the Skalniak plateau.

The trail back to the car park leads us along the north-western margin of the Skalniak plateau. The rock walls rimming the plateau are usually up to 10-20 m high. Not far from here, the only rockfall in the Stołowe Mountains recorded in historical times occurred. It was the collapse of the *Sypaci Skála* tor

during the night of 10th/11th May 2021. The event was described in a local newspaper and documented in a number of photographs and postcards.

We travel by cars back to Karłów for dinner and evening meeting.



Photo 14. Bipartite morphology of sandstone compartments and basal overhangs at the Błędne Skały. Note that the floor of the corridor is waterlogged (photo F. Duszyński).

POST SYMPOSIUM EXCURSION, variant A, May 27th, Saturday Czech pseudokarst terrains of Protected Landscape Area Broumovsko: northern part of the Adršpach Rocks and central part of the Kočičí Rocks

Petr Kuna

Agentura ochrany přírody a krajiny ČR, RP Východní Čechy, Správa CHKO Broumovsko, Ledhujská 59, 549 54
Police nad Metují, e-mail: petr.kuna@nature.cz

Route of the excursion

- By car: ca. 60 km
- Total walking distance: ca. 6.5 km.
- Gear needed: comfortable shoes with non-slip soles; headlamp/torch is recommended

Departure: 9:00. By car: Karlów – Police nad Metují (ca. 30 min. drive). Arrival at the parking place near supermarket PENNY – the first meeting point.

9:30: meeting with the guide, Mr. Petr Kuna. Organizing the transportation by business car of the PLA Broumovsko and other cars according to the possibilities of the participants and their further plans.

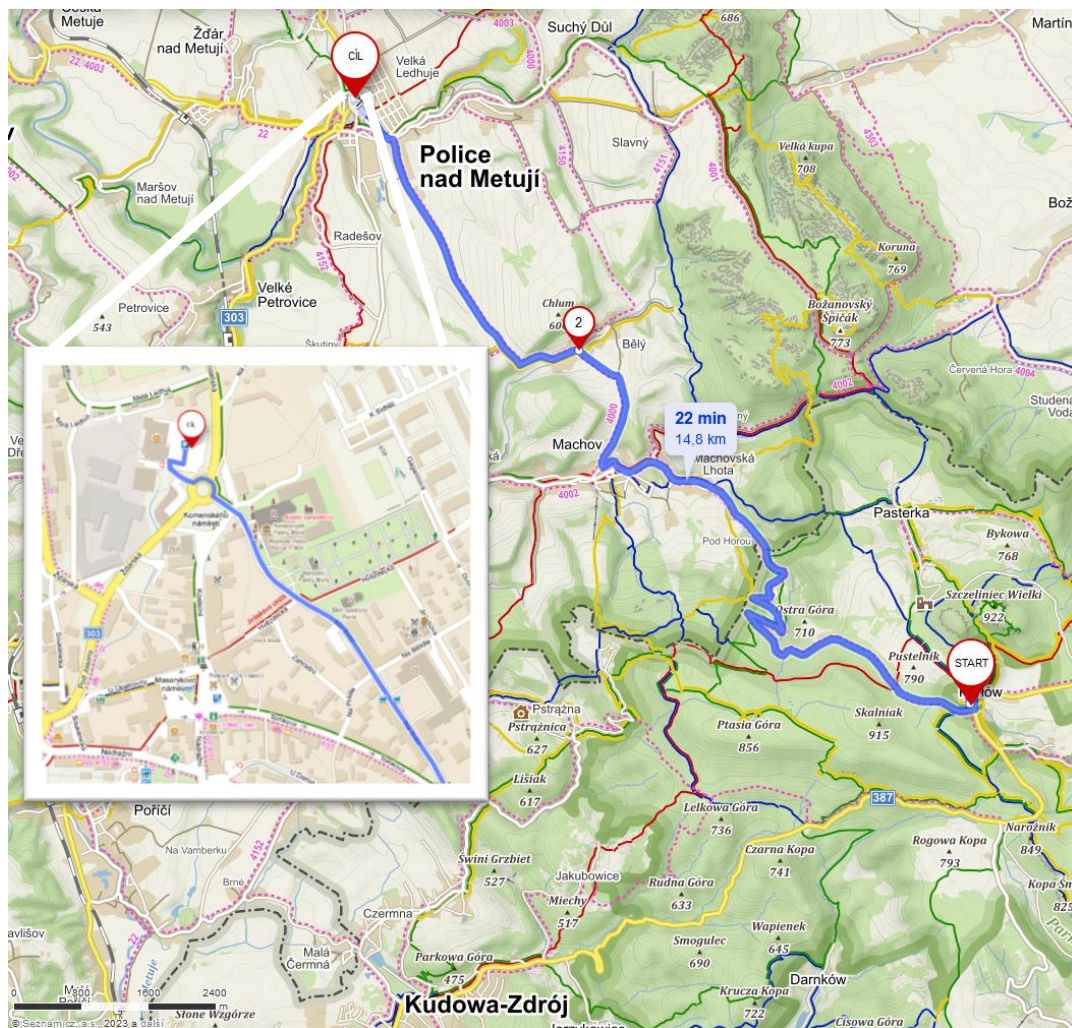


Figure 1. Route from Karlów to Police nad Metují. Map source: mapy.cz.

By car Police nad Metuji – Adršpach – to the second meeting point. (ca. 25 min drive)

9:50: parking according to the instructions of the guide near the entrance. Parking in Adršpach is limited. It is good to use as small number of cars as possible.

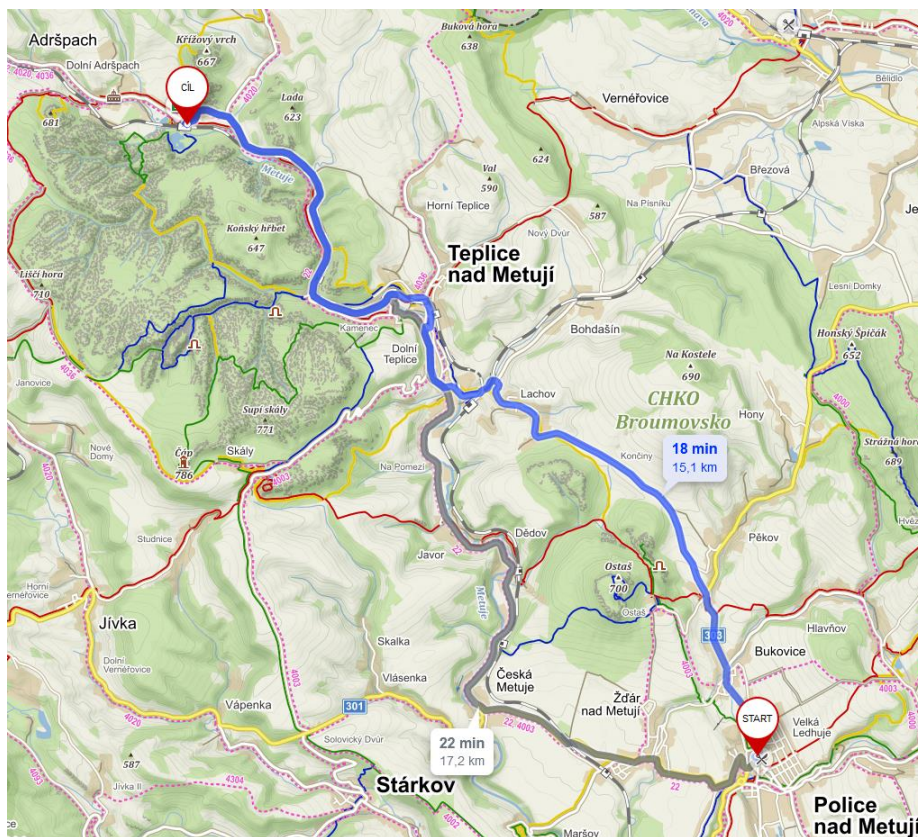
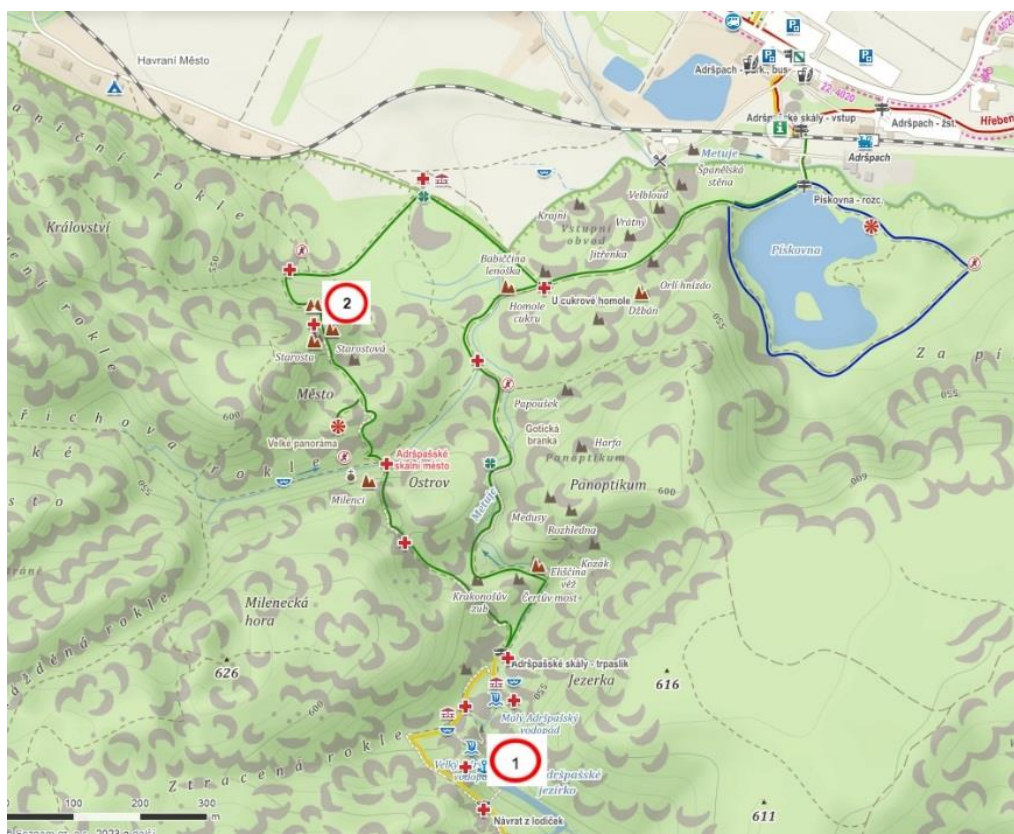


Figure 2. Route from Police nad Metuji to Adršpach (left) and the northern part of the Adršpach Rocks (below): 1 - Pod Velkým vodopádem Cave, 2 - Myší díra Cave. Map source: mapy.cz.



10:00: Walk through the Adršpach Rocks – National nature reserve and Nature 2000 site. Total walking distance: ca. 4 km (3 hours). Excursion programme includes visiting two caves: Pod Velkým vodopádem (“Under the Great Waterfall”) Cave and Myší díra (“Mouse Hole”) Cave. Both caves are located on the marked hiking trail. Lighting (headlamp or torch) is recommended.

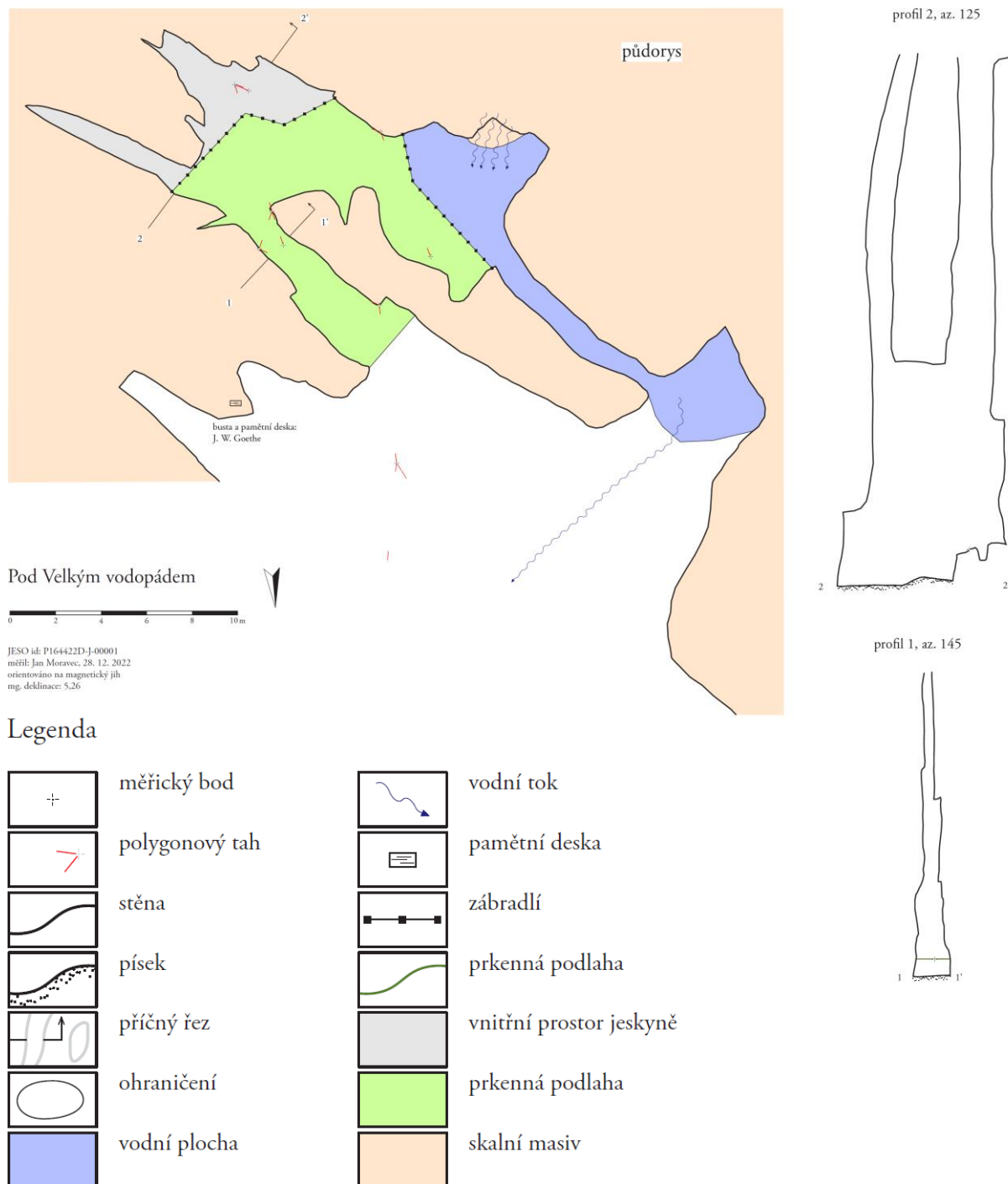
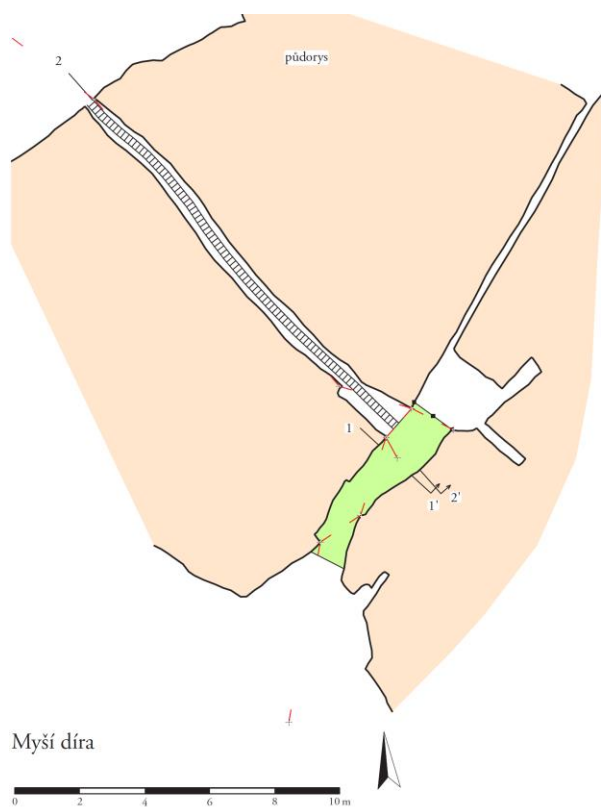


Figure 3. Map of the Pod Velkým vodopádem Cave. Map and profile by Jan Moravec.



Photo 1. Inside the Pod Velkým vodopádem Cave (Photo T. Krajča).



JESO id: P164422D-J-00002
 měřil: Jan Moravec, 28. 12. 2022
 orientováno na magnetický sever
 mg. deklinace: 5,26

Legenda

	měřický bod		schody
	polygonový tah		zábradlí
	stěna		prkenná podlaha
	písek		prkenná podlaha
	příčný řez		skalní masiv
	ohrazení		

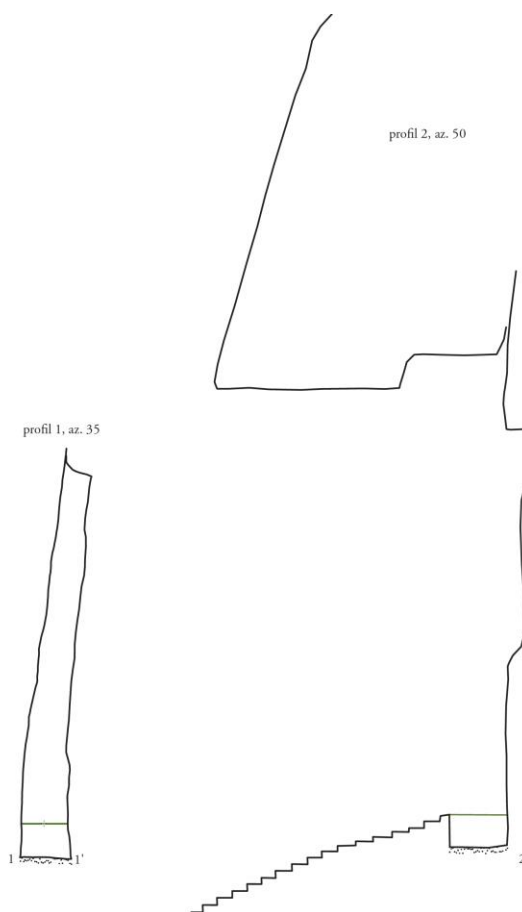


Figure 4. Map of the Myší díra Cave. Map and profile by Jan Moravec.



*Photo 2: Exit stairs from the Myší díra Cave.
(Photo P. Kuna)*

13:00: Lunch break.

14:00: Departure from Adršpach. By car to the Ostaš hill parking place, the third meeting point (ca. 20 min drive)

14:30: Walk through the nature monument and Nature 2000 site Kočičí skály (Cats Rocks). Total walking distance ca. 2.5 km. Excursion programme includes visiting caves: “Kočičí hrad” (“Cats castle”), “Liščí díra” (“Fox hole”) and “Sluj Českých bratří” (“Cave of The Czech Brothers”). Caves are located on the marked tourist trail (except the Liščí díra Cave). Lighting (headlamp or torch) is recommended.

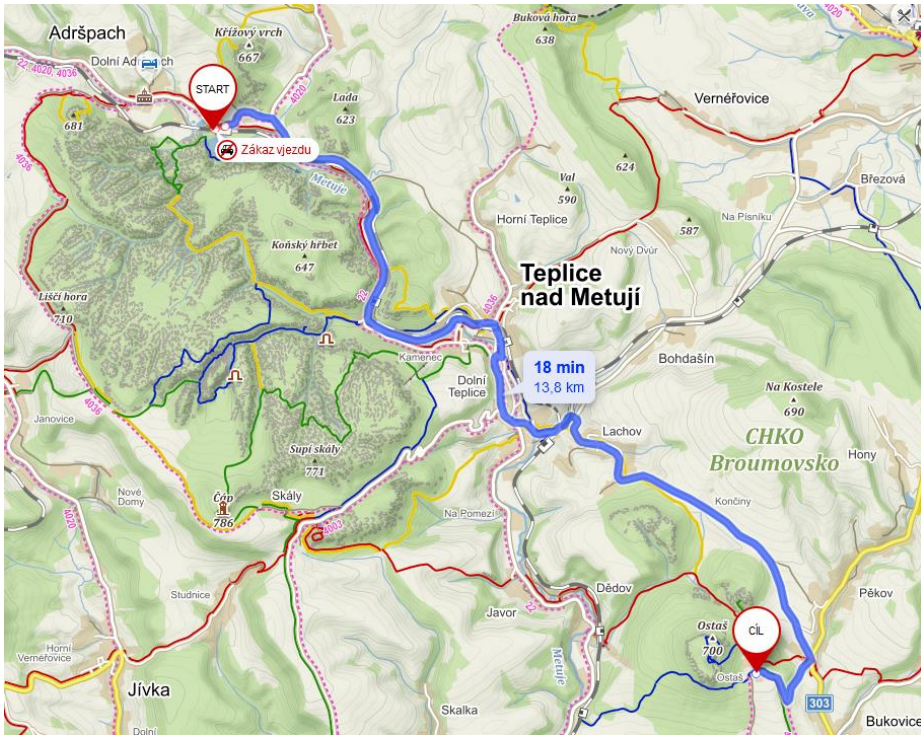
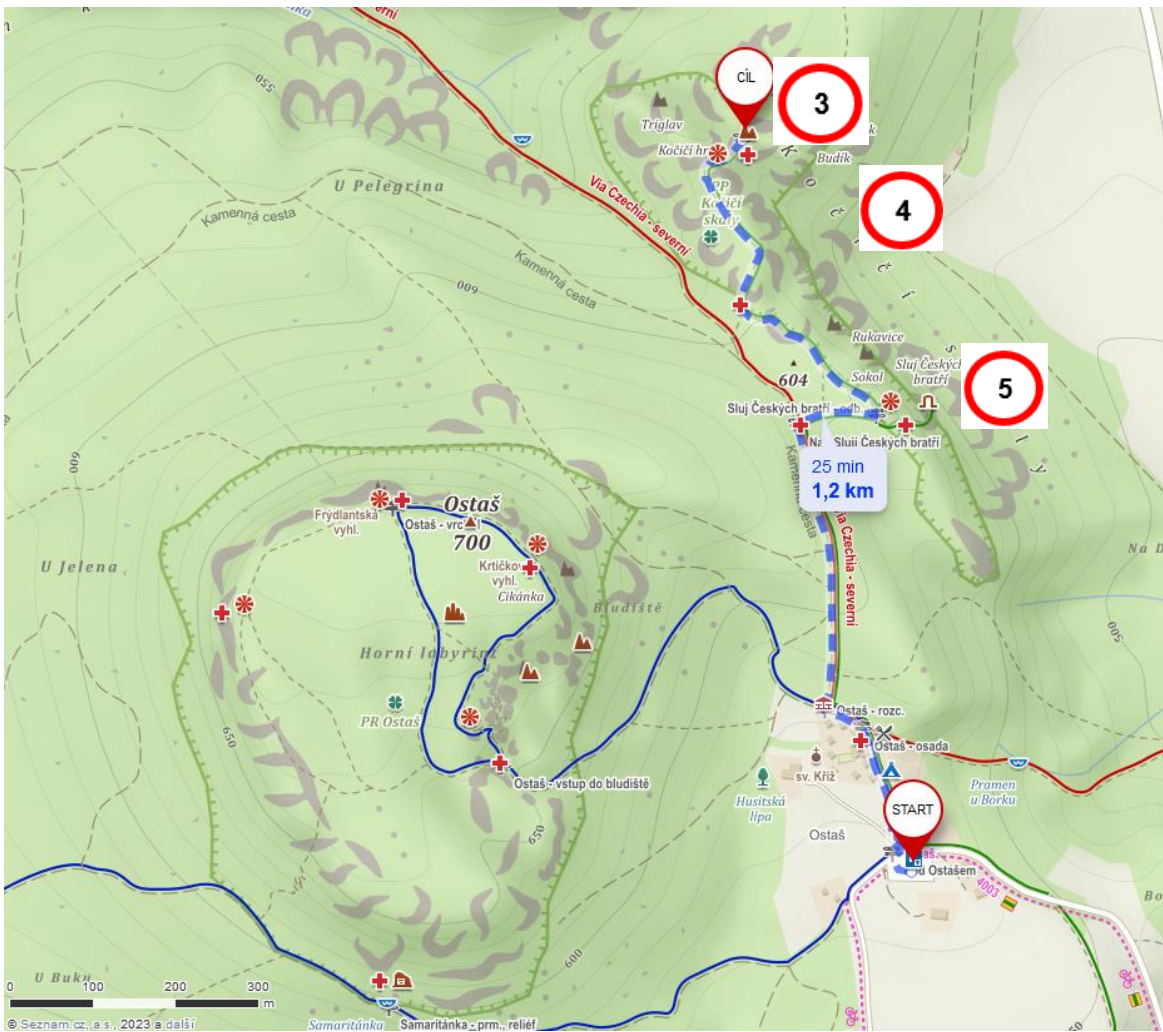


Figure 5. Route from to Adršpach to Ostas hill parking place (left) and location of the Kočičí skály site (below):
 3 - Kočičí hrad Cave,
 4 - Liščí díra Cave,
 5- Sluj Českých bratří Cave.

Map source: mapy.cz



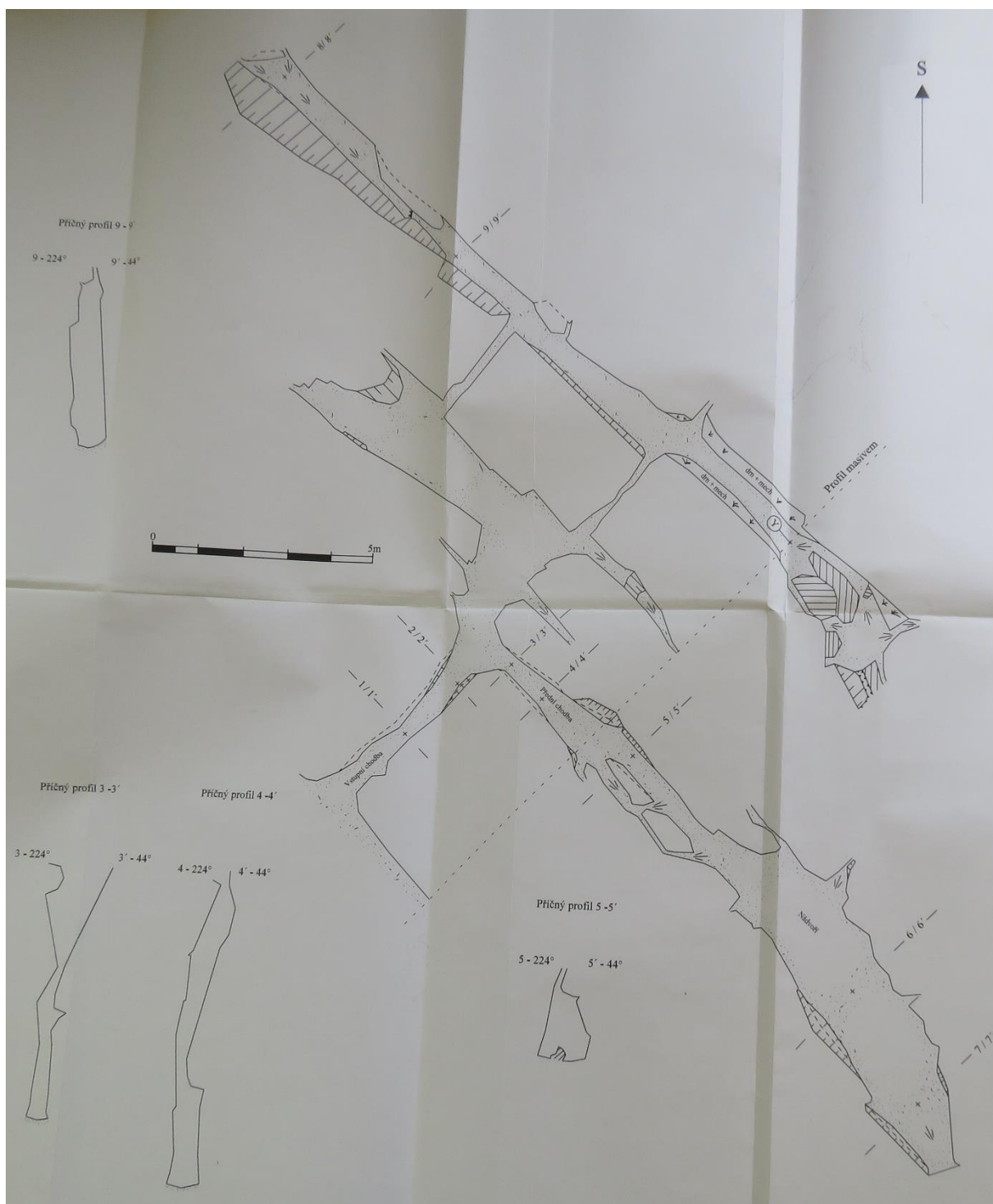


Figure 6. Map and profile of the Kočičí hrad Cave, Map and profile by T. Hanc. Czech speleological society, ZO 5-03 Broumov



Photos 3 and 4. Rocky block with the cave “Kočíčí hrad” (“Cats castle”) inside. (Photo P. Kuna).

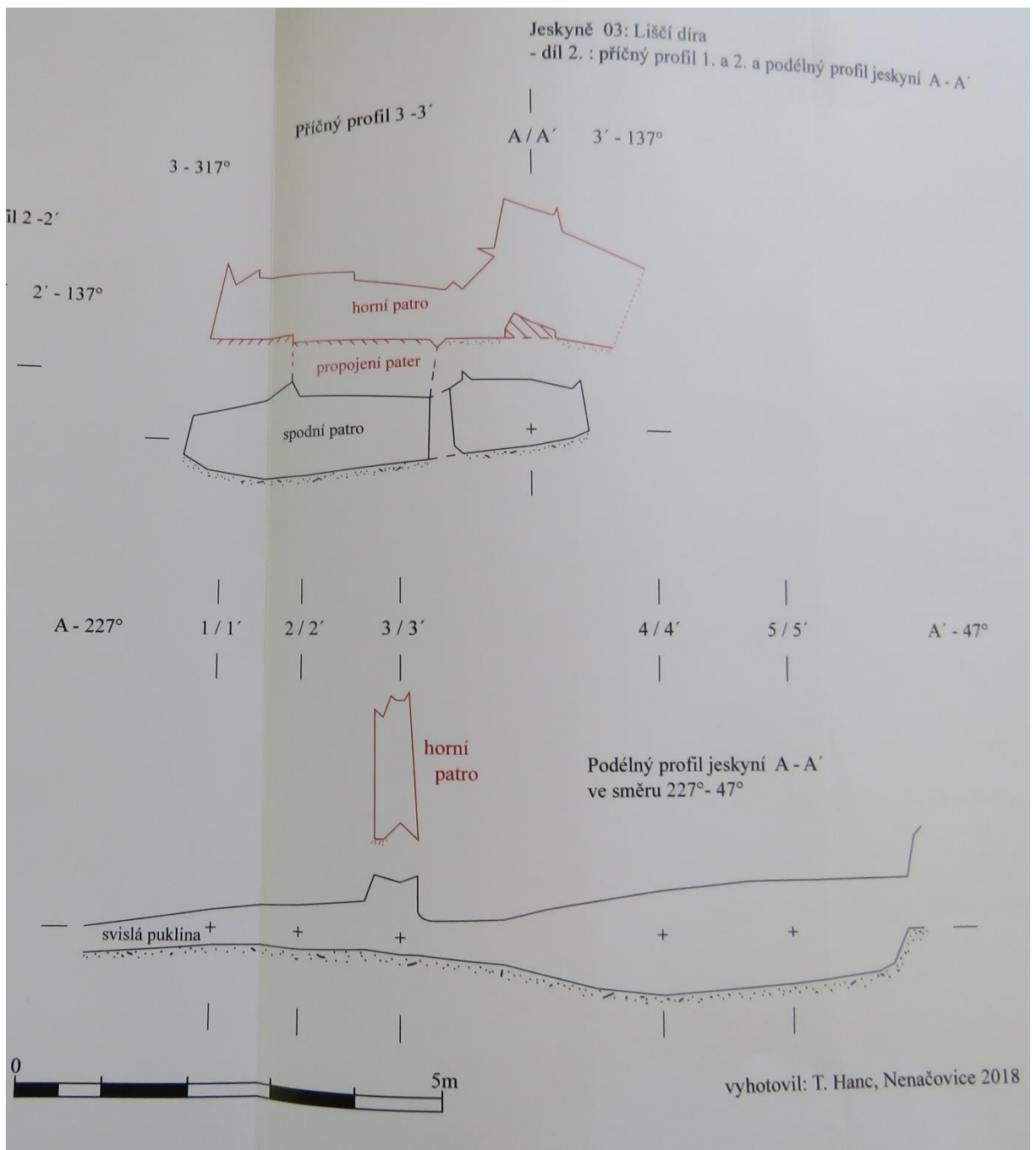


Figure 7. Map and profile of the Liščí díra Cave, Map and profile by T. Hanc. Czech speleological society, ZO 5-03 Broumov



*Photos 5 and 6. The cave “Liščí díra” (“Fox hole”) – view from the outside and from the inside.
(Photo P. Kuna).*

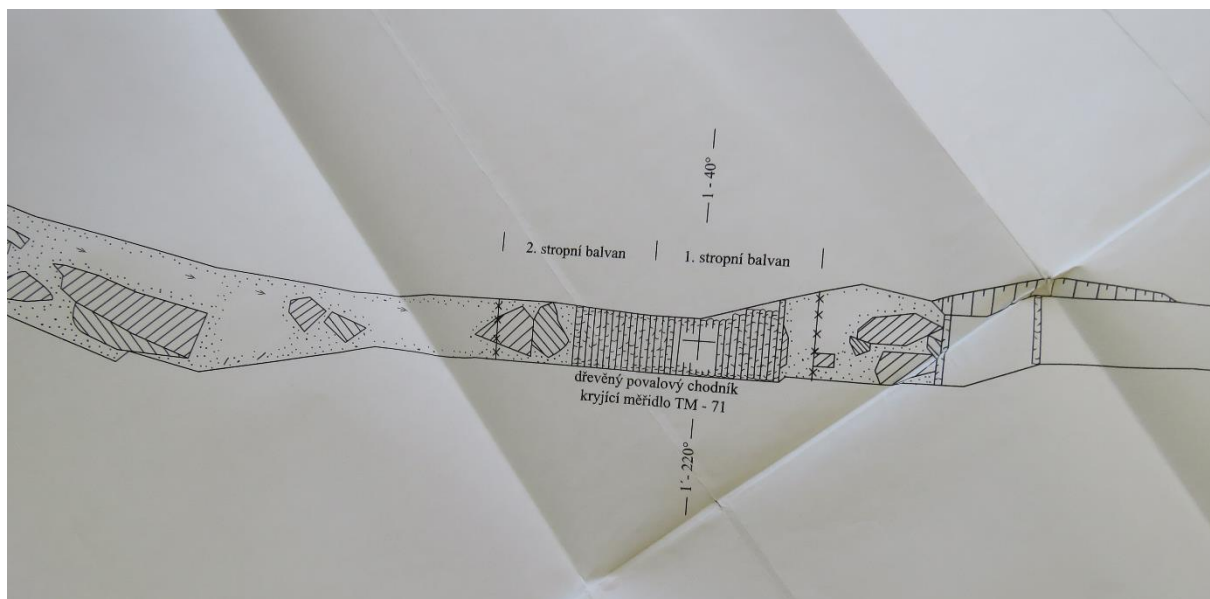


Figure 8. Map of the Sluj Českých bratří Cave., Map by T. Hanc. Czech speleological society, ZO 5-03 Broumov

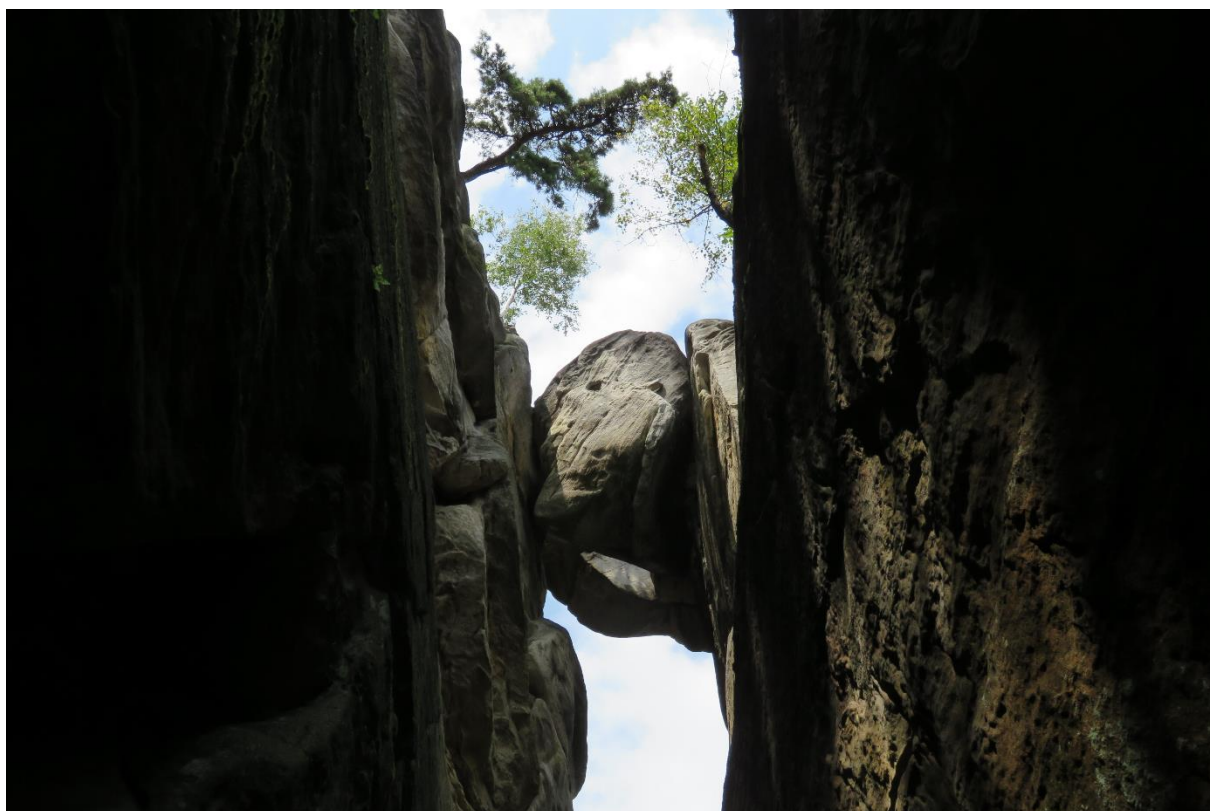


Photo 7. Skyward view from the Sluj Českých bratří Cave (Photo P. Kuna).

POST SYMPOSIUM EXCURSION, variant B, May 27th, Saturday
**Large caves near Slavný: jeskyňe Pod Luciferem (Cave under the Lucifer),
Tunel (Tunnel) and Olga, as well as rocky landforms of the southern part
of the Broumov Upland**

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Route of the excursion

By car Karlów–Slavný (on the crest of the Broumovské stěny – Broumov Cliffs, Fig. 1); on foot to the Pod Luciferem Cave (passage through an underground system of boulder type); on foot to Zelený hájek – ascent to the Tunel Cave (a brief visit of a crevice cave); on foot to the Olga Cave (passage through a part of the system of a boulder cave) – Pánův kříž Cross; on foot back to Slavný; by car back to Karlów.

Total walking distance: ca 13 km (Fig. 2).

Gear needed: overall, helmet, lighting.

Duration of underground excursions: min. 1 hour for each of the boulder caves.

Character of passage: combined passage through several passable narrows.



Fig. 1. A view along the crest of the Broumovské stěny (Broumov Cliffs), with the Klodzko Basin beneath inversion clouds (photo O. Jenka).

Introduction

The town of Broumov lies beyond the eastern margin of the relict Police Basin, forming a broad syncline elongated NW-SE. The Police Basin belongs to the Bohemian Cretaceous Basin but is separated from its continuous sedimentary fill by an anticline of Carboniferous sediments and by the reverse Hronov-Poříčí Fault activated in the post-Cretaceous times.

Two thick sandstone bodies in the Cretaceous (Cenomanian to Coniacian) fill of the Police Basin are exposed to the present surface (Čech, Gawlikowska 1999). Stratigraphically lower-lying body

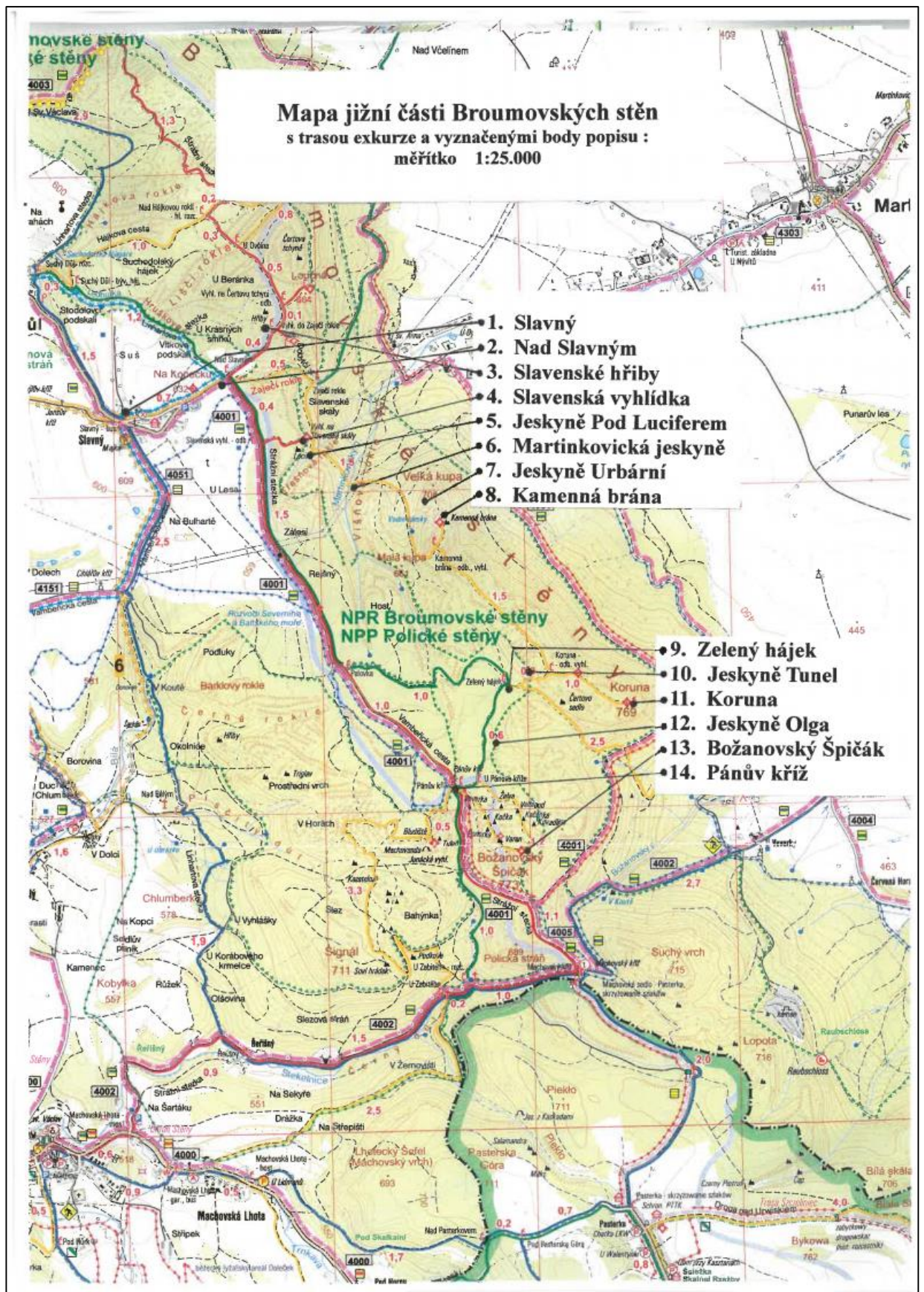


Fig. 2. Map of the southern part of the Broumovské stěny cliffs with the observation sites along the excursion trail.

of subarkoses is best exposed in the northeastern margin of the basin, forming the Broumovské stěny (Broumov Cliffs, Fig. 1) in the Czech Republic and Radkowskie Ściany (Radków Cliffs) in Poland. It is ranked to the Jizera Formation (Middle to Upper Turonian). A higher-positioned body of quartzose sandstones preserved in the axial part of the basin belongs to the Teplice Formation (Upper Turonian to Coniacian). Its dissection by systems of orthogonal joints and subsequent erosion gave rise to the table mountains of Ostaš and Hejda and to the Teplice and Adršpach rock cities.

The Broumov region features all types of pseudokarst caves (Vítek 1979, 1980): fissure caves, strata-bound caves, abri, crevice caves, talus caves (boulder caves), and caves of combined origin. The most significant in the region are talus caves, formed either in extensive blocky slope aprons or in rock-fall accumulations on bottoms of deep gorges. Although most of them are only 5-20 m long, the two caves visited during the current field trip are among the longest pseudokarst caves in the Czech Republic.

Caves in the Broumov region have been visited since very early times. The oldest written record of a cave from this region relates to Urbární Cave in the Broumov Cliffs and comes from the urbarium of the Broumov Benedictine monastery dominium of 1679. Modern speleological studies started in 1970s with the activities of TJ Slovan Broumov karst tourism club. This was transformed into Club 5-03 Broumov within the Czech Speleological Society in 1979. The main task of this club is the registry and documentation of all speleological objects, but also geological and geomorphological objects. In this respect, the Broumov region is particularly famous for its long talus caves, numerous root stalagmites, mushroom rocks or microrelief due to ferruginous cementation of sandstones. The number of registered caves increased from 32 in 1980 to the present number of 169. Activities of the club members also include installation of devices for geotechnical monitoring (dilatometers) and geodetical monitoring (since 1985). The Adršpašsko-teplické skály National Nature Reserve (since 1933, 18 km²) and the Broumovské stěny National Nature Reserve (since 1956, 12 km²) are parts of the Broumovsko Protected Landscape Area (since 1991).

Broumovské stěny (Broumov Cliffs)

Although only a few kilometres from the Teplice rock city, the Broumovské stěny (Broumov Cliffs) have a different character both in their geology and geomorphology. They form a cuesta-like ridge with a steep NE slope and a gentle but strongly dissected SW slope. The exposed sandstone body (Jizera Formation, Middle to Upper Turonian) lies stratigraphically below that of the Teplice rock city and reaches a thickness of 110 m. The rock contains, besides quartz grains, about 10 % of kaolinized feldspar grains and is therefore termed subarkose. Owing to the position in the NE limb of the Police Basin syncline, the subarkoses show a visible tectonic dip of 2-8° towards W to SW. Some of the bedding planes host accumulations of bivalve shells. Bedding planes showing steeper dips of ca. 20° are surfaces of sand banks prograding from the Cretaceous seashore into deeper waters. Cross bedding is also present but of smaller thickness than in the Teplice rock city (Adamovič et al. 2010).

Brittle tectonic deformation of the Broumovské stěny cliffs concentrates into regularly spaced joint sets striking NW-SE, parallel to the cuesta edge. On the top of the cuesta, these joints give rise to elongate “walls” or “fins”. Elsewhere, isolated rock pillars (tors) are formed, occasionally having the character of mushroom rocks (Fig. 3). Their tops are smooth or shaped by rinnenkarren. Vertical cliff faces bear



Fig. 3. Dozens of mushroom rocks are developed in the Broumovské stěny cliffs, in varied forms (photo O. Jenka).

thick rock crusts, often with polygonal cracks, but only poorly developed honeycomb pits. The NE slope of the ridge, i.e., the cuesta head, forms a prominent escarpment with signs of frost modelling and gravity-induced movement of blocks. The base of the slope and the bottoms of steep valleys are covered with thick talus deposits.

The ongoing speleological research now registers 26 caves of all different genetic types, with the most prominent being talus caves (e.g. Pod Luciferem Cave, Figs. 4, 5). Fissure and crevice caves are linked with the NW-SE jointing (e.g. Pod Hvězdou Cave). Toppling of rock pillars also produced high vaulted spaces having the character of false arches, e.g. Mariánská Cave.

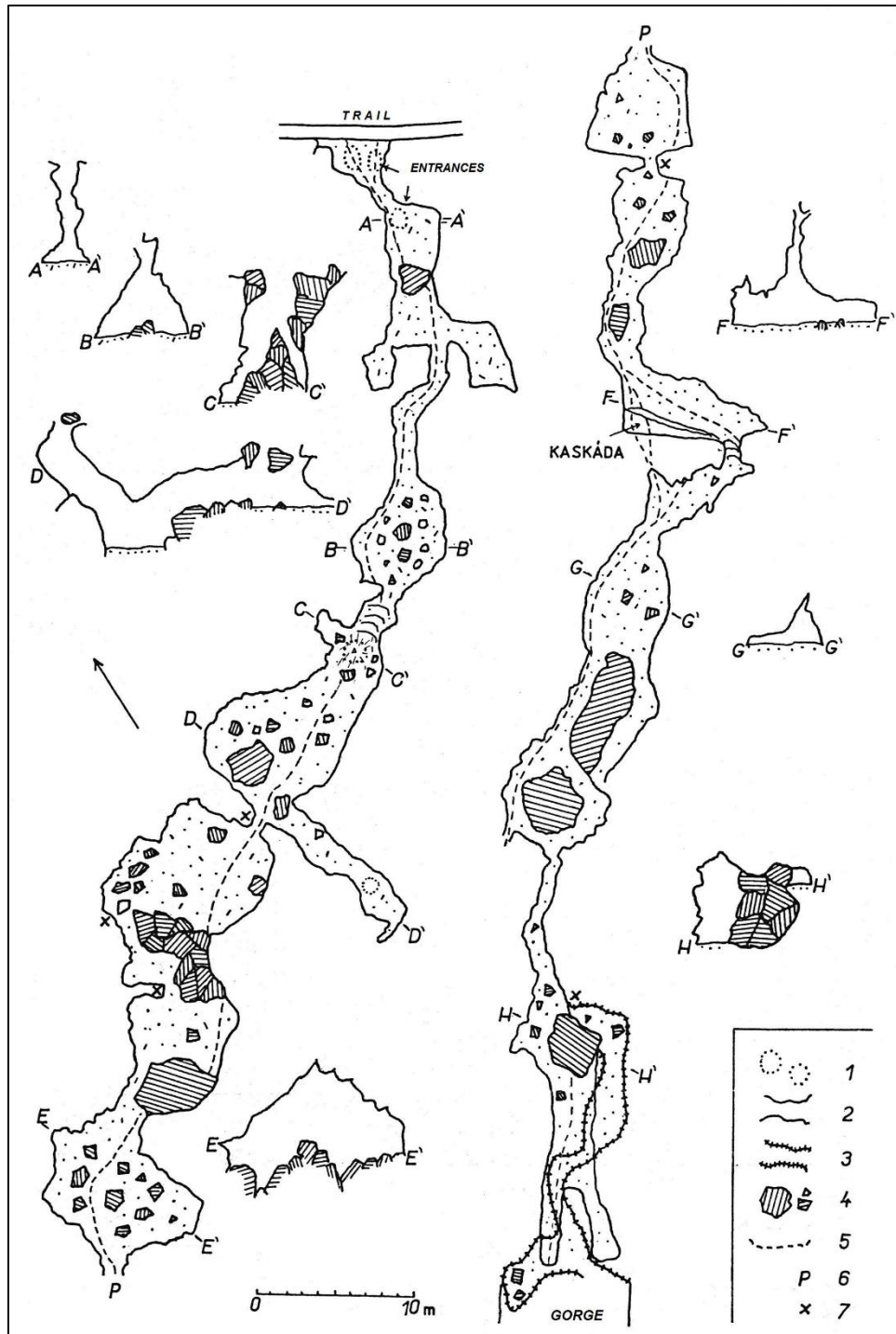
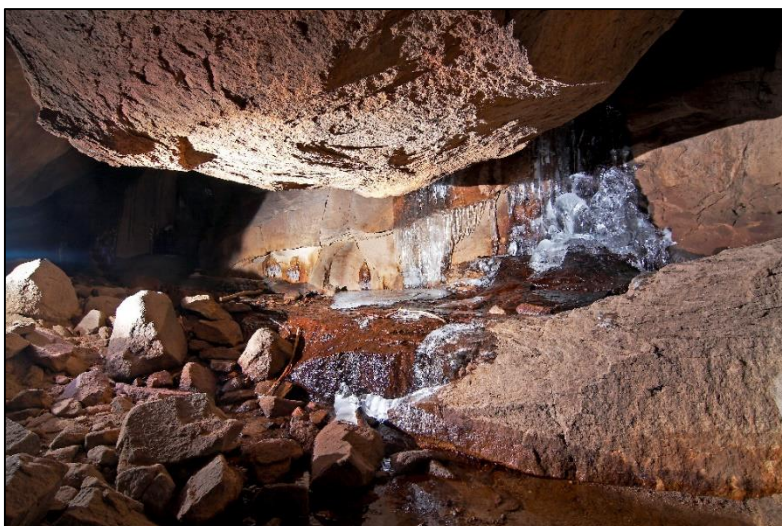


Fig. 4. A map of the Pod Luciferem Cave in the Broumovské stěny cliffs (after Vitek 1979). Explanation of symbols: 1 - entrance and chimney; 2 - cave contour; 3 - upper floor contour; 4 - boulders and talus; 5 - subterranean stream; 6 - continuation; 7 - narrow passage.

Fig. 5. Pod Luciferem Cave – a cascade on a subterranean stream (photo O. Jenka).



Descriptions of significant sites along the excursion route

Numbering of the sites corresponds to the numbers given in the map (Fig. 2).

1. Slavný: the highest-positioned village in the Police area (625 m a.s.l.) was founded by abbot Jan Chotovský in 1561 as the last community founded through the colonization of the Benedictine monastery in Broumov, not far from the crest of the Broumovské stěny cliffs. It is an important site for local year-round tourism and recreation.
2. Nad Slavným: a crossing of tourist trails on the crest of the Broumovské stěny cliffs at the boundary between their morphologically distinct northern part (a simple asymmetrical crest – a cuesta) and their southern part (a system of several sandstone structural plateaus). It is also a site of far views including that of the Krkonoše Mts. the ridge with the highest peak of Mt Sněžka (1603 m).
3. Slavný mushroom rocks: the most numerous group of mushroom rocks – mushroom-shaped cliffs of tor type with a more voluminous “cap” formed by a harder, more compact interval on the top, and a thinner “stipe” formed by softer, thinly bedded sandstone below. They pose a local tourist attraction.
4. Slavný viewpoint: a rock viewpoint above the steep eastern slope of the Broumovské stěny cliffs, providing views of the Broumovská Basin and the Javoří Mts. and Sowie Góry Mts. on the horizon.
5. Pod Luciferem Cave (Figs. 5, 6): a cave of boulder type, formed beneath a thick accumulation of blocks in the bottom of the Pod Luciferem Gorge (Lucifer: a tall, dominant rock pillar on the rocky edge of the crest). It is 405 m long, hosting a subterranean stream of one of the tributaries of the Martinkovický Stream. Relatively large domes (max. 20 m in length and 8 m in height) alternate with narrow passages. The cave has been known to speleologists for about 50 years and has been subjected to numerous surveys and biological and climatic studies.
6. Martinkovická Cave: a cave of boulder type, hosting one of the tributaries of the Martinkovický Stream. Basic investigation has not been completed yet, but the estimated length of the cave is over 200 m.
7. Urbární Cave: a combined crevice-boulder cave on the rocky edge of the Velká kupa Hill (708 m a.s.l.), first recorded as early as in the urbarry of the Broumov Benedictine dominium in 1676 as a long-standing wartime refuge for local population. Its basic archaeological research is under preparation.
8. Kamenná brána Arch (Fig. 6): a bizarre rock monument on the rocky edge of the Velká kupa



Fig. 6. The Kamenná brána Arch is one of the geomorphic peculiarities of the Broumov Cliffs (photo O. Jenka).

Hill (708 m a.s.l.), mentioned already in the urbarry of the Benedictine dominium in Broumov by its manager J. Hesselius in relation with visits of this romantic place by the Benedictine nobility.

9. Zelený hájek: a crossing of tourist trails in a saddle (710 m a.s.l.) between the structural plateaus of Velká kupa – Koruna (769 m a.s.l.) and Božanovský Špičák (773 m a.s.l.).

10. Tunel Cave (Fig. 7): a characteristic crevice cave developed in the SW margin of the sandstone structural plateau of Loučná hora–Koruna with a passable space (ca 50 m in length, crawling needed in rear part). Other caves of the same type are located nearby.

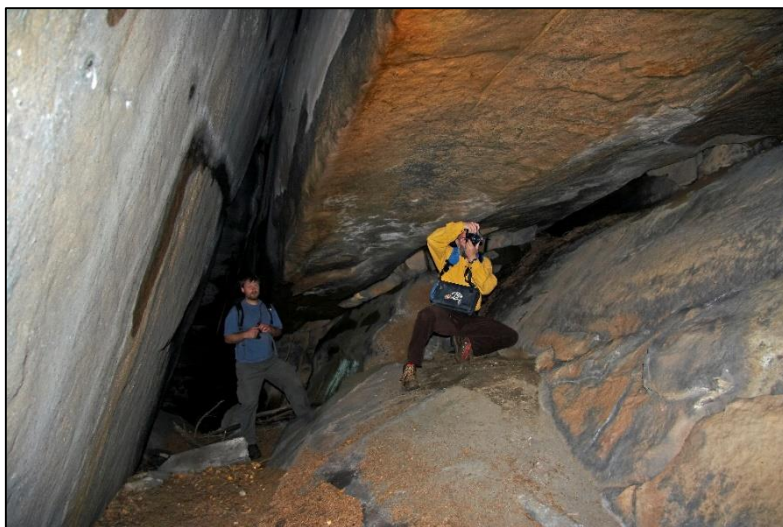


Fig. 7. The Tunel Cave is a characteristic crevice cave (photo O. Jenka).

11. Koruna Hill: a rocky summit (769 m a.s.l.) with a viewpoint on the southern margin of the Broumovské stěny, providing views of the Broumov Basin and the Kłodzko Basin, the neighbouring Stołowe Mts., mountain units of the Central and Eastern Sudetes (as far as Mt Králický Sněžník, 1425 m a.s.l.), exceptionally as far as the Jeseníky Mts. (Mt Praděd, 1491 m a.s.l.).



12. Olga Cave (Fig. 8): a cave system of boulder type in a gorge incised in the western part of the Božanovský Špičák Hill, hosting one of the tributaries of the Božanovský Stream. The cave comprises walking passages alternating with narrow crawl-up portions. A survey of the cave is under way now (estimated length: over 300 m).

Fig. 8. In the boulder system of the Olga Cave (photo O. Jenka).

13. Božanovský Špičák Hill: the highest peak of the Broumovské stěny cliffs, with a marked tourist loop trail on top of its summit structural plateau. The trail features a number of fantastically shaped rock formations including mushroom rocks. The rocky viewpoint on the southern edge of the summit provides far views of the near Stołowe Mts. and, across the Broumov Basin and the Kłodzko Basin, of the mountain units of the Central and Eastern Sudetes (Mt Králický Sněžník, 1425 m a.s.l., exceptionally Mt Praděd, 1491 m a.s.l.).

14. Pánův kříž Cross (730 m a.s.l.): a Baroque cross was erected in the saddle below the Božanovský Špičák Hill in 1827. It lies at the highest point of a pilgrim trail which has been used for centuries between Bohemia (Police nad Metují) and the pilgrimage centre of Wambierzyce in Silesia (now in Poland). The regular resting site of pilgrims is now an important crossing of marked tourist trails on the southern margin of the Broumovské stěny cliffs.

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