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Morfology and hydrogeology of Vârtop-Coiba Mică-Coiba Mare-Izbucul Tăuz underground system (Bihor Mountains)

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Abstract. The upper basin of Gârda Valley (Gârdişoara and Gârda) in the center of Bihor Mountains represents one of the most interesting karst areas, not only in Romania but also throughout Europe. On an aerial length of almost 4.5 km and over 500 m of difference in altitude, it develops a complicated underground drainage, which also contains some of the deepest sumps in Romania. The system is joined by some of the largest caves in România, such as Hodobana cave, Coiba Mică-Coiba Mare system, Pârâul Orbului cave, Iezere cave, Oii cave, Sohodol II pit and not least the important Tăuz spring (Izbucul Tăuz), explored so far on 1000 m length. All this karst system is the result of successive captures of the Gârdişoara Valley and losses in the adjacent hydrographic systems.

Introduction

The studied area develops in a massive limestone (400-600 m thick) of Upper Jurassic age within the Biharia terrane. On the other hand, in the Vârtop plateau the karst relief is in contact with deposits of the Lower Jurassic (clays, sandstones and quartz micro-conglomerates) belonging to the Hettangian-Sinemurian. This lithological contact led to a disorganized surface of hydrographic network, each

small watercourse is lost individually through ponor-caves or impenetrable swallets, the hydrographic organization taking place exclusively underground. The limestone deposits of Upper Jurassic age are affected by a fragile tectonics, of Saxon type, with many faults and major strikes (slip faults). It is noted a main fracture direction, NE-SW, and a secondary one, NW-SE. From the tectonic point of view, the whole area depends on the great fault of Galbena. The structural area is within a wide homocline. The limestone layers are inclined towards the SW, with falls of 30-40 degrees. The stratification discontinuities are either of the type of joints or of the type of diastema. These discontinuities played a major role, especially in the formation of the Coiba Mare cave. The hydrography of the area is focused on Gârdişoara and Gârda Valleys. Paleo-Gârda had a continuous course, but the karst capture from Coiba Mică cave, divided the entire valley into three sectors: the upper sector, Gârdişoara (between the Gura Apei spring and Coiba Mică cave), a short, medium sector, between Coiba Mică cave and Coiba Mare cave, with a character of sohodol (completely flooded by Gârdişoara only in large waters) and the lower-middle sector, of the Gârda Valley. The Vârtop plateau (developed at altitudes of 1200-1300 m) is a more complicated case, with countless small surfaces of water courses, which all have their source into the Călineasa plateau, creeks with lengths between 200 and 1000 m. The whole underground system has a final drainage point in Izbucul Tăuz spring, located at 850 m altitude, and having the highest discharge flow and depth in Bihor Mountains. But before the Izbucul Tăuz resurgence, Gârda Valley receives on the right the morphological confluence of the Sohodol Valley, a typical sohodol. An affluent of this sohodol is the Hodobana Creek, and in its left slope the largest maze in limestone of Europe, the Hodobana cave, is developed. Finally, in the upper sector of the Sohodol Valley, there is the Sohodol II pit, the karst plateau Iezere and Iezere cave at the watershed point.

Initially it was thought that the sole underground drainage is the one between Coiba Mare cave and Izbucul Tăuz resurgence, because in the 1950s the marking with fluorescein have shown this route. The explorations undertaken by the author, in collaboration with the Speleology Club „Z“ from Oradea, between 1973-2019, have demonstrated that we are dealing with a complex and impressive underground hydrographic network. Thus, a coloring done in 1980 in the Colibi cave (the highest one located in the Vârtop plateau) demonstrated a direct connection between the Colibi cave and the Pârâul Orbului cave, the colorant appearing in a tributary of this cave after only 3 hours. Another marking did in Pârâul Orbului cave showed fluorescein reappearing after five days in the tributary with sump (Black Sump) of the Secondary water course in Coiba Mare cave. With this spectacular coloring, a direct connection between the Vârtop plateau and the Izbucul Tăuz

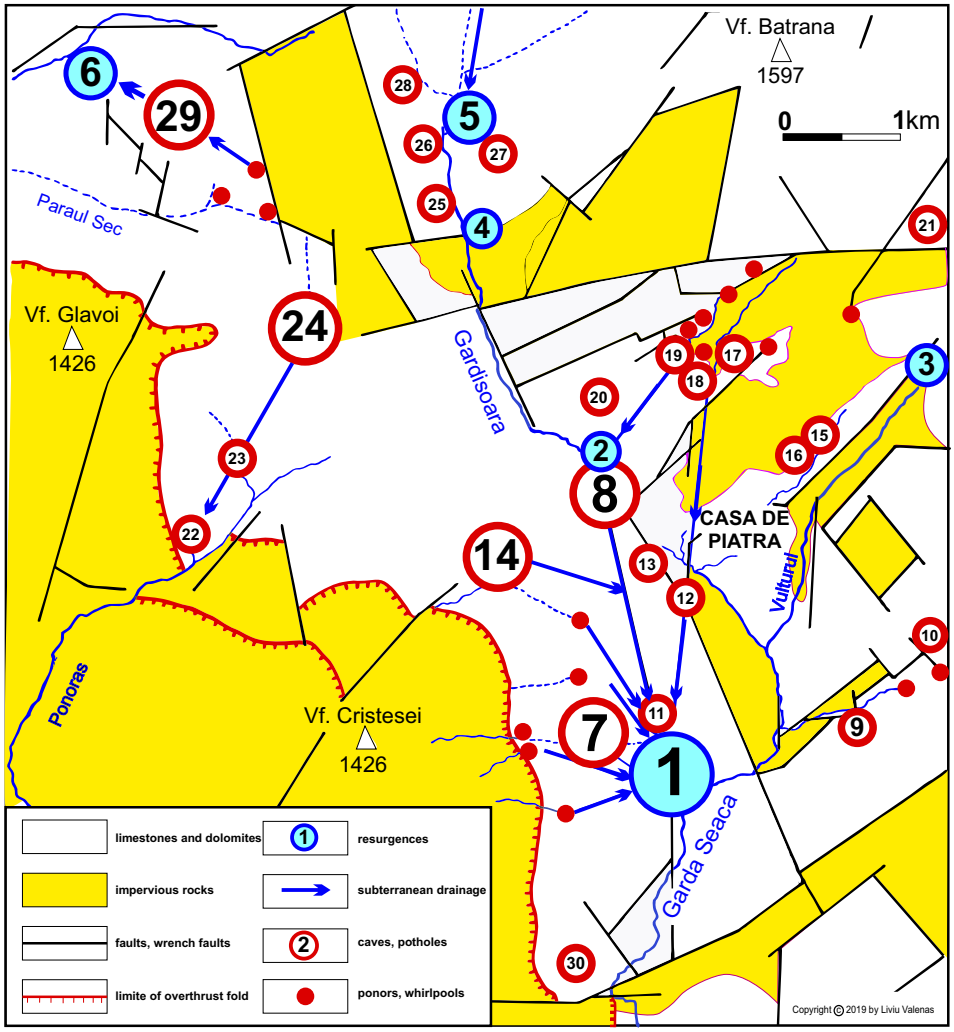

Figure 1. Geological and hydrogeological map of the area Casa de Piatră-Hodobana-Tăuz. (Cartography Liviu Vălenaș & Paul Damm). 1: Izbucul Tăuz, 2: Izbucul Coibița, 3: Izbucul Văii Vulturului, 4: Izbucul de la Coliba Ghiobului, 5: Izbucul Gura Apei, 6: Izvorul Rece, 7: Peștera din Pârâul Hodobanei, 8: Sistemul Coiba Mică-Coiba Mare, 9: Peștera cu Apă din Pârâul Brusturi, 10: Peștera-Aven din Pârâul Brusturi, 11: Peștera cu Două Intrări din Dealul Tăuz, 12: Peștera Mare din Băroaica, 13: Peștera Oii, 14: Avenul Sohodol II, 15: Avenul din Dunga Vulturului, 16: Peștera din Dunga Vulturului, 17: Peștera de la Colibi, 18: Peștera din Pârâul Orbului, 19: Peștera de după Deluț, 20: Peștera Ghețarul de la Vârtop, 21: Avenul I din Călineasa, 22: Peștera Moara Scochii, 23: Peștera Moara Dracului, 24: Peștera de la Iezere, 25: Peștera Șura, 26: Peștera cu Apă din Fața Bălăcenii, 27: Avenul I din Dâmbu Blidarului, 28: Peștera-Aven din Fața Bălăcenii, 29: Rețeaua Lumea Pierdută, 30: Peștera cu Patru Intrări din Pârâul Micușii.

spring was proved. The air-distance is 3.5 km, for a difference of altitude of 513 m, taking into account the deepest sump in the Izbucul Tăuz resurgence, its bottom being at an absolute altitude of 767 m. The relatively long time in which the dye appeared from Pârâul Orbului cave in to Coiba Mare cave makes us see a flow mostly under pressure. It is possible that at this secondary underground course (in relation to the first order drainage Coiba Mică cave - Izbucul Tăuz resurgence) other tributaries may also rally. However the underground courses in the Vârtop Plateau, i.e. those of the important De După Deluţ cave, De După Deluţ pit and De După Deluţ ponor, is finally organized into another underground drain, parallel to that between the Colibi cave and Coiba Mare cave, with final drain in the small spring of Coibiţa, located only 49 m in front of the large entrance from Coiba Mare cave. The discovery in 1979 of the great network of Hodobana cave once again demonstrated the complexity of the hydrogeological organization of the area. The three independent water courses in this underground network, including a 1020 m long underground river, have as their final drain the entire Izbucul Tăuz resurgence, and the Sohodol and Bolfu ponors, from the upper basin of the Sohodol Valley. The extremely small difference between the minus point of Hodobana cave and Izbucul Tăuz resurgence, of only 11 m, makes us to believe that we are still dealing with a flow under pressure. Paul Damm (Damm 2001) also saw in the Iezere cave, located 4.6 km air-distance from the Izbucul Tăuz resurgence, an insurgence of the Tăuz. Until proven otherwise (a coloring or marking) we are skeptical in this case. In contrast, the small water course of Sohodol II pit is, without discussion, a small underground tributary of the major drainage Coiba Mică - Coiba Mare system. For all these secondary drains (those from the Vârtop plateau, those from the Sohodol Valley basin and the Iezere cave), there are necessarily future markings.

Finally, lets deal with this major drain, Coiba Mică cave - Izbucul Tăuz resurgence. From the terminal sump (Lake of Death) from Coiba Mare cave to Izbucul Tăuz resurgence (sump no. 4), remains an air-distance of 1900 m and a difference of altitude of 80 m. Only this difference has made us to believe since 1978 to a partial flow in the vadose regime. This conclusion was also joined by Iancu Orăşeanu (Orăşeanu 1996), who, following new markings of this major underground course, highlighted a transit time of 7 days between Coiba Mică cave and Izbucul Tăuz resurgence, and during the 11 days of observation the flow had a single maximum, i.e. a piston type flow. According to Iancu Orăşeanu, the underground course has a free flow, without important tributaries, the delay of the tracer being due exclusively to the deep sump in Tăuz resurgence. In 2014 a team of Finnish divers, who attacked simultaneously, both the Tăuz Izbuc resurgence and the terminal sump in Coiba Mare cave, only partially confirmed this theory.

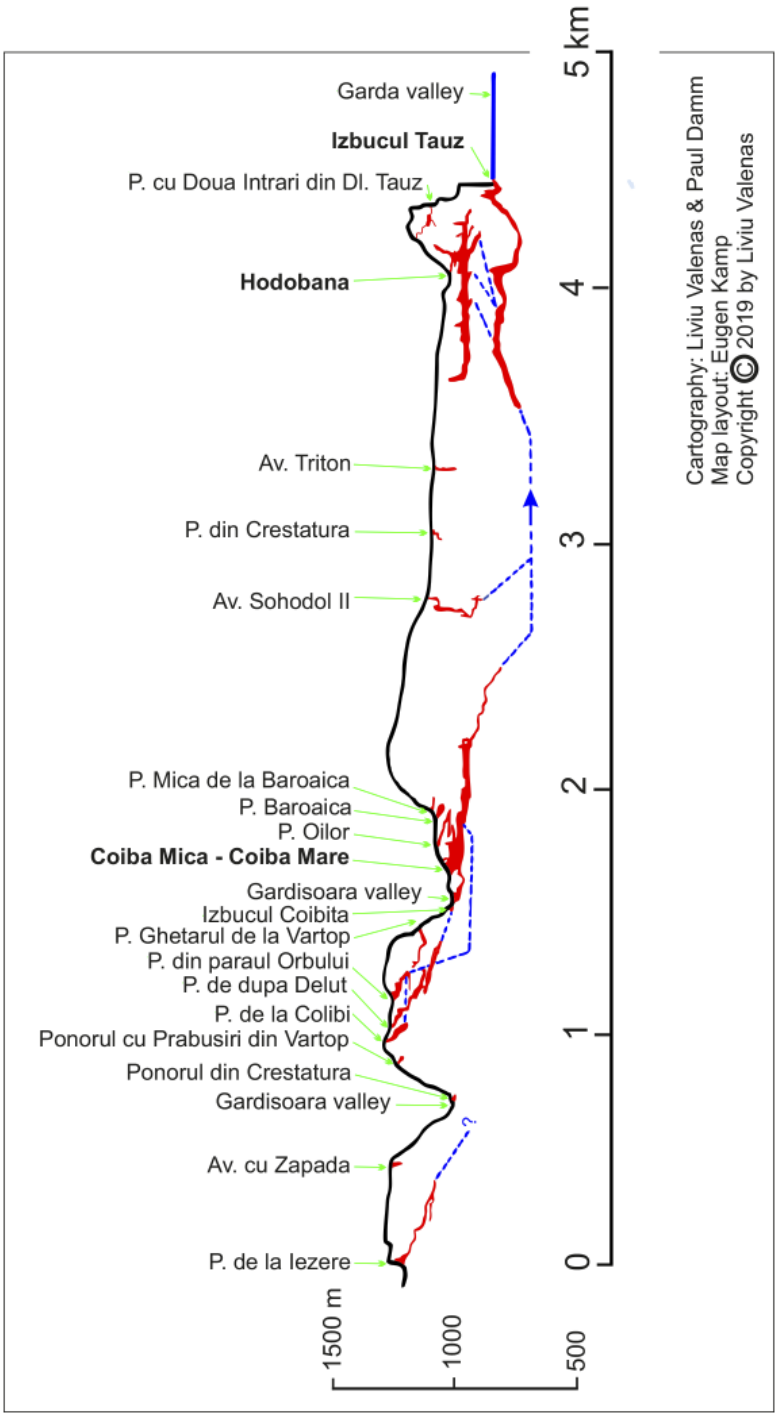

Figure 2. Longitudinal section of the Vârtop-Coiba Mică-Coiba Mare-Hodobana-Izbucul Tăuz area (Graphic by Liviu Vălenaș & Paul Damm).

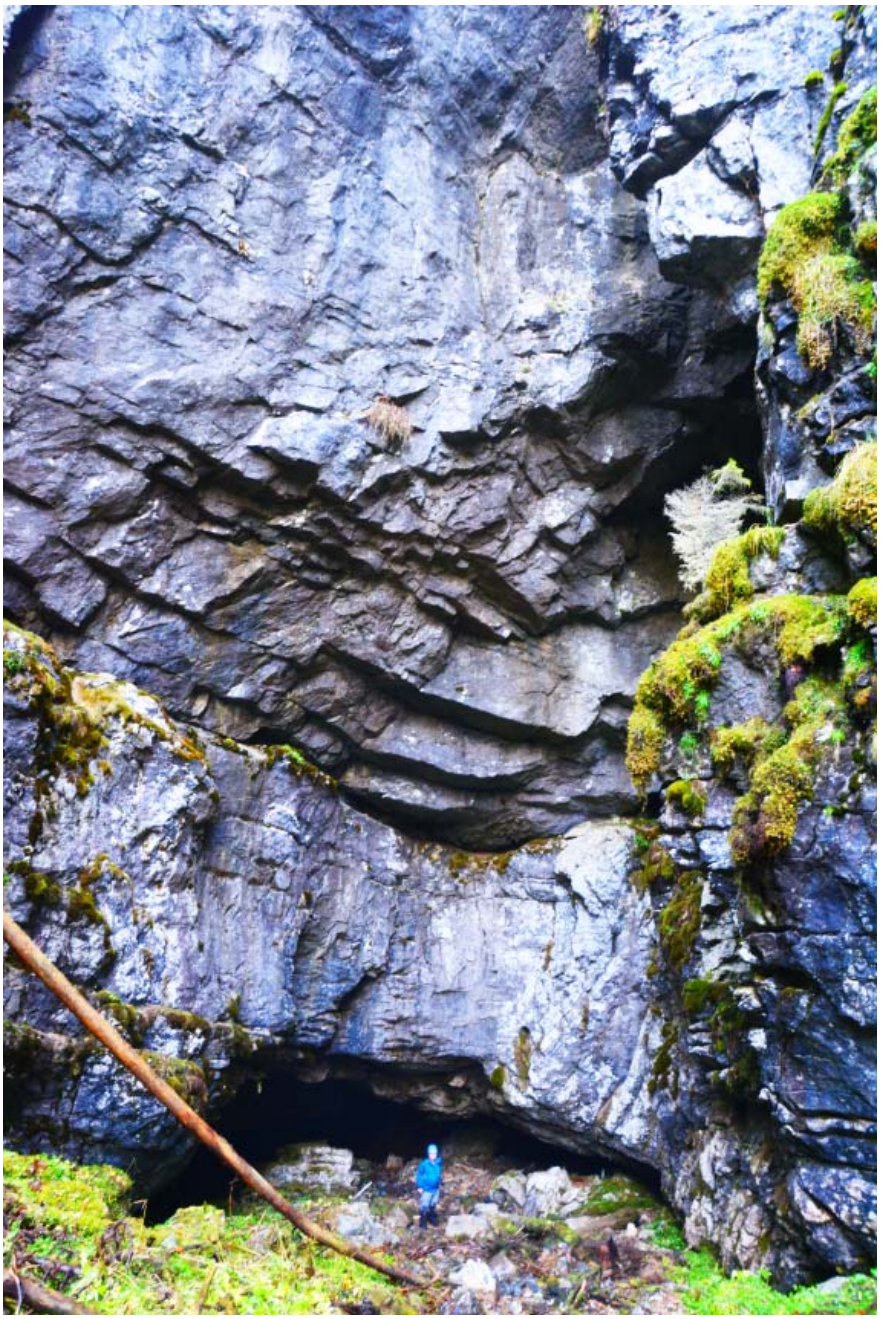

Figure 3. Pârâul Orbului cave in Vârtop plateau (Photo by Liviu Vălenaș, 2019).

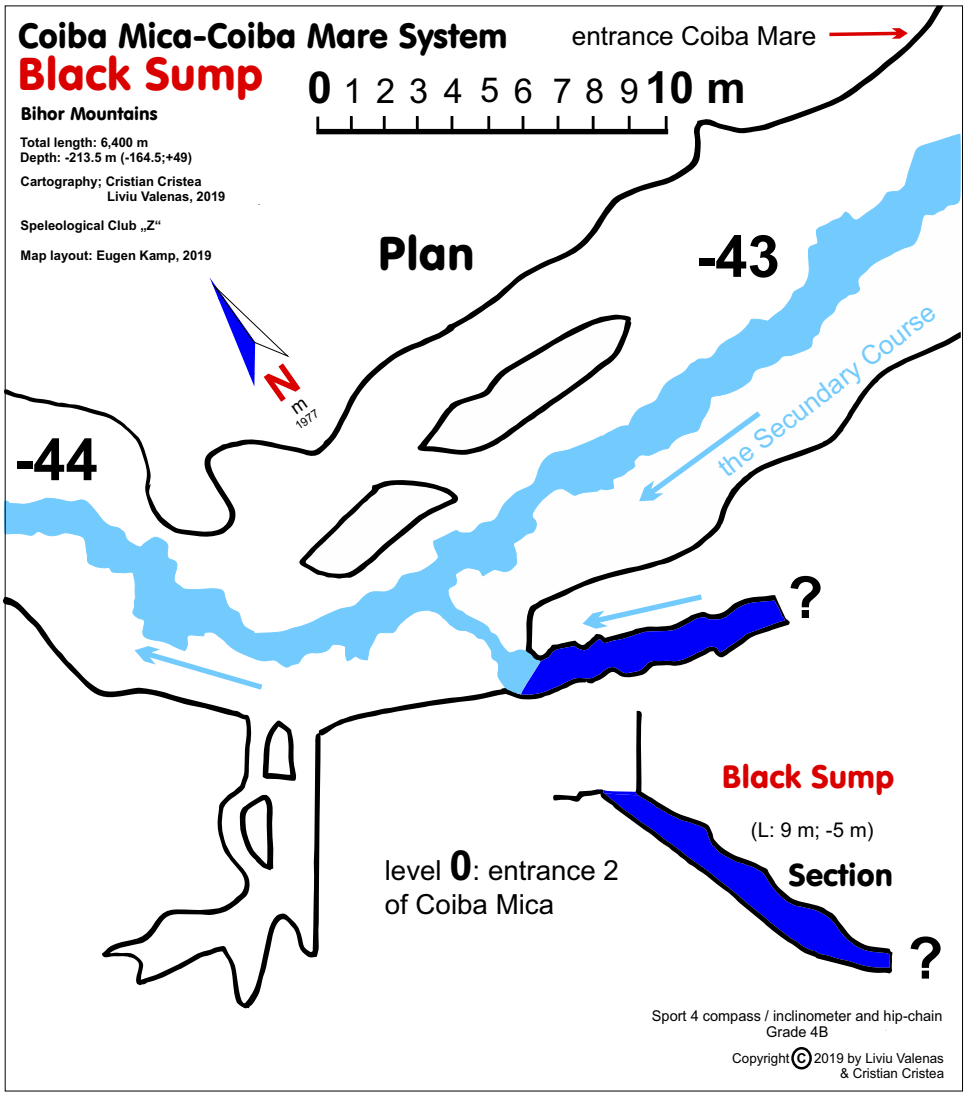

Figure 4. The Black Sump of Coiba Mare cave (Cartography by Cristian Cristea & Liviu Vălenaș, 2019).

Partly the underground course is vadose (in the explored area of Tăuz resurgence is also a waterfall of 4 m), but the explored gallery is divided by several deep sumps, the one in Coiba Mare cave is exceeding 100 m deep, so the delay of the tracer is due to several deep sumps. We observed no tributary on the vadose section of Izbucul Tăuz resurgence, but it is possible that the tributary from Hodobana, for example, appears submerged, directly in a sump (no. 2?).

Figure 5. Entrance to Coiba Mică cave completely flooded (Photo by Liviu Vălenaș, November 11, 2019).

The cave system Coiba Mică - Coiba Mare

The cave network Coiba Mică - Coiba Mare is an awesome Romanian cavern even if not the longest. The cave entrance portal is the largest, and its long stream has the biggest flow in Romania. A tremendous and complicated 4 km long phreatic-pipes maze at the entrance makes it unique in Europe. In 2014, scuba divers reached a depth of 92.5 m in final sump, a top national record of diving of that date (Pereţ & Drăgan 2016). The physical dimensions of the cave system are: total length: 6400 m; depth: 213.5 m (-164.5;+49); extension (not sump no 2): 585 m; total length/extension: 10.9.

History of explorations

The locals (Motz) have known the Coiba Mare cave's large entrance for hundreds of years. They named it Stone House (Casa de Piatră). Over time, the hamlet near cave received the name Stone House and the cave, the name of Coiba Mare to differentiate it from neighboring Coiba Mică cave.

In 1922, the biologists René Jeannel and Arnold (Arthur) Winkler visited the Coiba Mare cave (Jeannel & Racovita 1929). In 1953 and 1956, Marcian Bleahu, Iosif Viehmann and Dan Coman explored for the first time the cave

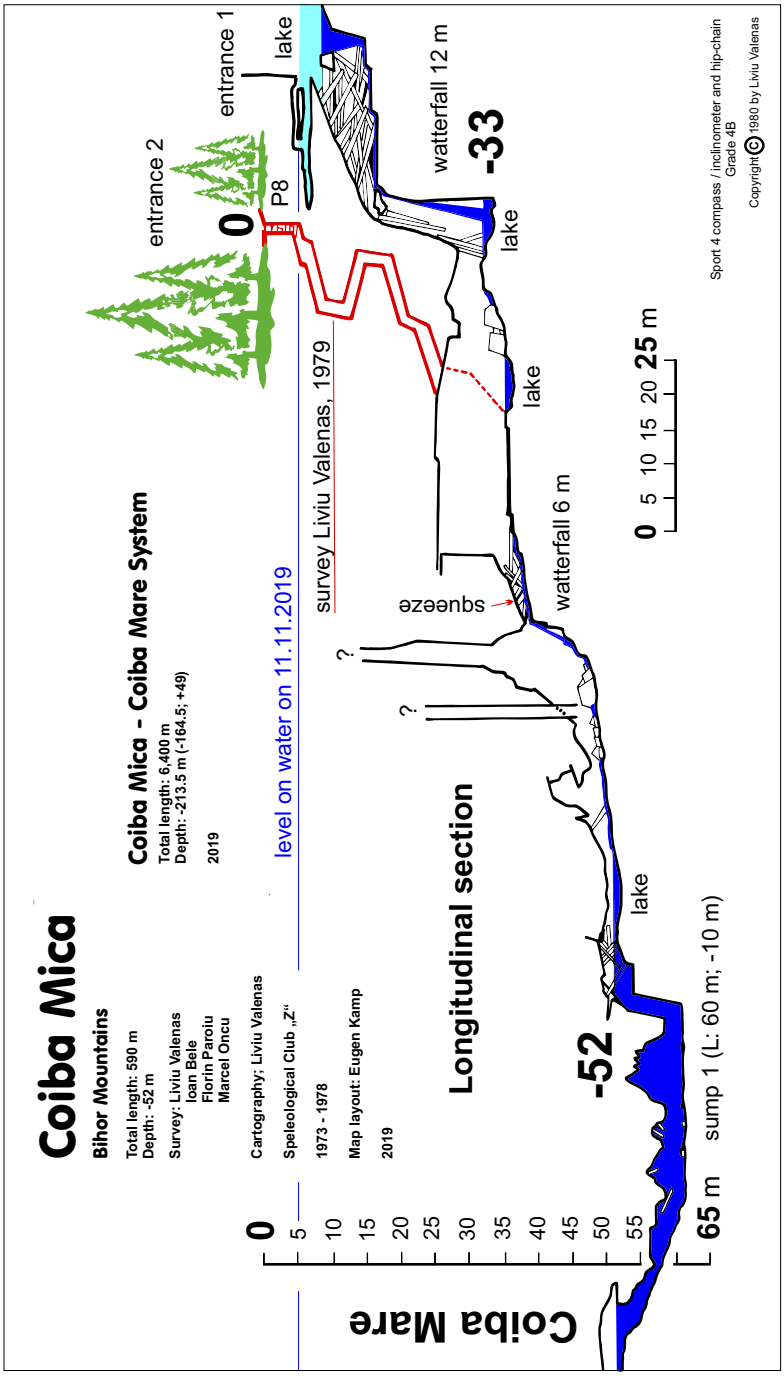

Figure 6. Longitudinal section through Coiba Mică cave (Cartography by Liviu Vălenaș, 2019).

Figure 7. The main entrance to Coiba Mare cave, the largest portal in Romania, 74 m wide and 47 m high (Photo by Dan Moldovan, 2018).

mainstream, limited by upstream and downstream terminal sumps. They surveyed 760 m and published the map in 1957, declaring the cave as “finished” and “of a local interest” (?!). As for Coiba Mică cave, Marcian Bleahu & co. defined it as “an impassable swallow hole” (?!). For the next two decades, the two caves fell in complete oblivion.

In February 1973 Liviu Vălenaş and Ioan Bele reached Coiba Mică cave and discovered not an “impenetrable swallow-hole”, but a true cavern. They explored and surveyed the cave on 270 m, but a sump stopped the downstream exploring. In 1975, the Speleological Club “Z” led by Liviu Vălenaş continued exploring and survey of the Coiba Mare cave. Between 1975 and 1976, the small team of speleologists: Liviu Vălenaş, Eleonora Vălenaş, Gheorghe Drimba and Emil Silvestru explored and surveyed the cave on 4724 m. The most significant result is a vast phreatic maze near the entrance, with a total length of 3874 m. The survey of the entrance portal proved it as the largest one in Romania: 74 m wide and 47 m tall. In 1977, a new team led by Liviu Vălenaş explored the cave with guest participation of Gábor Halasi†, Petru Brijan† and Ovidiu Cuc†. The length of the Coiba Mare cave reached 5400 m. In January 1978, the scuba diver Florin Păroiu (supported by Liviu Vălenaş, Nicolae Sasu, and Dorel Pop) passed the sump between Coiba Mare cave and Coiba Mică cave, realizing the junction between the two caves, the length of the new caves network reaching 5680 m.

Figure 8. Former open sump 1 of Coiba Mare cave, now the floods have completely swept the floor of the secondary course (Photo by Liviu Vălenaș, 2019).

Figure 9. The entrance to Coiba Mare cave flooded after a flood produced in winter (Photo by Ovidiu Guja, December 31, 2010).

Liviu Vălenaş published in 1978 the detailed map of the 5680 m (Vălenaș 1978). In 1979 Nicolae Sasu, together with a group of Polish speleologists, discovered a small pothole near Coiba Mică cave, making the junction with Coiba Mică cave. The total length of the cave system Coiba Mică - Coiba Mare is thus 6140 m. In 1979, the search for airy-parts in caves ended. Plunging in last Coiba Mare cave sump (Lake of Death) was sole choice to advance. In 1982, Liviu Vălenaş invited László Czakó, a Hungarian scuba diver to dive the lake. A giant plug of submerged timber logs forced the scuba diver to abandon at 16 m depth. Between 1973 and 1982, Speleological Club "Z" organized 14 exploration camps attended by 57 speleologists and scuba divers.

In 2014, a small group of Finnish scuba divers: Sami Paakkarinen and Patrick Gronquist, in collaboration with Adrian Pereţ, did a great performance in the downstream sump of Coiba Mare cave (Lake of Death). They dived 200 m up to the depth of 92.5 m, a top record of Romania (Pereț & Drăgan 2016). With this last action, the underground system reaches 6400 m total length and a deep of 213.5 m (-164.5; +49). In 2017, Speleological Club "Z" collaborated with the scuba diver Cristian Cristea. The last one dived for the first time the small sump

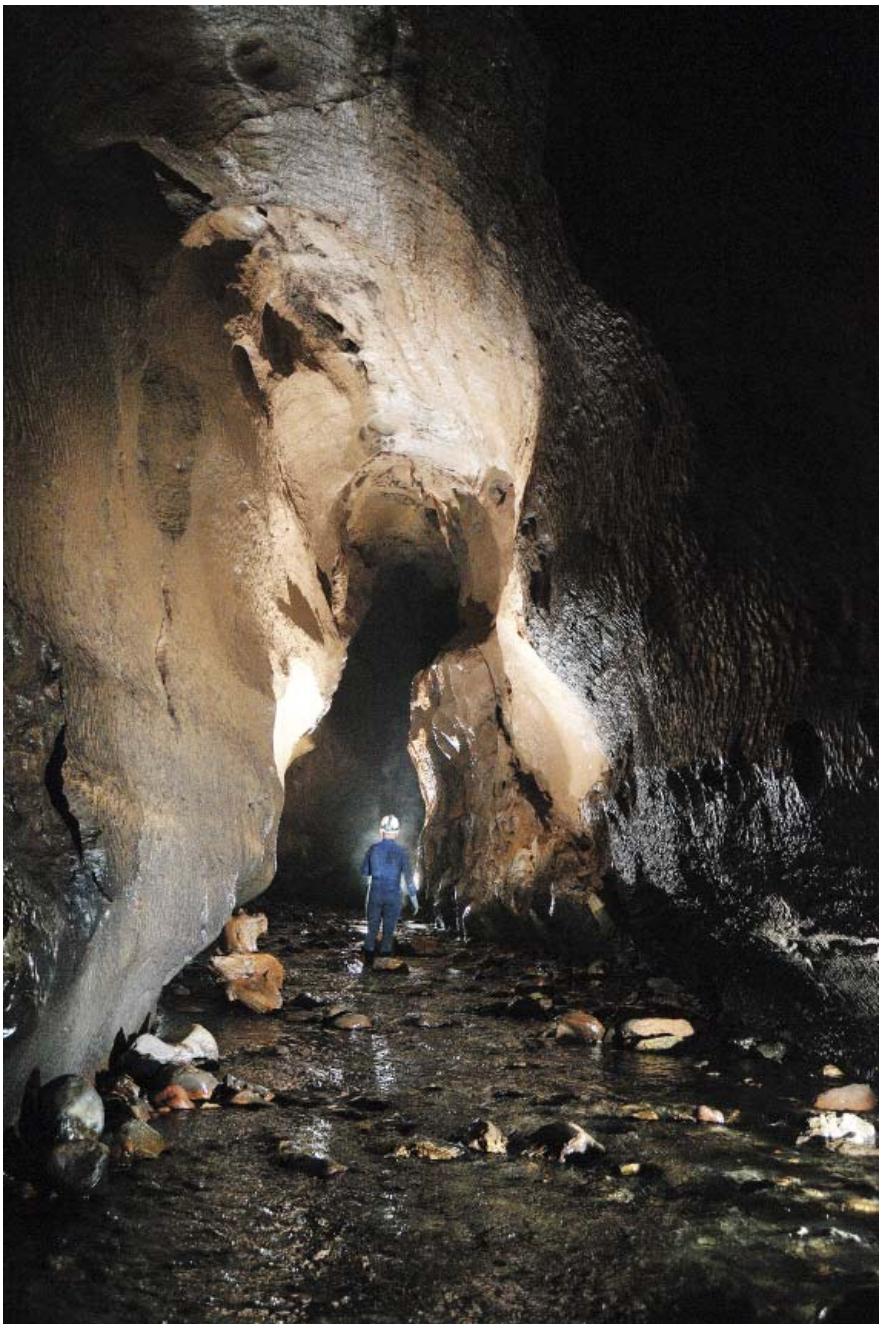

Figure 10. The Secondary Course in Coiba Mare cave (Photo by Ovidiu Guja and Iosif Gergely, 2014).

downstream of the open sump in Coiba Mare cave. He advanced 9 m to a depth of 5 m. Diving in this sump will resume soon.

Description

The caves network has two main entrances: Coiba Mică and Coiba Mare. Each has an active course joining underground one with other. The main water stream (underground Gârdişoara) enters through the Coiba Mică cave and runs the network on 725 m length. After 341 meters, the main course joins with the 317 m long secondary watercourse (from Coiba Mare cave). Tributaries of up to 85 m length add to cavern hydrography. In this active compound, must add the impressive 3,873.5 m long fossil maze, from the entrance in Coiba Mare cave. It is three quarters of the total length of the cave network Coiba Mică - Coiba Mare.

The entrance in Coiba Mică cave (1016 m altitude, elevation 0 m of the network: the pothole, 1028 m altitude) is at the of a 12 m high antithetic rock-step. After a 20/3 m entrance portal, the cavity presents a short descending path followed by a 12 m deep waterfall, the largest of the entire network. At the base of the waterfall, it opens in a 28/21/12 m hall, developed along the limestone layers. The active gallery presents a narrow passage of 1/1 m, and a 6 m waterfall dropping into an 18/13/15 m room full of boulders (Blocks Hall). The gallery continues more rectilinear, and after passing an open sump (ceiling at 0.5 m) at -35 m, it reaches the Sump 1 of the network, dived on January 1, 1978.

Downstream of Sump 1, the main watercourse passes through a 128 m gallery with a section of 5/4 m, having three notable lakes (one of these is 22 m long). After 341 m and at -40 m, the mainstream receives the waters of the 317 m long secondary watercourse, in the Confluence Hall (35/20/17 m). The secondary watercourse penetrates from the surface through the 74/47 m portal of Coiba Mare Cave (elevation -28 m, altitude 1000 m). At 8 m and 10 m east of the main entrance, opens two secondary fossil entrances, suspended in the wall of the large portal, with sizes of 7/2 m and 2.5/5 m. These two entrances open into a network of low galleries with phreatic morphology: the tube network. Through 14 phreatic tubes with lengths of 7-15 m (developed along rock layers), the 314 m long network communicates with the Great Hall and A.M. Winkler Hall.

After the great 74 m/47 m portal follows Great Hall (95/47 m), one of the largest halls in Romania. The Great Hall assures a connection to several small networks, belonging to the large maze from the entrance. At 60 meters from the entrance, on the left side of Great Hall, is the A.M. Winkler Hall (23/16/18 m), full of limestone blocks (-22 m). From this chamber extends to south the Bears

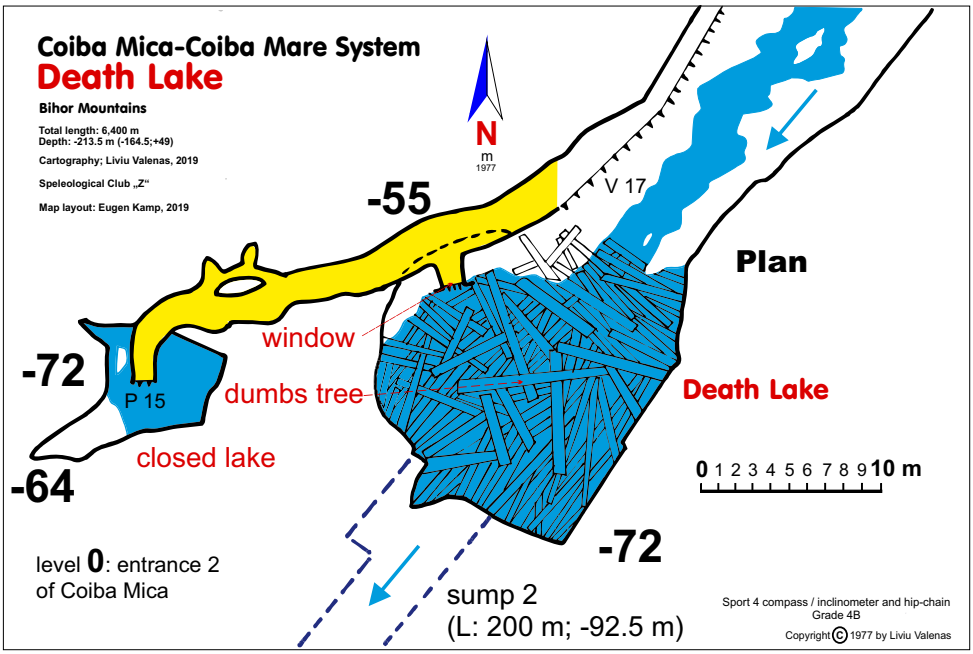

Figure 11. The terminal sump (Lake of Death) in Coiba Mare cave, cartography by Liviu Vălenaș, 2019.

Gallery one of the cavern's important galleries. The gallery has a length of 172 m and climbs on 41 m. Adding its upper and lateral floors the total length of this cave part reaches 670 m. We discovered the Bears Gallery in January 1976 after an unclogging. The Bears Gallery is one of the most magnificent cavities (with sections of 10/30 m), with a slope of 20-37 degrees covered by moonmilk. The horizontal terminal part bifurcates into two branches ended at 31 m and 24 m elevation. From -16 m elevation in the Bears Gallery, a 34 m long near-vertical chimney reaches the upper level of the Bears Gallery, representing a 314 m long maze floor. Through two other drops of 30 m, the upper level communicates again with the Bears Gallery. Between the 32 m level and elevation of 10 m, a 51 m long intermediate level exists that does not extends to the Bears Gallery.

Back to the 74/47 m portal, in its overhung ceiling, between the elevation -5 m and +9 m (+23 m and +37 m above Coiba Mare cave entrance), there are entrances to three galleries. Only the gallery at +9 m has important development. This gallery is a maze at the beginning (with many rock pillars), then presents two important drops of 20 m (obstructed) and 40 m who communicates to the Great Hall.

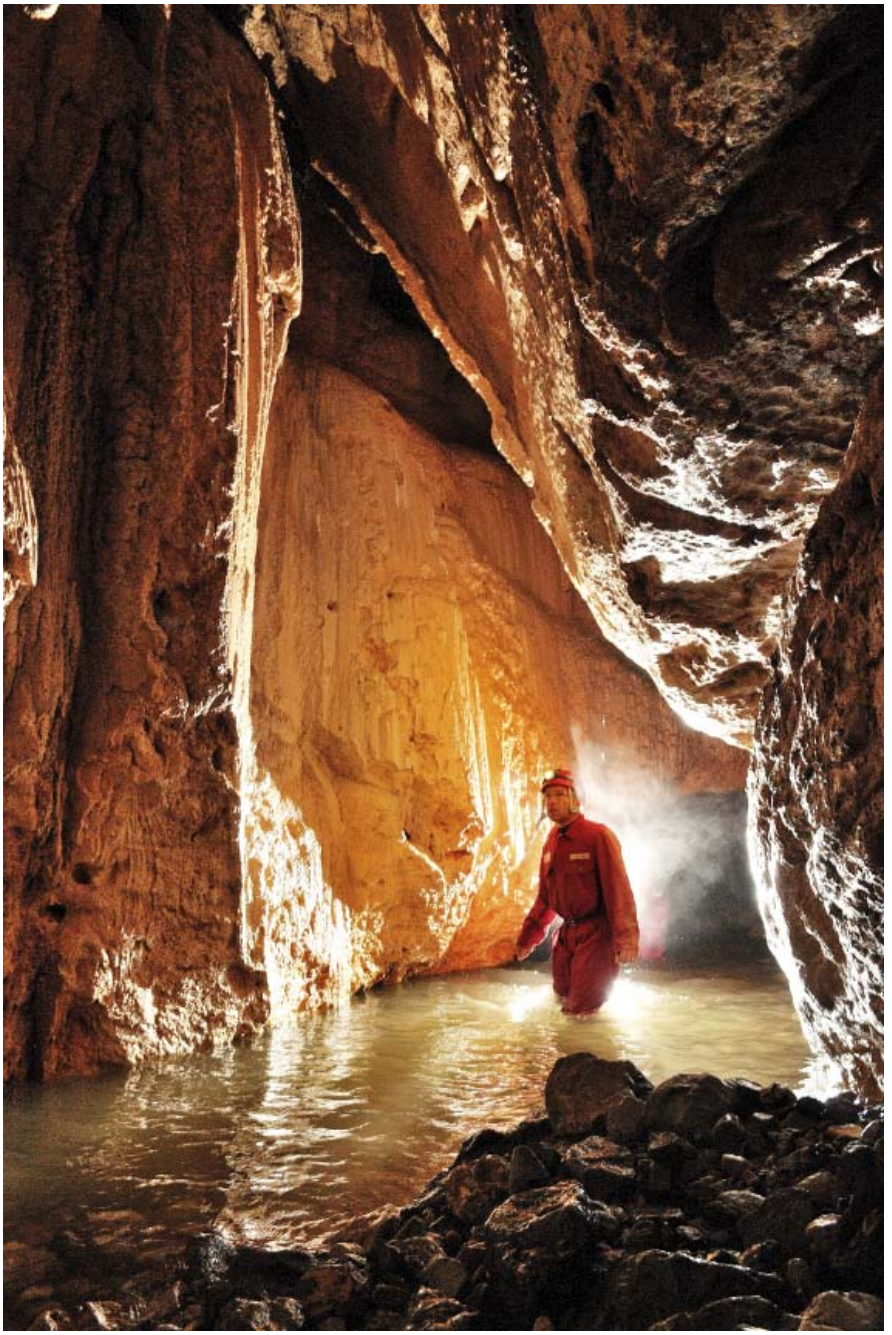

Figure 12. The main course in Coiba Mare cave (Photo by Ovidiu Guja & Iosif Gergely, 2014).

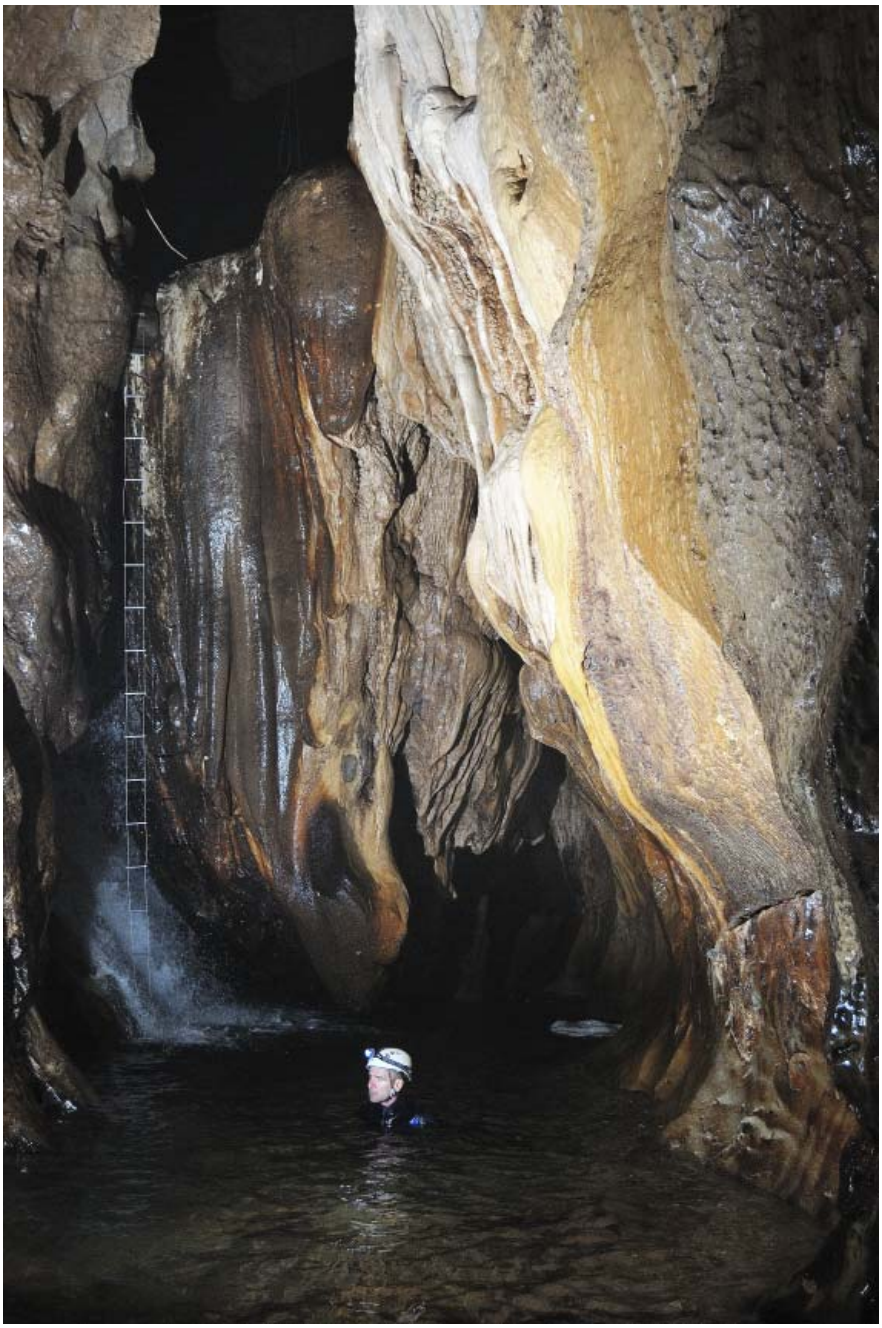

Figure 13. The 6 m high waterfall on the main course in Coiba Mare cave (Photo by Ovidiu Guja & Iosif Gergely, 2014).

In Great Hall's south-eastern wall, opens (on faces of rock layers) nine phreatic tubes. They belong to a 967 m long maze network (the Great Maze) on a 115 m horizontal distance. The tubes have a diameter of 1.5 m to 4 m and appear as a spider net. At every 5-10 m is a branching, and the next gallery exposes the same features. An impressive gallery of the Great Maze is a straight 27 m tube with a 1.4/2 m elliptical section. The Great Maze communicates with the active downstream from Great Hall, and also a descendant gallery intercepts a tiny, inactive sump linked to the inaccessible active network of the fossil maze.

In Great Hall's western part, following a wide 14-m-long gallery, it extends to the René Jeannel Hall, the next large hall (55/22/45 m) in Coiba Mică-Coiba Mare cave network. The most important gallery starting from this chamber is a 106 m long slide, a 30-60 degrees ascending slope, difficult to explore it due to moonmilk. At the Big Slide's upper end three rooms are developed, disposed at high levels. The highest point reached in the Coiba Mică-Coiba Mare cave network is White Hall at +49 m. The Big Slide rises to 85 m above René Jeannel Hall. At +4 m in Great Slide opens the 438 m long Small Maze, having the same morphology as that of Great Maze. We must mention two karstic items: a 70 m long active gallery passing above Grand Hall's watercourse and a 37 m deep pit communicating with Great Hall. Above this pit it is rising a 13 m tall chimney; a 50 m drop fragmented in two parts. The 37 m pit is linked to the 124 m long galleries of the Cheating Maze.

The secondary watercourse crosses Great Hall and reaches after 137 m in the active gallery the Open-Sump (a 2 m long ceiling lowered to 0.5 m). After Open-Sump the cavern's morphology changes. The maze portions are missing and the active galleries build the network. After their joins to the mainstream in the Confluence Hall, the united watercourses flow about 386 m, in an 15/20 m imposing gallery to the terminal sump (Death Lake) at -72 m. On this 386 m long segment of the cave, the active gallery receives only one notable 53 m long tributary, and it develops a top floor, represented by six galleries, the longest having 70 m. An escalade of 17 m upstream of Lake Death it is intercepted the last 23 m long fossil segment of the cave. From here, through another 15 m drop, we reach an another sump lake at −72 m, closed completely. The distance in plan, between this sump and the Lake of Death, is only 14 m. In 2014, scuba divers dived the terminal sump (Death Lake), Sump no 2, through a surprising 200 m long gallery with several 1/5 m sections and a negative slope, to the depth of -92.5 m and the gallery still continues (Pereţ & Drăgan 2016). In conclusion Coiba Mare cave has one of Europe's deepest sumps.

Figure 14. Phreatic morphology in the Great Maze of Coiba Mare cave (Photos by Liviu Vălenaș, 2019).

Figure 15. Phreatic morphology in the Great Maze of Coiba Mare cave (Photos by Liviu Vălenaș, 2019).

Figure 16. Phreatic morphology in the Great Maze of Coiba Mare cave (Photos by Liviu Vălenaș, 2019).

The Coiba Mică - Coiba Mare cave system is developed on a horizontal distance of 585 m (not sump no 2) and has a branching coefficient of 10.9, one of the highest figures for the endokarst of Romania. This high figure is for the Coiba Mare cave entrance's maze, which has 3,873.5 m and means 60.5% of the total cave network. This maze develops on a horizontal distance of 225 m, with a branching coefficient of 17.2. The remaining 31.8% (i.e. 1,806.5 m) of the cave network it is developed on a horizontal distance of 550 m, with a branching coefficient of 3.5. These figures prove that the Coiba Mică - Coiba Mare cave network comprises two distinct parts: a poor-branched active part, and a multiple-branched fossil labyrinthine part.

Geology and tectonics

The cave network Coiba Mică - Coiba Mare is developed in the fractured-limestone of Upper Jurassic age and in a frail tectonic of Saxon pattern. It is obvious on the cave's map that the galleries are developed along two-main-fractures: NE-SW and NW-SE, resembling a chess-board pattern. On the surface it may be recognized this tectonic pattern in the Gârdişoara - Gârda region.

Morphology and genesis

The Coiba Mică - Coiba Mare caves network is created from the water loss in distinct stages of Gârdişoara Valley. At beginning, losing water in the river-bed created the phreatic tubes maze in the Great Hall of Coiba Mare cave. Later, the two-stages sinking of the groundwater table shaped a two-level maze of galleries at 30 m high. The arrangement of phreatic tubes is in an angled plane and 50-m-deep wells make the access between the two epiphreatic levels. This model of tubes and wells from Coiba Mare cave is similar to the D.C. Ford's model for the Mendip region of England and named as phreatic-loop by D.C. Ford (Ford 1965, 1971). The valley has further deepened its bed and resulted in a fossil maze in which the re-shaping in vadose-regime stopped. The current entrance to Coiba Mare cave captured the valley through a vacuum capture- a theory imagined by M. Bleahu (1957). Then, the insurgence moved 370 m upward in the valley, i.e. the present entrance of the Coiba Mică cave. From that moment, the vadose regime re-shaped the cavern current active galleries. As regards the Great Hall (95/47 m) of Coiba Mare cave, a major north-south oriented fault disturbed the stability of the strata, resulting in their collapse and it created the hall. Then, dissolving emptied the hall of limestone blocks.

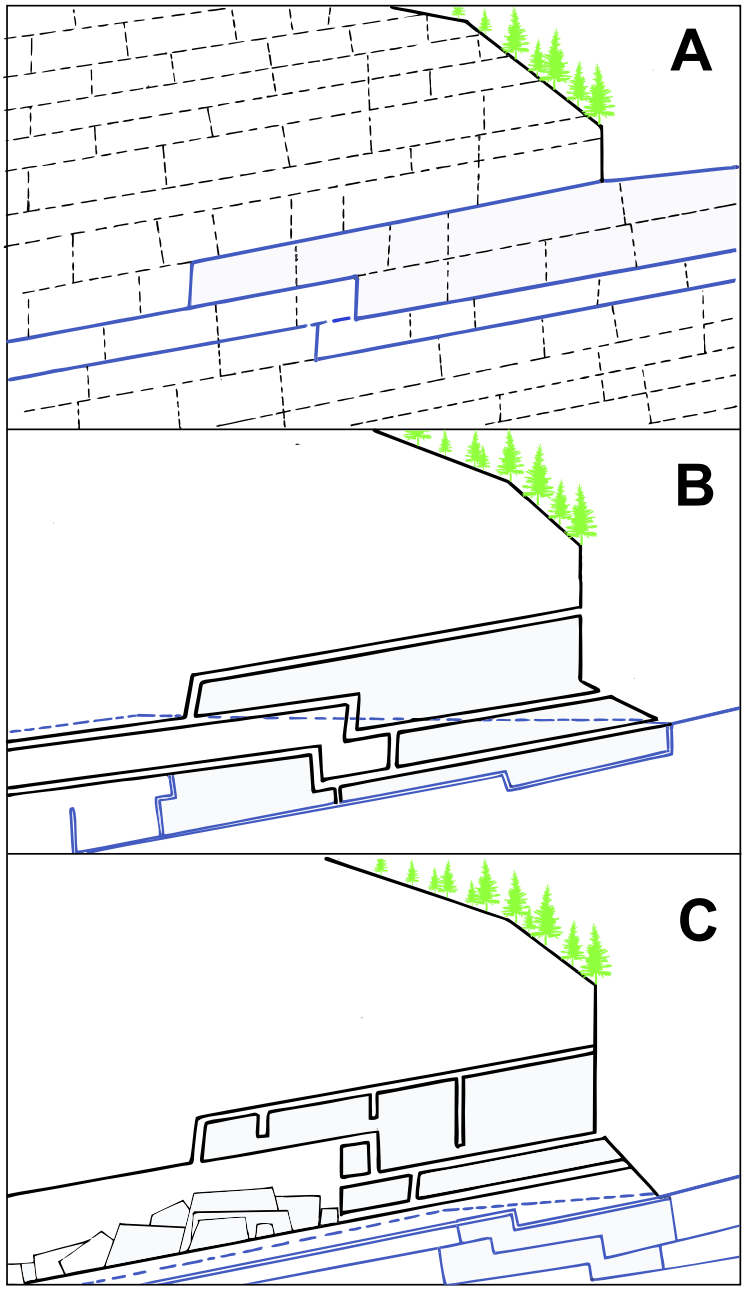

Figure 17. How formed the Great Maze and the Great Hall in Coiba Mare cave (Graphic by Liviu Vălenaș, 2019).

Figure 18. Izbucul Tăuz spring (Photo by Adrian Pereț, 2014).

Hydrogeology

The cave network of Coiba Mică - Coiba Mare has several active water courses. A 925 m long course drains Gârdişoara Valley through Coiba Mică cave and includes the sump where it dived 200 m. Then, a 317 m long secondary stream getting out from Coibiţa Spring and after only 49 m on the surface it penetrates into Coiba Mare cave through the large 74 m wide portal entrance. Coibiţa effluent drains the karst from the NW part of the Vârtop plateau. Both active courses, after their uniting in the Confluence Hall, receive eight other small tributaries with lengths up to 85 m, coming from infiltration water, and a high flow tributary that comes from the Black Sump. The last one drains the SE part of Vârtop plateau and caves from Colibi and Orbului Creek, according to a fluorescence marking performed in 1980. The drain of the entire caves network Coiba Mică - Coiba Mare is through the great Tăuz spring, at a horizontal distance of 2600 m (1900 m from sump no 4 of Tăuz) from the final sump in Coiba Mare cave. In 1978, L. Vălenaş (1978) imagined a theory for the last underground watercourse saying that the water flow alternates the vadose regime with that one under pressure, through very deep sumps. Finnish divers validated that theory in 2014.

As a curiosity, in Coiba Mare cave there are two active galleries that extend one above the other. A tiny stream of the Little Maze, going over the water course of Great Hall. Through the Tăuz spring, it drains water from the Colibi cave. So, the

whole hydrogeological network has a horizontal length of 3500 m and an elevation of 430 m (513 m, considering the sump 2 of Tăuz).

Climatology

The temperature inside the caves varies between 4.1 and 5.0 °C (4.1 °C has been registered in René Jeannel Hall on November 15, 2019). Humidity is over 90% (92% - René Jeannel Hall, November 15, 2019) and the cavern is strong ventilated. In winter time, in Great Hall at the cave entrance and in the most of Great Maze, the air temperature is between -5.0 and -10 °C , which leads to spectacular ice formations (stalactites and curtains up to 12 m high).

Comments

The caves network Coiba Mică - Coiba Mare is a unique cavern system in Romania, because of the 3.8 km long maze of phreatic tubes. The epiphreatic flowing created this maze (Vălenaș 1978). In 2018, C. Ciubotărescu and B. Onac (Ponta & Onac 2018) thought to a deep-phreatic pattern for the maze genesis, but they visited only the periphery of the maze. Genesis for the rest of the caves network is a vacuum capture of water imagined by M. Bleahu in 1957 (Bleahu 1957). The karst beneath Gârdişoara Valley sucked firstly the water stream through the swallow-hole Coiba Mare, then through the now-clogged pit near Coiba Mică cave and finally through the swallow-hole Coiba Mică. Today, a 35 m and 12 m antithetic steps divide the Gârdişoara Valley. Climatic oscillations in the Pleistocene and Holocene changed the river valley. An interlude of catastrophic rainfall, determined a temporary clogging of the Coiba Mare cave entrance, and resumption of subaerial course by the Gârdişoara Valley. We acknowledge M. Bleahu's ideas on the periglacial act in the full cavern genesis (Bleahu 1964).

Sohodol II Pit, a classic of the alpine speleology

Sohodol II pit is one of the deepest pit cave of Romania. Its depth of 193 meters and its 20 vertical shafts, give to it the status of European alpine pit cave. The physical dimensions are: total length: 507 m; depth: -193 m; extension: 74 m.

History of exploration

In September 1979, R. Sima, R. Părălișteand Z. Tabără from Turda City's Caving Club „Casa de Piatră" discovered and explored Sohodol II Pit to a depth of 37 meters. R. Sima, L. Pop and D. Felea resumed the pit research in June 1980. They

halted at -92 m by equipment problems at the deepest pitch, P38. Consequently, R. Sima signed an agreement of exploration with Speleological Club „Z“. On September 2, 1980, Liviu Vălenaș, Radu Sima, Lucian Pop and Dan Felea reached -193 m, the bottom of the pit cave, and surveyed the cavity. All action lasted less than 12 hours.

Description of Sohodol II Pit

Sohodol valley hosts the Sohodol II pit at 1150 m above sea level on the left slopes, at 40 m height above the bottom of the valley. The pit is 2,5 km upstream of Sohodol valley confluence with Gârda Valley (Gârda Seacă). The Sohodol II pit entrance is on the mountain rim. The interfluve has on opposite slopes (between Gârdişoara and Gârda Valleys), exposing the entrances to cave Coiba Mică-Coiba Mare (6400 m total length), Oilor (545 m length) and Băroaica (70 m length). Set in limestone pavements, the entrance of 0,55 m/0.40 m in Sohodol II pit enables the access to one shaft of 25 m depth (P 25). This shaft is like a cone. Following an accumulation of timber forming an unstable plug, a sloping gallery of 10 m continues through a vertical pit of 3.8 m (P 4) to a chamber of 2 m/2 m/7 m. From this room (-33 m depth), the cavity continues through a near horizontal gallery to the next shaft (P 34). The gallery has narrow passages and corallites. The stones‘ collapse produced a chaotic landscape of false „loops“. One of them is Dan Felea Chamber, 11 m/4 m/17 m.

At -40 m depth, is situated the opening of the second big overhanging pitch (P34) and at -54 m with a slight balancing of ropes, a platform may be reached. At -74m, the base of this shaft has a section of 7 m/4.5 m. After a short horizontal passage, a 45° galley with a 1m /4 m section continues immediately with two 8 m and 9 m overhanging vertical pits (P 8 and P 9) and has the access to a room of 8m/4m/14m, at -92 m depth. On the southern part of this hall is the opening of the biggest overhanging pitch of 37.7 m depth (P38). Like in P 34, a slight balancing at -110 m, allows reaching a good platform. The base of P 38 is wide of 7m/6 m (-130 m depth).

From this depth, the morphology of the pit cave is slightly changed, the shape of the cavity resembling a ‘canyon’ gallery. Although the vertical pits chains up to the final depth of -193m, they are of small size (generally between 2 and 4 m). Thus three negative steps (2.5 m, 3 m, 3 m) lead to a pit of 4.7 m (P5). At -150 m depth, following to three negative steps (between 1 m and 2.2 m), the orientation of the cavern is changing from N - S to SE - NW and stays up to -193 m depth. However, the morphology of the cavity remains the same. From -150 m depth, it

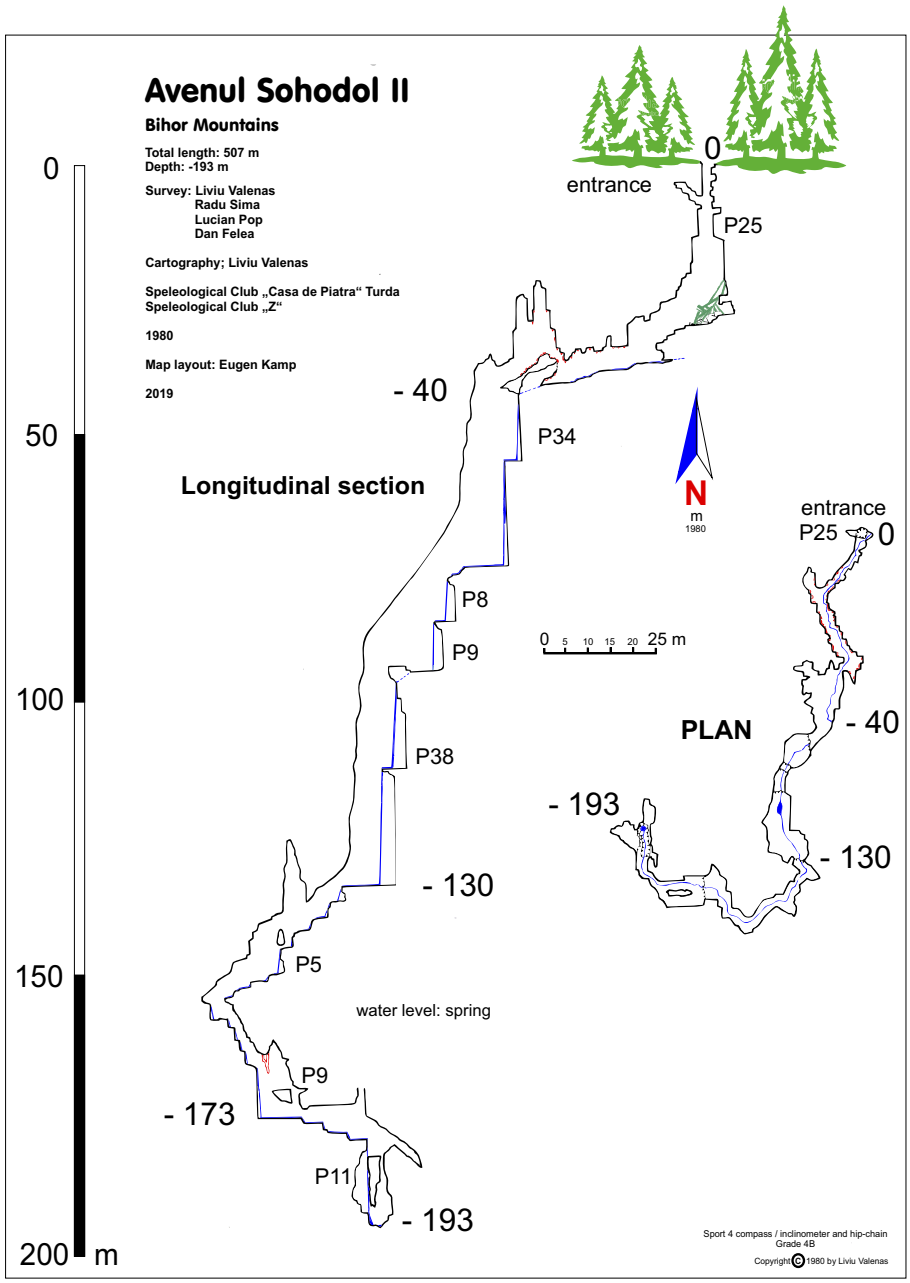

Figure 19. Sohodol II pit, longitudinal section and plan (Cartography by Liviu Vălenaș, 2019).

reaches -164 m depth through negative vertical steps, the biggest of which are 3.8 m, 3.0 m and 3.4 m, respectively. A slightly deeper pitch (P9) follows in a hall of 6m/3 m size at -173 m depth. This hall has the stone pillars resulted by contacting of parallel pits. From here, there are two ways ahead: a narrow canyon and a clay gallery in the top (with a section of 0.6/0.6 m) called the 'corkscrew'. Following four negative steps of 1 m, 0.2 m, 1.8 m and 1 m, a vertical pit of 3 m (P 3), extends in the Puțul Imposibil Hall (-180 m). After a 10.4 m shaft (P 11), followed immediately by another pit of 2.5 m depth (P 3), it reaches the bottom of the Sohodol II pit at -193 m depth. From this point there is not any hypothetical possibility of going deeper.

The development of Sohodol II pit is 507 m. 62.7% are vertical shafts, and 37.3% horizontal and angled galleries. Must underline the depth of 193 m is a chain of vertical pits only. It is an unusual case in the Bihor Mountains. Another note is about the short gap between vertical shafts(e.g. from - 40 m depth downwards the maximum break is 7 m). The pit cave has a unique verticalness and a total extension of 74 m. This morphometric depicts an alpine pit.

Geology and Tectonic

From the lithological point of view, the pit is developed in the Early Cretaceous limestone of Barremian or Aptian ages. The pit, however, extends probably into the Tithonic limestone at the bottom of the pit. The study of geologic sections might prove this theory. Sohodol II pit is developed along rock fractures, into a similar network of cracks like Coiba Mică-Coiba Mare cave system did.

Morphology and Genesis

The basic rock is visible everywhere inside the cavity. Dropping stones and clay deposits are not characteristic. From the -150 m downwards, it can see common speleothems. Typical pots often develop at the bottom of the vertical shafts. The morphology of the Sohodol II pit presents a transition from the phreatic pattern to the 'vadose flow' (mostly typical canyons and pots).

Hydrogeology

A permanent water spring from percolation, flowing from -33 m depth, defines the pit hydrology. The water supply mode is liable for steadily increasing of the flow rate up to -193 m depth. At the time of the last exploration (September 2, 1980), the flow was almost negligible. The water flow rate is possible to increase to one liter/sec or more in the spring or in the flood time. At -193 m, the water is collected in a small basin, without any obvious drainage. The drainage must exist, but it is weak.

Until now, we do not have consistent data on pit drainage. However, the location of the pit is in the proximity of the underground river of Coiba Mică-Coiba Mare system, and it makes us to believe that the pit continues, into the aquifer having the exit in the Tăuz resurgence. The air distance between the entrance in Sohodol II pit and Izbucul Tăuz resurgence is 2500 m and an altitude difference of 300 m (1150 m - 850 m above sea level).

The aerial distance is small between Sohodol II pit‘s bottom and the terminus sump of Coiba Mică-Coiba Mare cave system. The two ‚terminuses‘ are at the same altitude above sea level (957 m- bottom of Sohodol II pit and 956 m - the terminus sump in Coiba Mare cave). We supposed that Sohodol II pit is connected to the Izbucul Tăuz resurgence as the ‚base level‘ but this does not happen. In reality, Coiba Mică-Coiba Mare system drainage is the ‚base level‘. There is no doubt that the geologic appearance of the terminus area in Sohodol II pit indicates the reaching point of the ‚base level‘. Here is another search added to many others who question the concept of ‘base level’ in karst. In my opinion, this aspect of flowing finds its explanation in the parabolic curve under which the flow of water through limestone is generally carrying out. The ‚base level‘ for a drain of type 2 is the drain of type 1, to which water flows gravitationally. Sohodol II pit no doubt is a drain of type 2.

Climatology

The temperature inside the pit cave is a 4.4 - 5.0 degrees Celsius and humidity over 90%.

Comments

Sohodol II pit is developed first in the deep-phreatic regime, and then it is continued in a vadose flow along the main geological faults. From the morphologic point of view, the cavity is a typical alpine pit, excavated in the steady rock, without alluvial deposits.

Hodobana Cave, a unique maze in Europe

It is one of the largest (22,142 m total length) cave of Romania occurring in compact limestone of Jurassic age and resulted from the water-intake of Hodobana Creek on an aerial length of 812 m. The physical dimensions are: total length: 22,142 m; depth: 181 m (-121 m, +60 m); extension: 812 m; total length/extension: 27.3.

History of explorations

In April 1979, Florin Păroiu and Nicolae Sasu looked for access to the underground watercourse between final sump of Coiba Mare cave and Izbucul Tăuz spring. By chance, they found a tiny hole in one slope of Hodobana Creek, a tributary of Sohodol Valley. The entrance in the cave had only 1m/0.8 m and did not encourage the cavers, but a stream of air gave hope. After 13.5 m of a severe, upward crawl, they reached a tiny hall plenty of boulders. The air current blew weakly between floor stones. An easy removal of stones and a 2.5 m drop created access through rock boulders. They entered a 37 m long horizontal gallery (Subway Gallery) and then into a larger room - Florin Păroiu Hall. A confusing landscape, small drops, and squeezing paths led them to the edge of a large-size shaft - the Hope Shaft, 28 m deep where they stopped. Speleological Club "Z" organized a new campaign in August 1979. Nicolae Sasu, Florin Păroiu, Éva Györfi and Nicolae Paul descended the Hope Shaft. They crossed through a small phreatic gallery and through several tiny drops and reached the final sump at 150 m in depth (later mapped at -119 m). These first explorers of network appreciated cavity length at only 2 km.

In September 1979 Liviu Vălenaş decided to explore and survey the giant maze and took two revolutionary decisions using single-rope techniques and teams of two or three cavers. Together with Éva Györfi, he mapped the access up to final sump at -119 m depth. In October 1979, Liviu Vălenaş and Nicolae Sasu did a new campaign. After lowered to the 28 meter deep shaft in Gothic Hall, they walked upstream on the same course and mapped downward to the final sump. Climbed free a 4 m high waterfall, passed through a meandered route including Dante Hall and stopped above Mammoth Hall on the edge of a 20 m drop. An inclined plane avoided the drop and allowed free descend. The next four campaigns of mapping proved Hodobana cave being developed in the upstream watercourse with many floors. After the first 3-4 levels mapped, other floors have been discovered (24 floors in total including the intermediate levels). Exploration came to an end in October 1979 by lack of people. The solution was to join forces with other caving clubs or singles. Cavers from Romania and abroad came and helped Liviu Vălenaş to map the cavern. These caving clubs are "Emil Racoviţă" Bucharest, "Speodava" Ştei, "Flacăra" Iaşi, "Casa de Piatră" Turda, "Hades" Ploieşti and "Cristal" Timişoara from Romania and "ZHKTJ" Katowice from Poland. In December 1979, Liviu Vălenaş, Horia Mitrofan, Nicolae Stoica-Negulescu and Rodica Stoica-Negulescu explored Mammoth Hall and forced a squeeze to several fossil levels. Then, they discovered a 20-meter-wide shaft and descended it to a big underground river. A few days later, Liviu Vălenaş, Constantin Gagea, and two Polish cavers descended again to the big river hall. They explored the watercourse to an impenetrable sump. Then,

explored a 1020 m-long, meandered, and tight gallery on upstream course to an ending hall. In Terminus Hall it is a final 30 m high waterfall, and that team did not climb it. The ground surface is near to it. In February 1980, Liviu Vălenaş and Dan Nanu explored the Eastern Side. It is a fossil network (Slave Canyon, Wind Gallery, Dan Nanu Gallery, a.o.), representing a distinct part of the cave. Here are the most stunning speleothems and the largest galleries in diameter. During the 1980 year, the superior floors of the Hodobana cave have been mapped. There are 6 to 8 main floors and three times more secondary floors. In October 1980, Hodobana cave measured 15,752 m in length. During 1981, Liviu Vălenaş and Caius Tenţ discovered the continuance of Great Tributary. They mapped near 2 km through a new stream and its upper floors. It was the last important discovery in Hodobana cave. In 1981, the cave recorded 22,042 m of development. The discovery of a small upper floor by Liviu Vălenaş & co. in 1987, added to the cave length a new length, unchanged until today, of 22,142 m. In the year 1983, Liviu Vălenaş, Caving Club "Speodava" Ştei (Petru Brijan and Ovidiu Cuc), and Cristian Lascu organized scuba diving into the final sump at -119 m. Cristian Lascu dived and explored the sump on 5 m distance and 2 m in deep. The sump was tight, the water muddy and without visibility. The safety made him renounce. There is no hope of passing through this point to the underground river between Coiba Mare cave and Izbucul Tăuz spring.

A Polish team together with Nicolae Sasu climbed a 60 m high slide from the Coralloids Gallery. They used bolted anchors and reached a bottom bag near the surface. It is the greatest cavity positive elevation reached by cavers. Hence, Hodobana Cave has a total elevation unevenness of 181 m (-121; + 60).

Later, Petru Brijan tried to climb the 30 m high waterfall from the Terminus Hall using a climbing platform and bolts. He and Liviu Vălenaş transported in harsh conditions, a massive steel platform! Petru Brijan abandoned after climbed 10 m. A few months later, two Polish cavers used same the platform and bolts but abandoned after 20 m.

In 1983, Liviu Vălenaş completed the large map of Hodobana cave, at a scale of 1:200. In February 1984, Museum of Oradea City held a public meeting showing the map. After 1987, no one ever reached the final point of the cave. European cavers agreed that orientation inside the cave is impossible.

Description

In the middle of Gârda (Gârda Seacă) Valley, Hodobana cave opens into Hodobana Creek's right slope. Hodobana Creek is a tributary of Sohodol Valley in the river basin of the Gârda Seacă Valley. The first two valleys are karst-valleys,

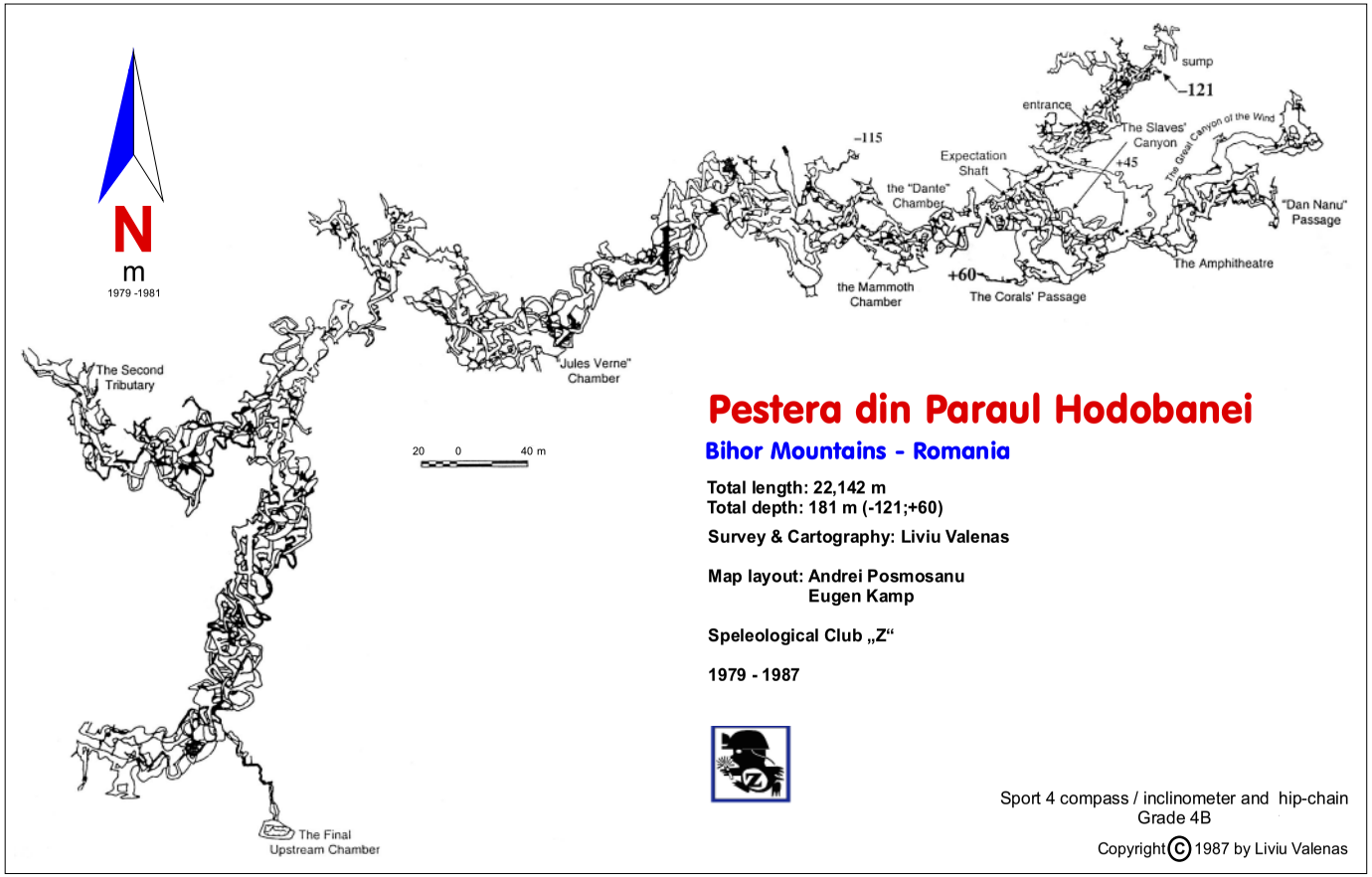

Figure 20. The plan of the cave from Hodobana Creek (Cartography by Liviu Vălenaș, 2019).

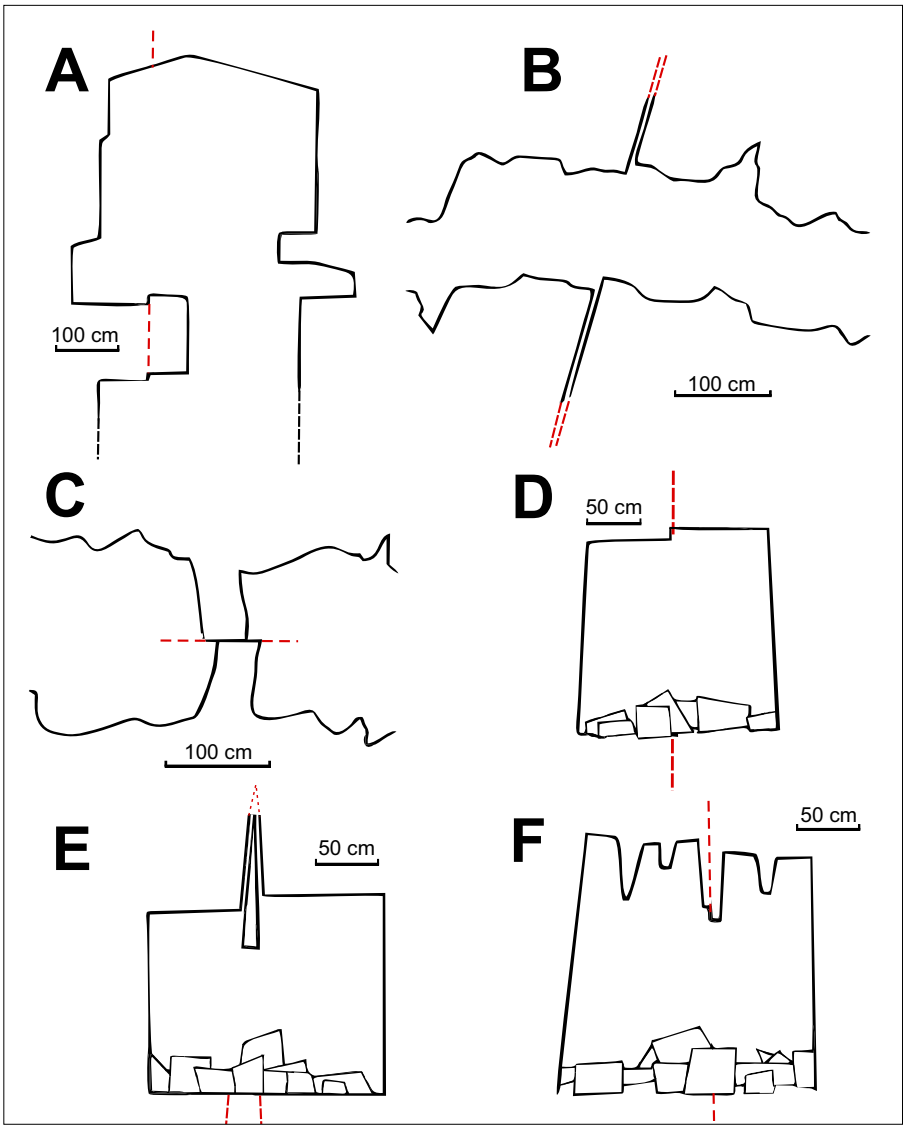

Figure 21. Active tectonics in the Peștera din Pârâul Hodobanei cave (Graphic by Liviu Vălenaș, 2019).

so-called “sohodol” - with no surface course and gorge up to 80 m high. The cave entrance has an elevation of 20 m above Hodobana Creek, and an altitude of 980 m above sea level. The cave is developed in E-SW direction. The water loss in Hodobana Creek, Hoanca Fileştilor Swallet and neighbouring sinks, created the three underground courses up to 1020 m length each.

The entrance into the underground network is small (1 m/0.80 m). After a 13.5 m long slightly ascending gallery, it continues in a small chamber of 5 m/2 m/1.5 m full of boulders. Through a 2.5 m-deep shaft, it reaches a small maze, followed by a 37 m-long and 1 m-high straight horizontal gallery, the Subway Gallery. This gallery is connected to a larger room, Florin Păroiu Hall and the continuance is confusing. It crawls along a new low passage, Hedgehogs Gallery, which opens in a broader space. In the left side, it ascends 50 m-high on Coralloids Gallery, the highest point of the network (+ 60 m). In the front-right, it is a slide descends to Hope (Speranţei) Shaft, 28 m-deep. Little to the right, it reaches the upper part of Slave Canyon, which allows shorting of the 28 m-deep shaft through a free descending. To the right, Slave Canyon, tight and challenging, extends into the Eastern Side. It is the fossil part of Hodobana Cave measuring 1.5 km of large galleries including Amphitheater Hall, Wind Gallery and Echo Gallery. The last one is a descending water slide with a unique acoustic in Romania. Eastern Side has the most stunning speleothems in Hodobana cave. Noteworthy a chimney is connected to the surface, the air stream and fir-tree roots prove this. From the bottom of P28, it descends to Gothic Hall. There on the right hand, a small-sized phreatic gallery hosts a stream that flows 6 m to a muddy sump. It is the deepest point of the network, -119 m (by diving, C. Lascu, -121m). The main continuation of the network starts with a free climbing over a 4 m high waterfall upward to Gothic Hall. In Hodobana cave 24 levels are developed on 6-8 core floors oriented on the west-southwest. It follows Dante Hall. A medium-sized rocky chamber. Through a negative angled phreatic tube with clay reaches the largest cavity of the network, the Mammoth Hall, full of boulders, 57 m long, 20 m wide and 42 m high. The top cave floor passes above this cavity and through a window can descend into the middle of the hall on a 40 m rope. It is the biggest cave vertical. A small stream disappears from this chamber into an impenetrable sump. The cave continues through the hall on the western side. It passes through a squeezing passage and then it continues as a step of 15 m high to a superior gallery with concretions. On the superior levels, it passes through “Storm”- an ascendant squeezing earth-floor passage where met the mightiest air blow and it reaches the top of Great River Hall, from where is a descent in two-steps of 20 m each direct in the hall. Downward, Great River ends in a rocky and impenetrable sump. The stream flow rate is 10l/s the biggest by far. The Great River flows along a meandered low level. The gallery has several cut meanders of 30-40 cm width and 1020 m length. After 200 m, a small 3 m high waterfall from the right side, announces the Great Tributary. The new gallery is 250 m long and multi-floored (over 2 km long). Great River continues its way and before its end is a junction, on the right side, with a

100 m long and low gallery. From here, the watercourse follows a narrow gallery ending in a 30 m high room with a waterfall coming from the ceiling. It is Terminus Hall at 2020 m from the cave entrance. Here, the ceiling has only few meters to surface. After Damm & Moréh (2011), the final waterfall originates from the nearby Hoanca Fileştilor Swallet.

Geology and tectonic

Hodobana cave develops in fractured-limestone of Upper Jurassic age. It is obvious in the cave's map that the galleries develop along two-main-fractures: NE-SW and NW-SE, somewhat in a "chessboard" pattern. At the surface it can recognize this tectonic pattern in the main faults and joints of the Gârdişoara-Gârda region.

Active tectonics

The cave from Hodobana Creek is adequate for the study of active tectonic in endokarst. We can define many forms, separated by morphology and forming mechanism. Below are these cases:

1. Galleries fractured on vertical

There are "micro-faults" (Fig. 21D), forming a tract of 5-10 cm, visible along the top of various galleries (cannot see it on the floors because of rubble or alluvial components). The morphology of ceilings shows separation occurred after the excavation and shaping of the galleries (on both sides of the micro-fault line are the same corrosion forms and speleothems).

2. Galleries fractured on horizontal (strike-slip faults)

This case (Fig. 21B) is more widespread in Hodobana cave than the last one. It is exposed in the gallery as a fracture that moved on the horizontal in opposite directions, often at a 60-80° angle, having a bigger displacement (10-30 cm) than the vertical faults case. The fault line spread from one wall to another and is a large crack unshaped later by corrosion and decompressed to 1-2 cm (often with friction mirrors).

3. Rock benches or terraces fractured on vertical

These refer to vertical oscillations of the gallery wall (Fig. 21A), divided on vertical by "micro-faults". The most prominent pattern is a rock-bench suspended at 18 meters above the Great River bed having the front taller with 5 cm than the inner part near the wall. This is not a local or gravitational event, but related to active tectonics.

4. Segmented pillars or corrosion blades

Micro-faults have sectioned on vertical these morphological forms (Figs. 21C, F) created in a phreatic regime, while the “micro-strike-slip faults” shaped them on horizontal.

5. Blades of rock distended

They (Fig. 21E) are frequent in the cave of Hodobana and are an odd form. It is a thin limestone blade (5-10 cm wide), lowered by gravity through friction between reactivated strikes between two “micro-faults”. Distended blades displaced on horizontal are rare.

6. Friction mirrors

Friction mirrors appear either from the reactivation of the original mirrors (and then polished) or are later mirrors produced by moving of “micro-strike-slip faults”. It is a normal form in Hodobana cave.

7. The crush of ceilings

This case has nothing to do with active tectonics, but within Hodobana cave is a specific feature generated by “micro-defects” and “micro-strike defects” that have destroyed the balance of limestone beds. The irreparable effect is a huge collapse of the rocks that lead to the closure of the galleries and the chambers.

A further detailed study can develop the forms described. We must notice the similarity with forms from the Occidental Tatra Mountains, Poland (Grodzicki 1970).

Morphology and genesis

Hodobana cave resulted from a progressive underground Hodobana Creek loss. The cave has been developed on the right slope, parallel to the actual valley, and it is near to the surface. Its genesis relates to Hodobana river bed water infiltration and to meteoric water loss in the large sinkholes and Hoanca Fileştilor swallow-hole from valley‘s origin watershed (Damm & Moréh 2011). The cave it is formed into a bati-phreatic regime, being immersed. The upper fossil-floor exhibits many elliptical sections and a great break of limestone because of intense tectonic. As a curiosity, this bati-phreatic gallery has no speleothems. The cave network at the beginning had one kilometer in extension. The eastern Side of Hodobana cave is a paleo-watercourse to a paleo-resurgence in Sohodol Valley. Between the Hall of Collapsed Stones and the surface is a distance of 100 or 150 meters but the paleo-resurgence did not find yet. In geological time, total loss of Gârda river moved downstream to Izbucul Tăuz spring (850 m altitude). The relevant

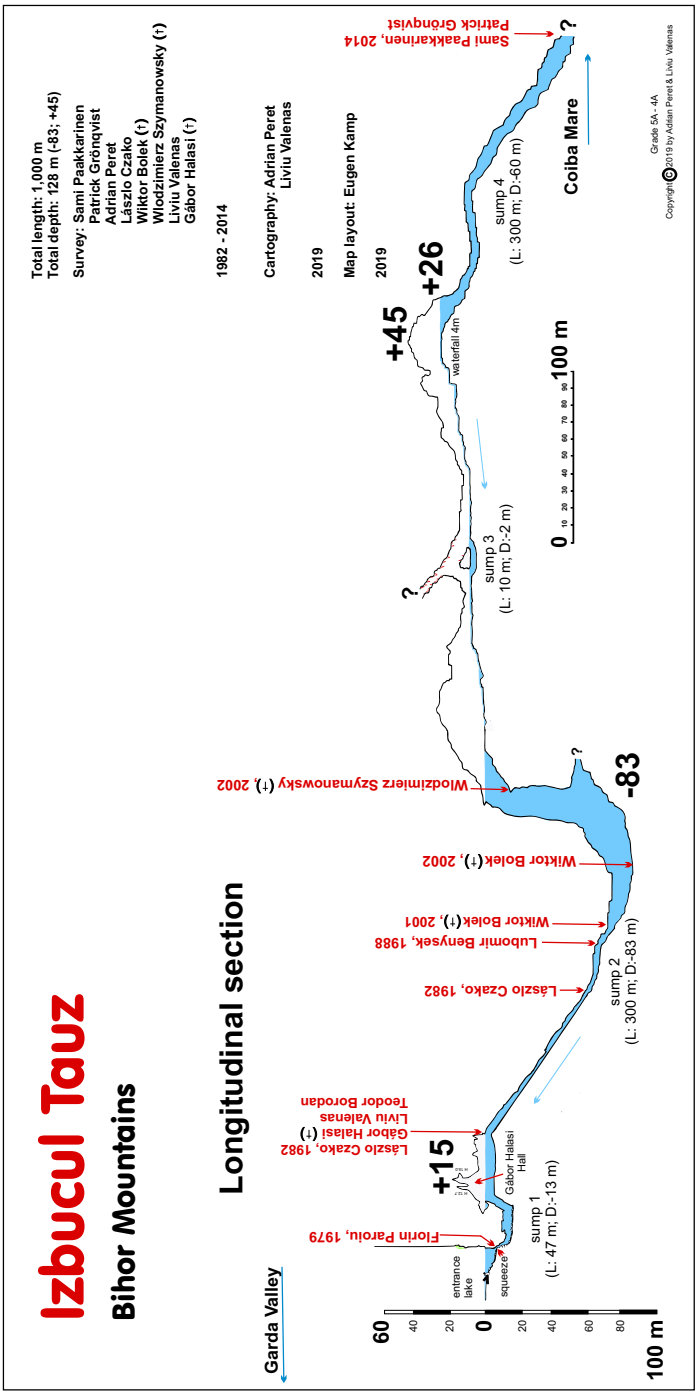

Figure 22. Longitudinal section through the Izbucul Tăuz spring (cartography by Adrian Pereț & Liviu Vălenaș, 2019).

underground course has moved beneath the Sohodol Valley and had an enormous impact on Hodobana cave. The paleo-watercourse of 2000 m long, has been separated into three major sectors and captured by the Izbucul Tăuz spring. The cavity passed to a vadous regime because Tăuz spring is at 140 m elevation below the Hodobana paleo-resurgence from the Sohodol Valley. Effect of the vadous regime is a remarkable multi-floored network, unique in Europe. Many of the floors are of the same gallery with narrow erosion levels filled with alluviums, collapses and speleothems.

Hydrogeology

Coloring of the watercourse was not yet done for Hodobana cave. But, without doubt, the three main underground watercourses drain through Izbucul Tăuz spring because the cave and the resurgence are in the same geologic unit, Tăuz Hill. Tăuz spring has a flow between 0.530 and 10 m^3/s at floods. Beyond small final sumps of the three main watercourses, the flow is changing to a phreatic regime until joining to the big groundwater stream between Coiba Mică cave and Izbucul Tăuz spring. A coloring or marking of water could prove it. For illustration, between the final sump from -119 m and Tăuz resurgence (850 m altitude) are only eleven meters elevation unevenness on an aerial distance of 800 meters and it sustains our hypothesis for a phreatic drainage regime. In 2014, two Finnish cave-divers, Sami Paakkarinen and Patrik Grönquist succeeded to dive at 83 m depth in the Tăuz spring sump no 2 and found a vadose stream, climbed a waterfall of 4 m and explored several hundreds of meters to the sump no 4.

Climate

The temperature of the air is 4-5 degrees Celsius. The cave is highly aerated, with many vented spaces. Humidity: over 90%.

Mineralogy

Hodobana cave is one of the richest caves in stalagmites and calcite crystals. They develop in the upper fossil-floors and in Eastern Side. Besides calcite, no further minerals have been identified. Galleries with watercourses and large halls affected by stones collapsing have no significant formations.

Evolution of the Gârdişoara Valley

Gârdişoara Valley (Gârda) is an epigenetic valley that deepened in the Bihor unite until the interception of the Upper Jurassic massive limestone stack. This valley had an underground watercourse for a long time through these limestones, digging

a canyon, of which today there is only the right slope conserved. The first loss in the underground was represented by the Băroaica cave, then the insurgence was moved a little further upstream, in the Oilor cave, both caves being suspended today, at 60 m relative altitude above the valley. These are fossil caves, with no active flow. It is possible that these two cavities have communicated each other in the past, as the Coiba Mică cave communicates with the Coiba Mare cave. We believe that the so-called „vacuum intake" as imagined by M. Bleahu (1957) was the main intake mechanism of the Gârdişoara River to underground. The proof that these two caves have the old insurgences of the Gârdişoara Valley, are the presence of quartzite pebbles, discovered by the present author in 1974 in these cavities, pebbles that could only come from the unkarstifiable-rocks-belt, which is 2 km upstream. Somewhat surprisingly, the Gârdișoara Valley left at one point these two caves, again for a long time, deepening with almost 60 m in the limestone bed. Probably a very humid climate allowed the transport of a huge amount of alluvium in these caves until their entrances were clogged. Later, by the erosion of the right slope of the Gârdişoara Valley, these entrances were re-opened again.

But the Gârdişoara River activated a new water loss, about 700 m in upstream, the current entrance to Coiba Mare cave. Here, however, the process was much more complicated, with three important phases. First, using exclusively the stratification faces of the limestone bed, a groundwater aquifer created, the proof is the huge maze of groundwater pipes (unique in Romania) from the entrance to Coiba Mare cave. The Gârdişoara Valley went underground again, into a second step, the water flow being exclusively under pressure. A new climate change caused the water course by 30 m underground, resulting in a second level of phreatic tubes. In these two phases we are convinced that Tăuz resurgence didn't existed, but another resurgence, closer, fossil today, which we could not yet discover, probably being totally clogged.

The third phase was the abandonment by the Gârdişoara River of the maze of groundwater pipes flowing in a vadose regime through Coiba Mare cave. Through the same vacuum caption, Gârdişoara River activated a new insurgence, at 370 m upstream, Coiba Mică cave. Instead Coiba Mare cave was still used, but only the median sector. At present Gârdişoara River is activating a new insurgence up, known as Ponorul din Crestătură, located upstream at 700 m from Coiba Mică cave. However, because the limestone bed continues 1.5 km downstream of the Izbuc Tăuz, it is possible that a new resurgence may be activated in the geological future further downstream. The underground system of the Gârdișoara Valley has a clear tendency of spatial expansion, both upstream and downstream.

Conclusions

The studied area is a spectacular example of karst multiple intake areas, the most important being the Gârdişoara Valley. The main cause of these recharge areas are without doubt the successive climatic changes, which have taken place from the lower Pleistocene to the present. From this point of view we can only rally to the conclusions reached by M. Bleahu (1964) regarding the role of the periglacial in the karstification processes in Bihor Mountains. A recent example reinforces this hypothesis. Coiba Mare cave had, for at least 100 years, at 95 meters from the entrance, a so-called opened sump 1, a part where the ceiling was lowered only 50 cm from the active course. In the last years, after the year 2000, the periodic floods (a consequence of global climate change) have simply cleaned the underground trough of the Secondary Course in Coiba Mare cave, today the ceiling is found not at 50 cm high, but at 3 m!; the opened sump 1 simply disappearing. Regarding the initial formation of the Coiba Mare cave, we see an almost perfect similarity with the theories of Ford (1965, 1968, 1971). The initial phase of a karst aquifer, after the latter is the formation of anastomoses on stratification faces. The water is forced, under pressure, to flow according to the inclination of the layers, until the hydrodynamic laws require the water, pushed by force, to ascend. In Coiba Mare cave these are easy to see, at present there are wells that connect with the different levels of groundwater tubes. Generally, many of these wells, which the Romanian speleologists wrongly believe that they were created into a vadose regime, are in fact the remains of a bathymetric regime, being formed not from top to bottom, but from bottom to top. Finally, for all underground networks, active or fossil, in the Vârtop-Casa de Piatră-Hodobana area, we do not see older erosional structures than the early Pleistocene.

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References

Benysek, L. 1988. - Cave-diving expedition Romania 88, *Speleoforum* **44**.

Bleahu, M. 1957. - Captarea carstică și importanța ei pentru morfologia regiunilor carstice. *Probleme de Geografie* **5**: 55-99.

Bleahu, M. 1964. - Formațiuni periglaciare în carstul din Munții Bihorului, *Lucrările Institutului de Speologie „E. Racoviță*, **3**: 35-66.

Bleahu, M. 1971. - Les surfaces d'aplanissement karstique des Carpates Roumaines et leur évolution, *Studia Geomorphologica Carpatho-Balcanica* **5**: 41-48.

Bleahu, M. 1974. - Morfologia carstică, Editura Științifică, 590 p.

Bleahu, M., Bordea, S. 1967. - Munții Apuseni. Bihor-Vlădeasa, Editura UCFS, 333 p.

Bleahu, M., Decu, V., Negrea, Ș., Pleșa, C., Povară, I., I. Viehmann. 1976. - Peșteri din România, Editura Științifică și Enciclopedică, 414 p.

Bleahu, M., Șerban, M. 1959. - Bazinul endoreic Padiș-Cetățile Ponorului. Propunere pentru un viitor parc național, *Ocrotirea Naturii* **4**: 89-125.

Bleahu, M., Dimitrescu, R., Bordea, S., Bordea, J., Mantea, G. 1980. - Harta geologică a României, Foaia Poiana Horea, *editura IGG*.

Bojar, A-N., Guja, O., Ștefănescu, D. 2015. - Vermiculation petterns in Coiba Mare cave, Bihor Mountains, Romania, *Quaternary International* **357**: 212-219.

Bolek, W. 2001. - Tăuz po raz drugi. *Jaskinie*, **4** (25): 24-26.

Coman, D. 1955. - Peștera de la Casa de Piatră, *Flacăra*, **18** (67): 20-21.

Ciubotărescu, C., Damm, P., Popescu, D. 1998. - Buletin Speologic Gârda, **1.**

Damm, P., Pop, C. 1998. - 25 de ani de explorări speologice în Munţii Apuseni, Editura Clubului de Speologie „Z".

Damm, P., Mitrofan, H. 2005. - Peștera din Pârâul Hodobanei, *Speomond* **9-10** (2004-2005).

Damm, P., Moréh, K. 2001. - Explorări speologice în partea central - estică a Munţilor Bihor, *Speomond* **6**: 10-12.

Ford, D. C. 1965. - The origin of limestone caverns: A model fome Central Mendip Hills, England, *Bul. NSS*, **27**(4): 109-132.

Ford, D. C. 1968. - Features of cavern development in Central Mendip, *Trans. Cave. Res. Group. of Great Britain* **10**(1): 11-25.

Ford, D. C. 1971. - Geologic structure and a new explanation of limestone caves, *The Transactions of the Cave Research Group of Great Britain* **13**(2): 81-94.

Grodzicki, J. 1970. - Rola tektoniki w genezie jaskin masywu Czerwonych Wierchów, *Speleologia* **1-2**: 33-48.

Guja, O., Viehmann, I. 2013. - Gheţarul de la Vârtop, *ed. Societății Naționale de Speologie*, 64 p.

Huber, W. 2011. - In the depths of the Coiba Mare. *Global Magazine of Leica Geosystems Reporter* **67**: 14-17.

Jeannel, R., Racovita, E. G. 1929. - Énumération des grottes visitées, 1918-1927 (7e série), *Archives de Zoologie Expérimentale et Générale* **62** (2): 293-608

Jennings, J. N. 1971. - Karst, *Australian National University Press*, 252 p.

Mangin, A. 1970. - Le sisteme karstique de Baget (Ariege), *Annales de Spéléologie* **25**: fasc. 3.

Mangin, A. 1974. - Contribution a l´étude hydrodynamique des aquiferes karstiques. Deuxieme partie. Concepts méthodologiques adoptes. Systeme karstiques étudiés, *Annales de Spéléologie* **29**: fasc. 4.

Mitrofan, H. 1985. - Acomodarea de adio, *Buletinul Informativ CCSS* **10**: 119-130.

Onac, B., Racoviță, G., Brad, T. 2010. - Atlasul peșterilor din Munții Apuseni, bazinul Arieșului Mare, Editura Todesco, 96 p.

Orăşeanu, I. 1996. - Contributions to the hydrogeology of karst areas of the Bihor-Vlădeasa Mountains (Romania) - *Theoretical and Applied Karstology*, **9** [1997]: 185-214.

Orăşeanu, I., Iurkiewicz, A. 1996. - Karst hydrogeology of Romania, Editura Belvedere, 181-214.

Orghidan, T., Negrea, Ș., Racoviță, G., Lascu, C. 1974. - Peșteri din România, *ed. Sport-Turism*, 170-177.

Palmer, A. N. 2007. - Cave geology, *Cave Books*, 454 p.

Păroiu, F., Vălenaș, L. 1981. - Scufundări autonome in bazinul Văii Gârda (Munții Bihor), *Buletinul Informativ CCSS* **5**: 42-51.

Pereț, A., Drăgan, C. 2016. - Explorarea Izbucului Tăuz, *Diving Romania Magazine* **3**: 27-29.

Ponta, G., Onac, B. 2018. - Caves and karst systems of Romania, Springer*,* 544 p.

Sima, R., Vălenaș, L. 1982. - Morfologia Avenului Sohodol II - Munții Bihor, *Buletinul Informativ CCSS* **6**: 159-165.

Sweeting, M. M. 1972. - Karst landformes, Macmillan, 336 p

Turi, V., Săsăran, E., Bucur, I. I. 2011. - New data on the Upper Jurassic-Lover Cretaceous limestone from Bihor Mountains: case study of Gârda Seacă-Hodobana region, Romania, *Studia Universitatis Babeș Bolyai Geologia* **56** (1): 11-27.

Vălenaș, L. 1976. - Privire de ansamblu asupra carstului din Munții Bihorului, *Nymphaea*, **4**: 21-58.

Vălenaș, L. 1976. - Carstul de la Casa de Piatră (Munţii Bihorului), *Caietul CSER* **4**: 150-169.

Vălenaș, L. 1976. - Coiba Mare, *România Pitorească* **57**: 20-21.

Vălenaș, L. 1978. - Morfologia sistemului Coiba Mare - Coiba Mică - Izbucul Tăuz, *Nymphaea* **5**: 329-362.

Vălenaş L. 1982. - Consideration preliminaires sur les problemes crees par la tectonique active de la Peştera din Pârâul Hodobanei (Monts Bihor), *Nymphaea* **10**: 183-194.

Vălenaş, L. 1984. - Stagiul de perfecţionare „Explorarea Râurilor Subterane" - Casa de Piatră - 1984, ed. Clubului de Speologie „Z", 8 p.

Vălenaș, L. 2014. - Cea mai groaznică peșteră din lume?: Hodobana, *„Neodacii" blog, neodacii.com.*, Strasbourg.

Vălenaș, L. 2014. - Un monument natural straniu al Europei: Peștera din Pârâul Hodobanei, *„Neodacii" blog*, *neodacii.com.*, Strasbourg.

Vălenaș, L. 2014. - Un labirint unic in Europa: Peștera din Pârâul Hodobanei, *„Asymetria" blog*, http://arhiva-romanilor.blogspot.fr/.

Vălenaș, L. 2014. - Explorări subacvatice senzaționale in sistemul carstic Coiba Mare – Izbucul Tăuz, *„Neodacii" blog*, *neodacii.com.*, Strasbourg.

Vălenaș, L. 2014. - Misterele Coibei Mari, *„Neodacii" blog*, *neodacii.com*., Strasbourg.

Vălenaș, L. 2014: - Senzaționalele recorduri ale scafandrilor speologi finlandezi in Munții Bihor, *Neodacii" blog*, *neodacii.com.*, Strasbourg.

Vălenaș, L. 2014. - Peștera Coiba Mare, o cavitate unică in Europa, *„Neodacii" blog*, *neodacii.com.,* Strasbourg.

Vălenaș, L. 2015. - România pitorească: Coiba Mare, cea mai mare intrare de peșteră din România, *„Neodacii" blog, neodacii.com.*, Strasbourg.

Vălenaș, L. 2016. - Peștera din Pârâul Hodobanei, *Caietele Clubului de Speologie „Z", serie noua*, **3**: 5-16

Vălenaș, L. 2016. - Avenul Sohodol II, un clasic al speologiei alpine, *Caietele Clubului de Speologie „Z", serie noua* **3**: 29-32.

Vălenaș, L. 2016. - Istoricul explorărilor speologice in sistemul Coiba Mare - Coiba Mică, *Caietele Clubului de Speologie „Z", serie noua* **3**: 35-42.

Vălenaș, L. 2016. - O rușine comunistă uitată: piratarea Coibei Mari in vara anului 1989, *„Neodacii" blog, neodacii.com.*, Strasbourg.

Vălenaș, L. 2016. - Un tipic aven alpin: Sohodol II din Munții Bihor, *„Neodacii" blog, neodacii.com.,* Strasbourg.

Vălenaș, L., Bleahu, M., Brijan, P., Halasi, G. 1977 - Inventarul speologic al Munților Bihor, *Nymphaea* **5**: 209-335.

Vălenaș, L., Damm, P. 1987. - Ştiri interne, Munţii Bihor, *Speotelex*, seria II, **2** (14): 6.

Vălenaș, L., Halasi, G., Czakó, L. 1982. - La morphologie et la hidrologie des conduits submergès du bassin de la Valée Gârda (Mts.Bihor), *Nymphaea* **10**: 195-205.

Vălenaș, L., Păroiu F. 1978. - Joncțiunea dintre Coiba Mare si Coiba Mică, *Buletinul Informativ FRTA-CCSS* **2**: 36-41.