Al-Ouat 'Ouate

Number 13 new series

الوطـــواط

العدد ١٣ السلسلة الجديدة

SPELEO CLUB DU LIBAN

2005

Revue Libanaise de Speleologie et de Karstologie

The Lebanese Journal of Speleology and Karstology

المجلة اللبنانية لدراسة المغاور وعلم الكارست

Editors

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The cave fans of Mghoret el Kassarat, Antelias
Photo by Issam Bou Jawdeh

Layout
Rana Karanouh

In collaboration with
The Lebanese National Council for Scientific Research

CNRS

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Why do cavers go into the trouble of exploring holes in the ground that are dark, cold, difficult and dangerous? This is a question that we, as cavers, had to answer many times.

But a more difficult question is why a group of people, who are crazy enough to go caving, spend so much time producing a magazine on what they have been doing.

For a group of cave addicts like us, this is a valid question.

The importance of the **Al-Ouat** 'Ouate does not only serve as proof of what we have been doing, it also transfers the experience of caving to the rest of the world, showing the beauty and magnificence of what lies beneath their very feet. This is important, especially in a country like Lebanon, where respect for most natural treasures does not exist. We are currently experiencing damage to hundreds of caves. They are being slowly destroyed either by quarries, by roadworks, by using them as sewage drains, by ignorant people who believe that concretions '*will grow back next year*', or by using them as dump sites for waste. The list is endless.

It is no mistake that Mgharet el Kassarat Antelias was chosen as the main attraction of this issue of **Al-Ouat** 'Ouate. This cave, a network of more than 4km of development, which has been partially destroyed by a quarry, now goes by the name of 'Mgharet el Kassarat' or the Cave of the Quarries.

We hope that this magazine would contribute to stopping this destruction by creating respect for the underwold. **Al-Ouat** 'Ouate appeal is not only for the professional caver, but also for the general public. We make sure that we have a balance in content, from scientific articles, to personal experience, to new discoveries, and other club activities such as trainings.

It is worth noting that this is the first issue of **Al-Ouat** 'Ouate since 1997, (although in 2002 a special issue on Mgharet el Shatawie was published) and it has been a difficult task trying to structure this specific issue after the magazine's long absence.

Initially, we decided to only include articles up to 2003. but there was no way we could include all the catch up articles since 1997, so we had to drop almost half of those.

We look forward to seeing future publications of **Al-Ouat** 'Ouate and wish to take this opportunity to thank the team that worked on this issue (whether in thinking, writing, photographing, proof reading, or map collecting) for their hard work and dedication.

Wael Hmeidan
Head of the Al-Ouat'Ouat N°13 Committee

(The commitee consists of Sami Karkabi, Marc Memi, Fadi Nader and Walid Jadi)

> Gallery inside Mgharet el Moutran
(Photo by Issam Bou Jawdeh)

> Gallery inside Mgharet el Kassarat
(Photo by Issam Bou Jawdeh)







Contents

MGHARET EL KASSARAT, ANTELIAS • History, Morphology and Speleology

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> The bat colony in mgharet el Kassarat (Photo by Sami Karkabi)

Mgharet el Kassarat (from Arabic, 'the cave of the quarries') is located in the Antelias locality within the coastal area of central Lebanon, a few kilometers to the north of the Beirut City (capital of Lebanon). This article presents a short historical overview of the discovery and exploration of this cave as well as a speleological description of its momentous galleries and morphological features.

The discovery of Magharet el Kassarat is inherently related to the discovery and exploration of the deepest cave in Lebanon (Houet [from Arabic, 'sinkhole'] Fouar ed Dara, in the Majdal Tarchich locality; see Karkabi, 1971) in the late 1960s. The exploration of this sinkhole located near the top of central Mount Lebanon (~1600m above sea level, asl) was followed by two dye tests (1965 and 1967) performed inside Houet Fouar ed Dara, about twenty kilometers to the east of el Kassarat cave (not known then). The dye injected at the bottom of the sinkhole in Majdel Tarchich reappeared 10 days later principally in the Faouar Antelias Spring, about 21 km downstream along the coast (~75m asl). These tests carried out by the cavers of the Speleo Club du Liban (SCL) led them to believe that an important karstic system lied hidden somewhere between the sinkhole and the spring. In the hope of finding a cave just upstream the Faouar Antelias spring similarly to the nearby Jeita Spring (Fig. 1), a series of surface inspections were conducted in the Antelias area but remained unsuccessful until 1969. During that time, the area upstream of the spring was already being quarried. On February 18 of 1969, Sami Karkabi – a leading caver at the time – was contacted by the quarrying people informing him of a cavity under a collapsed part in the floor of the Antelias quarries. Within four days, the SCL organized an exploratory outing to the cavity and discovered 800m of underground passages.

The 1969 Discovery

The opening in the floor of the quarries led to a large room about 14 m wide and 20 m high (Fig. 2). The cavers then wandered 600m down gradient, northward to reach a mud choke. In the opposite direction, about 230m of development ended up with a siphon. Later in July of the same year, the SCL revisited the cave with British cavers from the Yorkshire Ramblers Club to survey the discovered passages. But during that visit and to the cavers' amazement, the siphon was dry, they heard a distant sound of roaring water (Middleton J.R., 1970). Following the sound, the cavers discovered an underground river with about three kilometers of development. Since then 'Magharet el Kassarat' (or the Cave of the Quarries) was coined as the name for this cave, which was –and still is– one of the ten longest caves in Lebanon.

The Period Following the Discovery

It was not long enough that the quarries had reached the level of the cave. An entire section was completely quarried out. The entrance to the cave was blocked (sealed) with rock debris as the cavers were not allowed to search for any eventual entrance to access the cave for security reasons. However, access to the part of the cave down gradient of the original (first) roof entrance, which leads to a mud choke, was still possible. The main cave and its underground river were lost (see Nader, 1997). The Lebanese strife that hit the country by storm in 1975 prevented any serious control on the quarries, which rapidly expanded covering a much larger surface-area. At that time all hopes to save the cave and re-access its momentous galleries and underground river vanished. Since then, the underground river of the Kassarat Cave became more of a legend narrated by the elders of the Spéléo-Club du Liban who had the privilege of visiting it.

The Rediscovery

In the 1990s, after the end of the Lebanese war, the SCL cavers tried again to search for the lost cave, but ongoing quarrying made their quest impossible. In 1996, efforts to relieve shortage in fresh water supply in the Metn Caza and the Greater Beirut area were being spent by the Government. The Council for Development and Reconstruction had commissioned a private consultancy firm (BTD Bureau Technique pour le Développement), to conduct a study for exploiting the waters of the Antelias underground river. In order to select the appropriate catchment works and exploit the underground river, the cave had to be found first. For that purpose, geophysical investigation (geo-electrical and electromagnetic –VLF) was carried out but the results remained inconclusive without constructing control wells (Nader, 1997). Therefore, exploration drilling had to be undertaken and 13 boreholes were drilled. Only one borehole (No. 11) had struck a cavity worth investigating. A home video camera was turned into a video-probe and the installation of a TV monitor was set up near the well (Nader, 1997). The image of a small portion of the cave with a row of stalactites and cave flowstones was transmitted to the surface. Though what could be seen was less than a 10m long cavity, this contributed to the decision of reaming the borehole and sending cavers for an actual investigation. The well was enlarged to a diameter of 70cm allowing cavers inside. Sami Karkabi, Antoine Comaty, Hughes Badaoui and Fadi Nader (all SCL cavers at that time) went down inside this borehole and reached a well-decorated, dry gallery with distinctive speleothems about 25 m below the surface (Nader, 1997). After about 100 m and 28 years, the underground river of the mythical Kassarat Cave was found again, the borehole having hit nothing else but the "Galerie Sèche" (see enclosed map) that was originally surveyed by the older cavers. Since that day, the cave of the Kassarat has been explored and re-mapped, with new galleries and new wonders discovered. More than 3.2 Km of development have been discovered and surveyed.

Cave Morphology

The total development – i.e. the overall length of the surveyed passages – of Magharet el Kassarat is about 4648 km (see enclosed map). The cave's main (sinuous) axis generally trends East-West, with only a few side-galleries. The surveyed underground passages are grouped into twelve sections; each of which is characterized by special geomorphological and speleological features. Certain hydrogeological characteristics were also employed in defining these sections; which are discussed in turn from the inland (eastern) extremity of the cave towards its entrance (i.e. westwards), less than one kilometer upstream of the Fouar Antelias spring.

Section 1: Fault Plane Chamber

This is the east-southernmost part of the Kassarat cave (enclosed map). A small siphon with stagnant waters in a tunnel-shaped gallery (a couple of meters wide and high) marks the very end of the cave. The siphon waters flow in an arc shaped conduit and disappear to the northeast. Some 40m of cave development connects the siphon with a huge chamber consisting of two main parts: The 'echo-hall' (also called 'Salle du Comité') including the beautiful 'Breast Room' ('Salle des Seins'), and the Fault Plane Hall sensu-stricto.

In fact, the two parts are associated to a NNE-SSW fault which has resulted in an enormous hall through mass-wasting (ceiling collapse). The eastern part of the Fault Plane Chamber consists of a big hill made up of collapsed rocks. To the northern side (the highest point), a sinkhole was found at the boundary between the wall of the chamber (fault plane) and the eboulis. To the

north-eastern extremity (before the siphon segment), the ground (lowest point of the chamber) is covered by white calcite ('Planché Stalagmitique') underlying a few mound-like stalagmites, a couple of which look like breasts surrounded by white flowstone.

The Fault Plane chamber is a large room, where a distinctive fault plane can be seen on one side and collapsed rocks on the other; this is a dry portion of the cave. This room extends for about 250m before the small Breast Room is reached. The width of the Fault Plane room reaches at some point about 40m.

Section II: The Junction Gallery

The western border of the Fault Plane Chamber is demarcated by a gallery the axis of which trends almost perpendicular to that of the fault. The length of this gallery is about 100m. It connects the Fault Plane Chamber to the Northern Siphon Section – the northern easternmost extremity of the cave system. That's why it is called the Junction Gallery. About 10m from the connection, an opening was found in the ceiling from which water drips. This was explored with the mast and the help of a Belgian team from the SPEKUL caving club; a room extending over the intersection was found and surveyed (called the Belgian Room).

Section III: The Northern Siphon Section

This section consists of a sinuous gallery floored with thick mud deposits, within which (almost at the center) a water channel conveys water sourced from a terminal siphon. The ceiling and the walls of this section are very similar to phreatic karst with lobes and smooth dissolution patterns.

Section IV: The Martin's Gallery

The Martin's Gallery is a fossil gallery extending for about 190 m and turning right for about 180° to become parallel again to the main cave axis. Both sections (III and IV) form respectively the northern and southern branches of a Y-pattern, converging into the easternmost extremity of the Upstream Main Gallery (Section V). A sinkhole about 7m deep is found, some 70m from the Y-junction, in a small room on the right. This section ends with a mud choke.

Section V: The Upstream Main Gallery

This includes a huge room of collapse debris and a bypass, the water flowing from Section III (the Northern Siphon) cascades into the Upstream Main Gallery which trends almost East-West. To the easternmost edge of this gallery the width is the maximum as well as the height (this part is formed by intense ceiling collapse and rock debris), while the cave passage narrows down westward before reaching the point of intersection with the Major Siphon Section – i.e. Section (VI) – and the Downstream Main Gallery – i.e. Section VII. These form a Y branching pattern (see map). Here it is important to note that the water flowing through the Upstream Gallery diverts southward towards the Major Siphon rather than continuing westward into the Downstream Gallery (see enclosed map).

Section VI: The Major Siphon Section

The Major Siphon section extends for a bit more than 300m. About 70m south of the intersection of this section with the main axis of the cave, the water flows to the right (i.e. west) into a small network that turns back northward towards the Downstream Gallery (Section VII). Here, the bifurcation represents the lowest point. It is believed that water rushing into this siphon from both sides is the same water that reemerges further downstream in the cave (ca. Downstream Gallery) at the start of the collapsed blocks portion where dye injection used to be carried out. The majority of the water is sourced further upstream of this section, where the major siphon was found. Note a 90° shift in the passage direction from NW-SE to NE-SW characterizing the Major Siphon Section.

A dive was attempted in the major siphon, which led to the discovery of an additional 200m approximately as shown in the map. It appears that further submerged galleries may still be discovered beyond that extent and perhaps some other dry galleries as well; further discovery in that submerged portion of the cave awaits divers.

Section VII: The Downstream Main Gallery

This gallery conveys the waters flowing from the Upstream Main Gallery and mostly from the Major Siphon. It is subdivided in different sub-sections according to speleological, geomorphological and hydrogeological characteristics. These are (from east to west): 1)The Pearl Area and Collapse Zone, 2) the Huge Gours Gallery, 3) the Little Cascade and 'Main Courante' Part, 4) the River-Lake, 5) the Braided Stream, and 6) the Toboggan Sink.

The Pearl Area and Collapse Zone

This Section extends for about 220m until the second Y intersection. After about 180m, pearls are found on the floor of the cave which gave this section its name. A smaller passage runs parallel to the main segment and diverts the incoming water, which has allowed the presence of pearls in the main gallery. This small wet passage is about 90m long and has its upstream side almost at the Y intersection. The Pearl Section reaches a maximum width of about 15m and constitutes a large passage.

As discussed above, the water flowing from Section V through the Pearl Area rushes to the left into the Major Siphon section. The large room ending in this Y-intersection is characterized by a sand bank where SCL members camp and have their snacks usually during their expeditions inside the cave.

The Huge Gours Gallery

After the waterfall a more or less straight development of the cave termed the Gours (rimstone) Section due to the presence of large gours/rimstone pools, extends for about 100m before a right turn and about 60m lead to a slope of collapsed blocks of rock and concretions. This section is characterized by a very high ceiling, and a more or less rectangular development. It is worth mentioning that a passageway over an elevated platform full of stalagmites and a descent between draperies has to be tackled along the way. After this platform a nice walk along a shallow portion of the river characterized by mud banks leads to a slope of collapsed rocks. It is in this portion of the cave where a gauging section was established and regular measurements were being carried out by SCL speleologists and BTD hydrogeologists for the Council for Development and Reconstruction water supply study.

The start of the collapsed blocks portion is well known for being the dye injection point during tracer testing carried out by the SCL inside the cave to quantify the variation of flow inside and outside the cave, understand better the karstic development and the connection of the main Antelias Underground River with nearby springs such as those of Chatawi cave, Faouar Antelias, and others. Beyond this point and until the first Y Intersection the cave is dry and water is nowhere to be seen.

The collapsed blocks portion leads to a beautiful tunnel like space which is completely covered with white concretions. On the floor small ponds of water where a calcite film can be seen growing as well as beautiful pearls. At the entrance of this passage, a slowly decomposing dead bat became a reference point inside the cave during the re-exploration and surveying period. This passage is followed by a muddy slope climb where calcite has grown on top of the mud creating popcorn like features in addition to stalagmites and coulées. SCL has also placed red and white bands to establish one passageway and minimize damage to the easily breakable concretion cover.

The mud slope ultimately leads to the first Y intersection of the cave, which is also the SCL Camp Section. After surveying, the whole part including the collapsed blocks, the tunnel like passage, and the mud slope were found to be all in one large room created by a collapsed roof.

The Little Cascade and 'Main-Courante'

This sub-section is located about 60m upstream the underground river from the President's Gallery. For a short period of time during spring when snowmelt is occurring, the waterfall disappears with the rising water level. Most of the year, the waterfall has to be crossed by getting off from the dinghies about 10m before the waterfall and climbing the cave wall on the right bank or to the left when going up and then tackling a "main courante" before going down a rope of about 5m. The dinghies are left behind since further progress into the rest of the cave no longer requires their use.

The River-Lake

This part of the river is characterized by still, calm water with sand beaches. The water depth is shallow and the gallery is relatively wide (4 to 5m) and meandering. The ceiling is relatively high (as much as 20 meters).

The Braided-Stream

As the water depth decreases, the calm river turns into a braided stream floored with rock debris and blocks of rocks of various sizes. Here the water velocity increases. In the dry season, this part is almost dry as the water percolates into the boulders and gravels on the river-bed.

The Toboggan Sink

The river waters disappear in the Toboggan Sink, which forms a feature similar to a sink in a blind valley, geomorphologically speaking. This can be considered as the western end of the active part of the Kassarat cave. The Entrance Section intersects at almost 90° the underground river at the point where the river, which was flowing in quite a large main passage, ends with a wall, which is potentially a result of displacement along a N-S trending fault. At that point, two karstic 'tubes', which are part of the Tobogan Section extending to the northwest and located at the floor level drain the whole underground river most of the year. Their toboggan like shape where waterswirls down gave this portion its name.

During the second half of winter and the short spring (March-May), when the water levels are at their highest, the discharge of the underground river considerably increases and exceeds 2 m³/s (Labaki, 1998), hence cannot be accommodated by the narrow Toboggan conduits. This is when the water level of the river significantly increases up to 10m higher than during the low flow period. As a result, water floods the Entrance Section, which becomes inaccessible. For a short period of time when the discharge is at a maximum, the main axis of the cave becomes a lake far back to the first Y intersection in the cave, where a boulder slope has to be climbed.

In addition to the two active conduits, which accommodate the entire flow during low flow conditions, a third parallel, adjacent passage north of the others can be accessed at those times. This passage leads into a small labyrinth where the active conduits may be observed from window like openings. This conduit ultimately leads down into a siphon about 90m from the start of the Toboggan Section. Water flowing down into the Toboggan ultimately reaches an impenetrable siphon of water.

The Toboggan Section is characterized by wall and floor scallops indicating the northwest direction of

waterflow and the intermittent pressurized flow conditions occurring. Naturally no concretions are observed in this section, which can be considered as the youngest portion of the cave as suggested by its development in a dead end like wall within the main cave axis, its relatively much smaller proportions, in addition to its hydraulic dynamicity. It appears that structural displacements have forced the underground river to abandon its main path which was likely through the Entrance Section and the Bear Cave. This may be explained by the Entrance Section becoming at too much of an angle with the main axis and at a higher elevation. A lower bypass was therefore potentially dug by water and the water moved into the Toboggan Section.

Section VIII: The Dry (Fossil) Galleries

This section consists of the dry galleries which are higher than the cave main axis. One of these galleries (called previously 'Gallerie Sèche') was surveyed in 1969 and was the same gallery struck by the borehole through which the re-discovery of the cave took place in 1997 (see above). The other gallery ('Gallerie du Président') was discovered after 1997.

Section VIIIa: Galerie Sèche

About 40m upstream from the Toboggan and the intersection with the Entrance Section, the Dry Gallery, which is accessed from the northern side (right bank) of the underground river, extends for about 140m. This gallery was explored and surveyed in 1969 (Karkabi, 1988) and is characterized by beautiful stalactites and stalagmites several meters long. It is a fossil gallery about 20m higher than the river during low flow conditions. The ceiling, floor, and walls are almost entirely filled with flowstones and different speleothems.

A red and white tape was placed in this gallery to delineate a passageway through the stalagmites and flowstones and to minimize the unavoidable damage resulting from caving activities.

Section VIIIb: Galerie du Président

So far the main axis of the cave, where the underground river is flowing, is trending NW-SE. From the intersection with the dry gallery, a dinghy is needed to further advance into the cave. About 40 m further upstream, an opening about 8m higher than the river course during low flow conditions is accessed by a rope. This same opening can be accessed by a dinghy during snow melt season when water levels are at their highest as the water level rises about 8m in this section of the cave.

The opening leads to the President's Gallery as it was named to pay tribute to the President of the SCL at the time, Hughes Badaoui, who discovered it. The gallery extends for about 150m and exhibits beautiful concretions varying from common stalactites and stalagmites to helictites and eccentrics, disc speleothems, draperies, and coulées. In a way it suits well its name since it gives the impression of an area reserved for presidents.

Section IX: The Entrance Network Post 1997

This part of the cave comprises the recently excavated section, which used to be part of the cave until quarrying made it an opening by removing the downstream part as shown on the enclosed map. To the west the cave used to extend into what is currently known as the Bear Cave the opening of which now lies about 300m away in an other quarry face. Quarrying has thus separated the main cave from the Bear Cave by completely wiping out some 340m of cave development. The Entrance Section extends about 270m East from the entrance till the Tobogan Section where the Underground River disappears completely to reemerge in the Faouar Antelias Spring as proven by dye testing (Labaki, 1998).

The Entrance Section has a width ranging between 10 to 15 m, and about 20m in the last 40m before reaching the underground river. The height of the passage reaches more than 20m in some areas but is generally about 10m. The passage is mostly sloping towards the east, which is in the opposite direction of the main underground river axis sloping to the west similarly to the underground river flow. This is the reason why the entrance section may be considered along with the Bear cave as a fossil gallery no longer part of the active system itself. Small colonies of fruits bats are abundantly found in this section of the cave.

About 25m from the entrance, a ramping passage accessed at the floor level is found in the southern wall of the cave. This is a muddy and sandy passage oriented southwest that used to be accessed while walking upright in 1969. Thus the water dynamics in this portion of the cave have most probably changed due to quarrying activities. There was no topography of this portion of the cave in 1969 and so it is not clear to what extent it was impacted by quarrying. It is however suggested from the position of the second 1969 entrance (see map), which no longer exists, and the presence of one passage leading towards the quarry face that major changes have affected this area.

Section X: Magharet ed Dibb (The Bear cave)

Today, The Bear Cave isseparatedfrom the main Kassarat cave as a result of quarrying. Its entrance is through a mud slope from one of the quarry faces downstream from the main Kassarat cave entrance (see map). The Bear Cave extends for about 550m and is a muddy cave. When water floods from the main entrance of the Kassarat cave and runoff water flow into the quarry floor a lot of water seeps into the Bear Cave.
This cave has earned its name due to the discovery of bear bones at its very end, up a mud choke. This finding leads my suggestion that originally this cave was linked

with the outside and could have constituted an entrance to the Kassarat cave (prior to quarrying) that was never found. Karkabi (2003) indicates that a small cave that was known to exist before quarrying has completely been removed and could have been linked to the bear cave. The present altered topography of the area makes it however difficult to be certain.

Conclusion

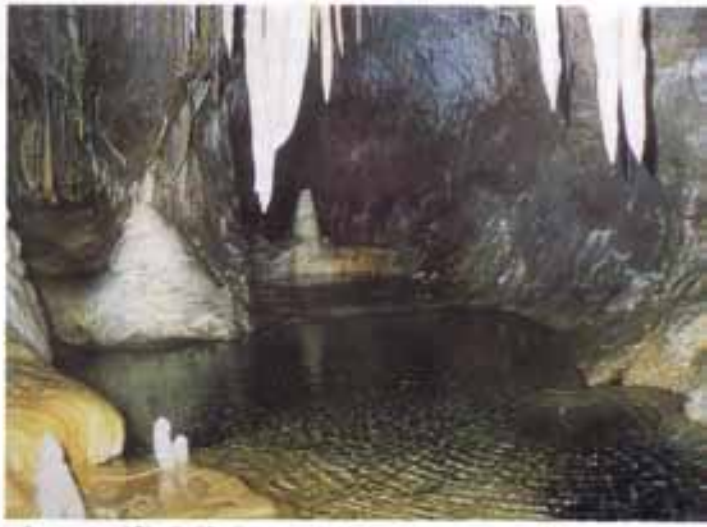
The beauty of the Antelias Kassarat Cave can only be matched by that of its complex history of discovery, loss, and rediscovery. Today, quarrying has stopped but the future of the cave still remain uncertain: will it remain hostage to the quarries where access is still granted with difficulty? Will it be part of a showcave project, which will reveal its astonishing beauty to the public? Or will it be a breathtaking journey granted occasionally to cavers in search of nature's hidden underground treasures?

Whether these questions will be answered in the future, the Antelias Kassarat Cave has undoubtedly carved memories with unique emotions in the hearts of those who were lucky enough to take part in its discovery and rediscovery.

Acknowledgments

The authors would like to thank Mr S. Karkabi and Mr H. Badaoui for providing photos for this article. Special thanks are also extended to all SCL members who participated in the numerous excursions inside the Antelias Cave Complex and contributed in exploring, rigging, mapping, and photographing the cave.

> The underground river (Photo by Sami Karkabi)



> A water pool 2km inside the cave (Photo by Sami Karkabi)

> Helictites inside the cave (Photo by Sami Karkabi)

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THE TRAVERSE OF HOUET EL DAKHOUN

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(Summarised from Nader, F. H. 2000. The story of Houet ed-Dakhoun. The International Caver Magazine, Aven International Publications, U.K, 24, 50-55.)

> **The sketch survey of Houet el Dakhoun** (From Nader, 2000)

> **Houet el Dakhoun** (Photo by Rana Karanouh)

Houet el-Dakhoun is an open-air sinkhole. One of the most powerful rivers of Lebanon flows through this sinkhole and reappears 500m downstream from a huge crack in the massive dolostone cliff. Several times throughout its history the SCL attempted to traverse the whole karstic development of Houet el-Dakhoun, but all of these outings failed. In 1999 this challenge was re-attempted (Nader, 2000).

> The location of Houet el Dakhoun (from Nader, 2000)

Pioneer Lebanese cavers, during the 1950's, have been very curious and amazed by one of the most interesting karstological feature in the Nahr Ibrahim valley, called Houet el-Dakhoun (or the chimney sinkhole).

Houet el-Dakhoun is an open-air sinkhole. One of the most powerful rivers of Lebanon, Nahr Ibrahim (with a flow-rate reaching up to 3m³/sec) flows through this sinkhole, then re-appears again 500m downstream from a huge crack in the massive dolostone cliff.

The powerful rush of water into the sinkhole causes the release of huge clouds of water vapour, especially during the spring season. These clouds can be seen from several kilometers away making it look like a natural chimney.

Several outings were needed to traverse the whole karstic development of Houet el-Dakhoun, but all of these attempts failed, with one trip almost causing the death of a caver. For a long time, the network of Houet el-Dakhoun remained a secret and no one thought of trying to discover this hidden tunnel; not until nature itself decided to give us a unique opportunity in 1999.

The unusually low precipitation rates of the years 1998-1999 allowed the flow rate of all Lebanese rivers to decrease dramatically. This motivated SCL cavers to try again to traverse the network.

On August 1st 1999, a team of cavers decided to try the traverse from the lower end of the cave. Moving against the current, passing three lakes, several waterfalls and some squeezes, they reached a waterfall that they could not pass. This waterfall came to be known as the 'Terrible Cascade'.

The second attempt was on August 15th 1999, when the cavers decided to target the upstream entrance of Houet el-Dakhoun. The entrance began with an impressive 80m deep open-air pitch. At the bottom of this pitch the river forms a marvelous waterfall that ends with a lake and a rock island in the middle, serving as a landing spot. The team continued progressing into the cave, crossing huge rimstone dams and a second lake. Then they found themselves having to cross a narrow canyon (sometimes only 50cm wide). Two of the cavers swam across it and rigged a rope for security. Upon reaching a third lake their progression was stopped because they had ran out of ropes. The two cavers had to swim back against the current because the ropes had sunk into the water and they could not use them anymore.

On the third trial, August 22nd 1999, the team took more equipment and plastic ropes to prevent sinking. While the cavers were rigging the 80m waterfall, a big rock slipped and hit one of the cavers who was rigging below. The rock hit the front of his helmet and slid along the right side of his body. The caver suffered from temporary amnesia, but eventually he was able to go up the rope alone.

In spite of this terrible accident, the rest of the team decided to continue the exploration, but the accident had left the team in a state of shock. They were only able to rig until the third lake then they decided to go back up and leave again the secret of Houet el-Dakhoun hidden.

Sunday, September 12th 1999. Another attempt: Two teams; each entering the network from a different end. The team that entered from the lower side faced the same fate of the first trial, and had to stop at the 'Terrible Cascade'. The second team reached the third lake easily but then they had to cross a horrifying waterfall, that came to be known as the 'Moulinex'. Following that there was a 30m pit and a fourth lake, and the team continued looking for the 'Terrible Cascade' and the huge rock that lay at its top. The network seemed never ending, reaching a fifth lake 50m long with no sunlight. After swimming across the lake, there was another 20m to 30m stretch of huge blocks of rocks, ending with a waterfall that led to a pool and then to yet another waterfall.

Then there it was, the huge rock in the middle of the stream, which meant that the last cascade was none other than the 'Terrible Cascade'. The two teams were able to hear each other across the waterfall. Now all they have to do was rig the 3m high waterfall. Finally the two teams met and Houet el-Dakhoun had nothing more to hide.

Information on Houet el Dakhoun:

x = 157.340m
y = 237.790m
z = 625 m
Map of Faraya 1/20 000

Geology: Kesrouane Formation, J4
Total development: 400m
Total elevation difference: 130m

The members of the club involved in this exploration were:
Abir Fakhry, Jackie Kechichian, Issam Bou Jawdeh, Rena Karamouk, Naoum Bechir, Fadi Nader, Elie Hankache, Samer Mudallal, Marc Metni, Marwan Sinno, Hughes Badaoui, Joseph Mhanna, Abed El Dayeh, Nadia Neeman, Rania Soubra, Elie Chouery, Bekri Koranfol, Johnny Frem and Hikmat Ghosn.

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-Selected reports from the SCL archives

SPELEOLOGICAL EXPLORATION

هوة قطين عازار

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في الهوة (صورة عصام سباط)

بالاعلى نزولاً (صورة عصام سباط)

تقرير موجز عن الرحلة التي قام بها النادي اللبناني للتنقيب في المغاور إلى هوة قطين عازار وذلك في ١١ ، ١٧ ، ١٨ آب ٢٠٠٢

A summary report on the SCL trip to Houet Qattine Azar in 16th, 17th, 18th of August 2002

الموقع

خريطة: ورقة عين طورة (المتن) ٦ ١/٢٠٠٠٠

x = ١٥٦,٠٨م

y = ٢١٧,٢٠م

z = ١٤١٠م

G ologie: Jurassique, j4

طريقة الوصول

مدخل الهوة الذي يستعمل كحظيرة للماعز وهو معروف بشكل جيد في الضياع المجاورة لمحل ترشيش.

قبل أيام من دخول الهوة (صورة عصام سباط)

الموضوع

قام النادي اللبناني للتنقيب في المغاور في ١٦ آب ٢٠٠٢ برحلة إلى هوة قطين عزار (ثاني أعمق هوة في لبنان بعمق يفوق -٥٠٠م) دامت الرحلة ثلاثة أيام وقد تميزت بالسرعة الفائقة. ويعود الفضل في ذلك لاتحاد الفرق التي كانت تقوم بتجهيز الهوة بالإضافة إلى النظام التام الذي دام طوال الوقت. كان من المقرر أن يستمر تجهيز الهوة إلى اليوم الثاني وأن يخصص اليوم الثالث للاستكشاف والتصوير. أما نزع التجهيزات فيكون في الأسبوع الثاني. وقد تم توزيع ثلاثة فرق تعمل على التوالي لتجهيز الهوة . ينطلق الفريق الأول في اليوم الأول ليصل لعمق (-١١٩م) وينطلق الفريق الثاني خلال الفترة الصباحية من اليوم الثاني ليصل لعمق (-٢٤٢م) وينطلق الفريق الثالث عصر اليوم الثاني تجهيز الهوة بشكل تام.

وبالفعل قام الفريق الأول المؤلف من محمد الحلو فادي فرّا وخليل الأشقر بالانطلاق في حوالي الساعة الثانية عشرة ظهراً لتجهيز القسم المطلوب. وفوجئنا بانتهاء العمل المطلوب خلال ساعتين. وتفادياً لإضاعة الوقت اتجه خليل فوراً نحو السطح ليطلب من الفريق الثاني المؤلف من عصام بو جودة ومحمد علي عرداتي ومعاوية خاروطة بالاستنفار ونقل جميع الادوات الموجودة على السطح لاستكمال التجهيز الذي أصرّ البعض أن ينجز في اليوم نفسه.

وفور وصول هذه الإمدادات استكمل التجهيز وصولاً إلى عمق -٢٤٢م وهو ما كان بلوغه متوقعاً في اليوم الثاني. أما القسم الذي بقي أمامنا فكان الأهم فهو تمثل ببئر يبلغ عمقه ١٨٢م ويسجل رقماً قياسياً في الشرق الأوسط. بدأت المشاورات حول امكانية الفريق الثاني استكمال تجهيز القسم الثالث من الهوة فتمّ تجهيز ٢٥ متراً ولم قرر الجميع التوقف والصعود نحو السطح لإفساح المجال للفريق الثالث بالمشاركة في هذه الإنجازات. وعند بلوغنا السطح طلبنا من الفريق المذكور المؤلف من فادي نادر ومارك متني وميشال مفرج الهبوط وانجاز ما تبقى من الهوة. علماً بأن جميع التجهيزات المطلوبة كانت بانتظارهم في الأسفل. واتجه الثلاثة نحو المهمة وعلامات الدهشة تعتريهم كما اعترت باقي أعضاء النادي لدى معرفتهم أن تجهيز الهوة قد أنجز بشكل تام في الفترة الممتدة من ظهر يوم الجمعة حتى مساءها. وهكذا خلد جميع المشاركين إلى الراحة والنوم مخلفين وراءهم هوة قطين عزار كاملة التجهيز وبوقت قياسي.

وفي صباح يوم السبت توافدت الوفود التي بدت على وجوههم جميعاً علامات التعجب والدهشة لحظة معرفتهم بانتهاء التجهيز. فلم يكن بوسع كل منهم إلا ارتداء جميع معداته والاتجاه داخل الهوة فكان يوماً سياحياً

عصام سياط يتسلق بئر الـ٣٩ متر (صورة محمد الحلو)

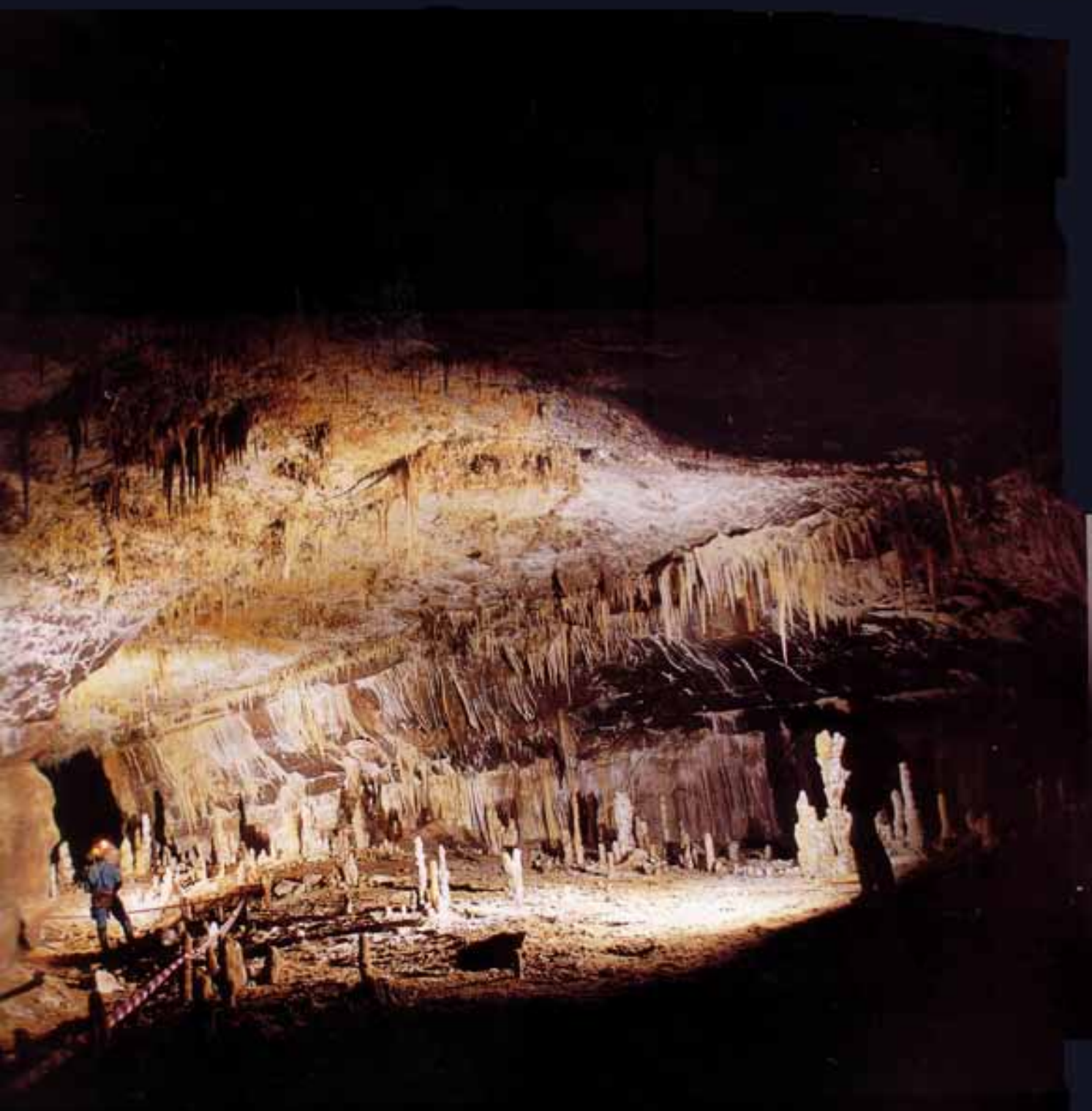
طويلاً جاب فيه معظم أعضاء النادي أعماق هذه الهوة. فتشكل فريق مؤلف من هادي قعسماني. فراس فياض. ليلى مارون. وأحمد الزعيم . وفريق آخر مؤلف من عصام سياط. صبحي غالب. ناصر العتر ومحمد الحلو.

ولم تقتصر زيارة هؤلاء الفرق على التصوير والاستكشاف فقط. بل تعدت ذلك لمحاولة تنظيف الهوة من بقايا قوارير المياه والمشروبات الرياضية المتروكة داخلها .وهكذا مضى اليوم الثاني من هذه الرحلة حتى المساء حيث خلد الجميع للنوم بعد اجتماع تقرر فيه نزع التجهيزات من الهوة. في اليوم التالي عبر الفرق التي تم تنظيمها لكل أجزاء الهوة. وفي الصباح وبعد تناول وجبة الفطور انطلق الفريق الأول المؤلف من جوزيف مهنا عصام بوجودة ومحمد الحلو نحو قاع الهوة وصولاً إلى النهر الجوفي. وهو أشبه بمدينة أو بمعسكر تدريب مليء بالأسرة وبذلات الغطس وأدوات التكييل وغيرها من التجهيزات المتروكة في القاع. قمنا بأخذ بعض الصور وبدأنا بالصعود (عصام ومحمد) وبدأ جوزف مهنا بفك التجهيزات. في هذه الأثناء بدأ الفريق الثاني المؤلف من ناصر العتر صبحي غالب ومعاوية خاروطة بالهبوط ليقوموا بعملية نقل المعدات نحو السطح.

و بدأت الفرق تتوافد نحو الأسفل كلّ حسب الوقت المحدد لديه .ليجد جو بانتظاره بحقيبة مملوءة فيحملها ويتوجه نحو السطح ويعود جو ليكمل نزع الحبال فبدت الهوة كخليّة نحل تعج بالمصطلحات العلمية المعترف بها بين المغاوير مثل:

Corde libre ..... fractionnement libre
..... attention .... je descends

وعلى عمق -١٧٠م التقى جو مهنا وائل حميدان الذي كان بانتظاره ليكمل عنه المهمة واتجه هو بدوره نحو السطح. وهنا تابع وائل نزع التجهيزات ليصل إلى سطح الهوة مستعيناً بالفريق المؤلف من فراس فياض .ميشال مفرج . ليلى مارون وغيرهم الذين أنهوا مهمتهم حوالي الساعة الخامسة من مساء الأحد. بعد زيارة خاطفة وسريعة لهذه الهوة الرائعة متمكنين من الاستمتاع بكل ما تحتويه هذه الهواية من استكشاف ورياضة وعلم .



> Gallery inside Mgharet el Kassarat
(Photo by Issam Bou Jawdeh)

LES SCL SPELEOLOGUES DE TRIPOLI EL MINA

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Photo 1
> **Mgharet Achou** (Photo by Mohammad Hallal)

Photo 2
> **Jourd Mrebbine** (Photo by Mohammad Hallal)

يروي هذا المقال قصة تشكّل فريق من المغاوير التابعين للنادي اللبناني للتنقيب في المغاور في مدينة الميناء – طرابلس داخل جمعية الكشاف المسلم . كان الفريق في البداية معنياً برحلات السير والاستكشاف النهري والتخييم الثلجي ثم ما لبث أن وسع نشاطاته وابتدأ في موضوع استكشاف المغاور عام ١٩٩٧ على يد وليد حفار – عصام سباط ومحمد الحلو. ونرى كيف كانت المعدات بدائية ومبتكرة على يد أعضاء الفريق وكيف استطاعوا أن يستكشفوا بها العديد من الهوات قبل أن يبتدئوا بامتلاك المعدات الحديثة منذ العام ١٩٩٨ وهم اليوم أعضاء ناشطون في النادي اللبناني للتنقيب في المغاور ويشاركون في معظم نشاطاته.

This article is about a group of cavers who come from the Mina city in Tripoli and who belong to the Scouts Association. In the beginning the group was intersted in hiking, camping, canyoning and in 1997 it expanded its interests to include speleology and caving. Walid Haffar was the pioneer in this allowing the group to discover many new sinkholes and caves even before the standard equipment were available to them. To date they have become active cavers of the Speleo Club du Liban.

> **Gouffre Kafr el Dean** (Photo by Issam Sbat)

> **1997, Walid Haffar and Mohamad el Helou** (Photo by Issam Sbat)

Nous sommes un groupe de scout (section Mina des scouts musulmans de Tripoli-Mina) très intéressé par la spéléologie. En 1991 nous ignorions tout de cette discipline. Nous pratiquions la randonnée pédestre et la découverte des lits de rivière tels la Kadicha et Joauz el Aarka. Dès 1995 nous avons élargi notre cercle d'action vers Mrebbine (Denniyé) et atteint le célèbre Qornet es Saouda, le plus haut sommet du Liban et du Proche-Orient (3083 m) À partir de cette date et jusqu'à ce jour nous pratiquions chaque année les camps hivernaux à Noël et dressions nos tentes sur la neige au plateau de Kammoua. Notre parcours le plus important (le 10 août 1996) a été celui de joindre Tripoli à la Békaa en passant par Qornet es Sauda et Yamounné et ce en six jours de marche.

Notre passion pour la spéléologie s'est révélée à la lecture d'un article paru dans le revue Science et Vie illustré de nombreuses et belles photos décrivant longuement cette discipline. C'est suite à l'insistance de notre ami Walid Haffar que nous avons décidé de nous adonner à cette activité.

Walid Haffar était le "leader" de notre groupe. Nous sommes au mois de janvier 1997. Il décide de commencer par l'exploration de la grotte de Zahlan (Aka Achou'). L'équipe est constituée de Issam Sbat, Mohamed el Hélou, Talal Mekawi, Rabih et Walid Haffar. Cette première incursion est suivie par l'exploration de notre premier gouffre situé à Kaferbine (Sfiré).

Un -50 mètres qui nous a fait tous peur. L'orifice était étroit et la profondeur énorme pour nous. Mais nous avons décidé d'y descendre avec le matériel de bord. Nous sommes retournés à Tripoli et avons emprunté une échelle à corde à montants en bois dont le poids dépassait le kg au mètre. L'échelle n'atteignait pas le sol. Mohamed el Hélou descendu en premier continu sur une énorme corde de 2cm de diamètre.

C'est au mois de mars de la même année que notre découverte la plus importante a été celle de Mgharet Zod. C'est à la suite d'un camp à el Dénniyé que nous avons entendu des rumeurs relatives à la présence d'une nouvelle grotte dans la région. Nous avons décidé d'y aller sur l'heure. L'exploration de 800 mètres de galeries a été effectuée lors de trois sorties consécutives. C'est alors que Walid Haffar contacte Fadi Nader dans le but de collaborer à l'exploration et qu'une équipe du S.C.Liban composée de Martin Gédéon, Sami Karkabi, Marc Metni, Fadi Nader et Marwan Senno arrive à Tripoli pour poursuivre l'exploration. Quant à nous notre groupe était composé de Walid Haffar, Rabih Haffar et Issam Sbat.

Cette sortie a été une étape très importante dans notre cheminement spéléologique. C'était notre première rencontre avec quelques membres du S.C.Liban. Nous étions très impressionnés par leurs équipements et par l'approche didactique de la spéléologie.

Août 1997 : un cours de spéléo et des fiches techniques nous ont été remis, mais nous ne possédions toujours pas de matériel. Nous pénétrions dans les grottes munies d'un équipement rudimentaire. Nous avons même exploré un gouffre de – 45 mètres dans des conditions particulières. A la descente nous utilisions 2 mousquetons pour le rappel alors que

> **Quammouaa** (Photo by Issam Bou)

> **Mgharet el Kassarat** (Photo by Issam Bou)

la remontée s'effectuait avec deux cordelettes et 2 nœuds de prussik ! A cette époque nous comptions quatre membres actifs : Rabih Maraach, Wassim Dakashe, Mohamed Sankari, Mohamad Ali Annous.

Avril 1998 : nous achetons deux équipements individuels et une corde de 50 mètres. Nous avons consulté nombreux ouvrages spécialisés et fiches techniques. C'est ainsi que nous avons bien maîtrisé la procédure d'exploration de la spéléologie alpine.

Nous avons à notre actif les explorations suivantes :

Février 2001 : Ayant terminé mes études universitaires, Mohammed el Helou et moi-même avons décidé de nous inscrire au S.C.Liban. Pendant cette période notre matériel s'est enrichi de 6 équipements individuels, 4 cordes de 50 m chaque, 20 plaquettes, matériel à spitage, sangles …

Février 2002 : la grande étape précédée de plusieurs réunions avec Issam Bou Jawdeh a été l'inscription en totalité du groupe de Tripoli au S.C.Liban avec lequel nous travaillons avec fierté et solidarité. Aujourd'hui les spéléologues de Tripoli font de grandes explorations : Faouar Dara, Qattine Azar, Jouret el Aabed, Jiita … et comptent un leurs membres au sein du comité du S.C.Liban.

> **Kornet el Sauda** (Photo by Mohammad Helou)

> **Mgharet Zod** (Photo by Mohammad Helou)

TRAINING

CAVE RESCUE TRAINING FOR THE SAUDI GEOLOGICAL SURVEY

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> At the end of the rescue training in Mgharet Rouaiss
(Photo by Issam Bou Jawdeh)

Upon the request of the Saudi Geological Society, the Spéléo-Club du Liban conducted a training in cave rescue for two successive years. The team was trained from the basic SRT ascent and descent techniques to cave rescue and surveying.

above
> Issa Zaidan giving the first aid training sessions.
(Photo by Issam Bou Jawdeh)

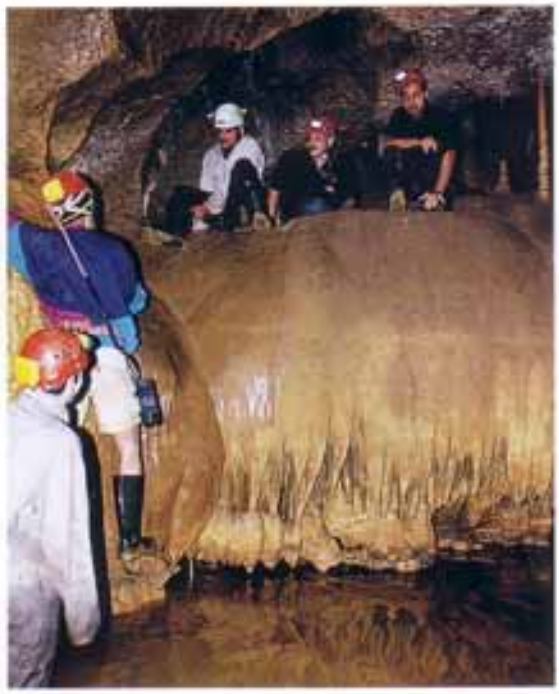
left
> Technique training at SCL s club-house.
(Photo by Issam Bou Jawdeh)

The Spéléo Club du Liban (SCL), throughout its 50 years of existence, has always been a regional pioneer in the science and technique of cave rescue. This resulted in international consideration of the club as a rescue entity particulary in the Arabic speaking countries. More than ten large maneuvers were conducted in the 1990's (Bechara, 2002). These included maneuvers with the SSF (Spéléo-Secours Francais), the Lebanese Army, and the Red Cross (Bechara, 2002). Maneuvers have included simple cave rescues in horizontal and vertical caves and complex ones which introduced helicopter evacuations and river rescues to Lebanon for the first time. Five and seven rescuers from the Red Cross in 1992 and 2003 respectively were trained to aid in the cave rescue evacuations. Similarly a group of five officers from the Lebanese army were trained in 1998 and 1999 to establish a Lebanese army entity that aids in rescue operations.

The last real time rescue was conducted in 2002 when the Syrian Government contacted the SCL and Lebanese Adventure for a mountain rescue of a lost girl. The rescue was conducted on a large scale with the Syrian army to cover a wide area, where the victim might be present in. The victim was recovered after ten days but it was too late (Bechara, 2002).

The quest by the Saudi Geological Survey (SGS) to discover and map caves in the Kingdom of Saudi Arabia led to the establishment of a caving entity within SGS. Activities of this caving entity had accelerated in the last few years. The Middle-East Speleological Symposium in 2001 highlighted the tremendous effort this small entity is putting forward in discovering and mapping new cave. Such caving activities have also raised some concerns on the safety of cavers. Therefore, upon the request of the SGS, the SCL provided for two consecutive years (2002 and 2003) an intensive 10 days course in cave rescue and first aid techniques.

> Survey training inside Mgharet Nabaa el Shatawie
(Photo by Issam Bou Jawdeh)



> Inside Mgharet Nabaa el Shatawie
(Photo by Rana Karaanouh)

For two years in a row first aid specialist Joe Zaidain introduced to the SGS team the first aid techniques in several sessions that amounted to approximately 30 hours. The sessions were both theoretical and practical in the SCL headquarters and in open air, in a nearby pine forest. The first aid course introduced to the SGS members included several of the vital techniques each caver should be acquainted with in order to be ready to aid in the basic rescue if needed. These included vital signs inspection: consciousness, breathing, pulse, and shock symptoms, dealing with bleeding and hemorrhaging, setting of broken arms, broken shoulders, broken legs, broken fingers, fractured ankles, the Heimlich Maneuver and the positioning of an injured person.

The SGS members were also introduced to the history of the single rope technique, the ropes that are utilized in caving and cave rescue, the rigging techniques and the special rigging needed for rescue in vertical caves. All the techniques were also demonstrated in the practical sessions that took place mainly outdoors especially on the Natural Bridge of Faqra, in Central Mount Lebanon.

In addition to the rescue and first aid techniques, the SGS members were taught underground surveying techniques. A real time application was also done in the Mgharet Nabba el Shatawie in Khallet el Khazim, South Lebanon.

> Training tactics being discussed inside Mgharet Roueiss
(Photo by Issam Bou Jawdah)

> Rescue training inside Mgharet Roueiss
(Photo by Issam Bou Jawdah)

The final day of the course in the year 2002 witnessed a large cave rescue maneuver inside the Rouaiss cave in Aqoura, central Mount Lebanon. The case was an injured caver 500m inside the cave. The number of rescuers were 25 cavers including the SGS team. The cave was rated as difficult for this kind of rescue maneuver. After some difficulty in the application of several techniques in narrow, slippery, vertical and easy passages the victim was successfully transported out of the cave .

The training was necessary to keep the SGS members in shape to accommodate any accident that may happen in the future. On February 2003 (before the training session of that year) an accident occurred to one of the SGS members during their field activities (Saudi Gazette, 2003). On the mouth of Um Quradi Cave a lava tube in the Khaybar Lava field, located north of el Madina in Saudi Arabia an accident occurred to Saeed Al-Amoudi one of the members of the SGS caving unit. He suffered multiple injuries. Bleeding from the head was stopped and the broken leg fixed and the victim was covered to keep at warm. After that, the authorities were called and a helicopter transported the victim to the nearest hospital. The caver was x-rayed and no serious injury was found and he resumed his activities including his training in Lebanon (in the year 2003).

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A SEMI - QUANTITATIVE DESCRIPTION OF A DYE TRACING EXPERIMENT IN THE FOUAR ANTELIAS DRAINAGE BASIN

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> A waterfall inside Mgharet el Kassarat (Photo by Rana Karanouh)

L'expérience de traçage à l'uranine dans l'aquifère calcaire du Kesrouan (J4) entre le gouffre Qattine Azar et la source Faouar Antélias a démontré l'existence d'un système karstique très développé dont le bassin versant occupe une superficie totale de 280 km² environ. La source de Faouar Antélias constitue l'exsurgence principale de ce système où la vitesse d'écoulement souterrain pourrait dépasser les 1,2 cm/s en période de crues. Des traces de colorant ont également été recueillies dans les bassins versants de Daichouniyeh et Jeita. Cette découverte implique que le bassin de Faouar Antélias et ceux des systèmes avoisinants sont vulnérables à toute décharge de contaminants non traités, qu'elle soit occasionnelle ou régulière.

The tracer experiment in the limestone aquifer of Kesrouan (J4) between Qattine Azar sinkhole and Faouar Antelias spring has revealed the existence of a highly developed karstic system which drainage basin covers an area of approximately 280 km². The Faouar Antelias spring constitutes the main outlet for water in this system where groundwater velocity may exceed 1.2 cm/s during the wet season. Traces of fluorescein were also recovered in the Daichouniyeh and Jeita drainage basins. The finding highlights the vulnerability of the system and the neighbouring ones to both incidental and prolonged spills of contaminants within the drainage basin.

Background

The entrance to Maghuret El Kassarat cave was first discovered by the Spéléo Club du Liban (SCL) in 1969. The finding was of major hydrogeologic significance because the cave hosts an important karstic spring complex comprising the primary issue at Faouar Antelias and its subsidiary outflows at Maqsbieh and Saltaneh.

As in most karstic systems, the exact extent of the catchment area was poorly understood prior to the test. The topographic drainage basin of the spring was approximately 25 km^2; however, dye tracing experiments at the Faouar Dara sinkhole in 1965, 1967 and 1969 (Hakim and Karkabi, 1988) had already revealed the existence of a well developed karstic system extending from the heights of the Mount Lebanon to the coast.

In June 1996, the Association Libanaise d'Etudes Spélélogiques (ALES) discovered another important sinkhole in the area: Qattine Azar. The finding prompted fundamental questions concerning the connectivity between the new sinkhole and the Faouar Antelias spring system. The dye tracer test reported hereafter was part of a comprehensive study that was conducted to address this main question, in addition to other hydrogeologic and environmental concerns that will not be discussed here. The project was a collaborative effort between SCL and ALES during which more than 50 volunteers were involved in round-the-clock sampling of the tracer.

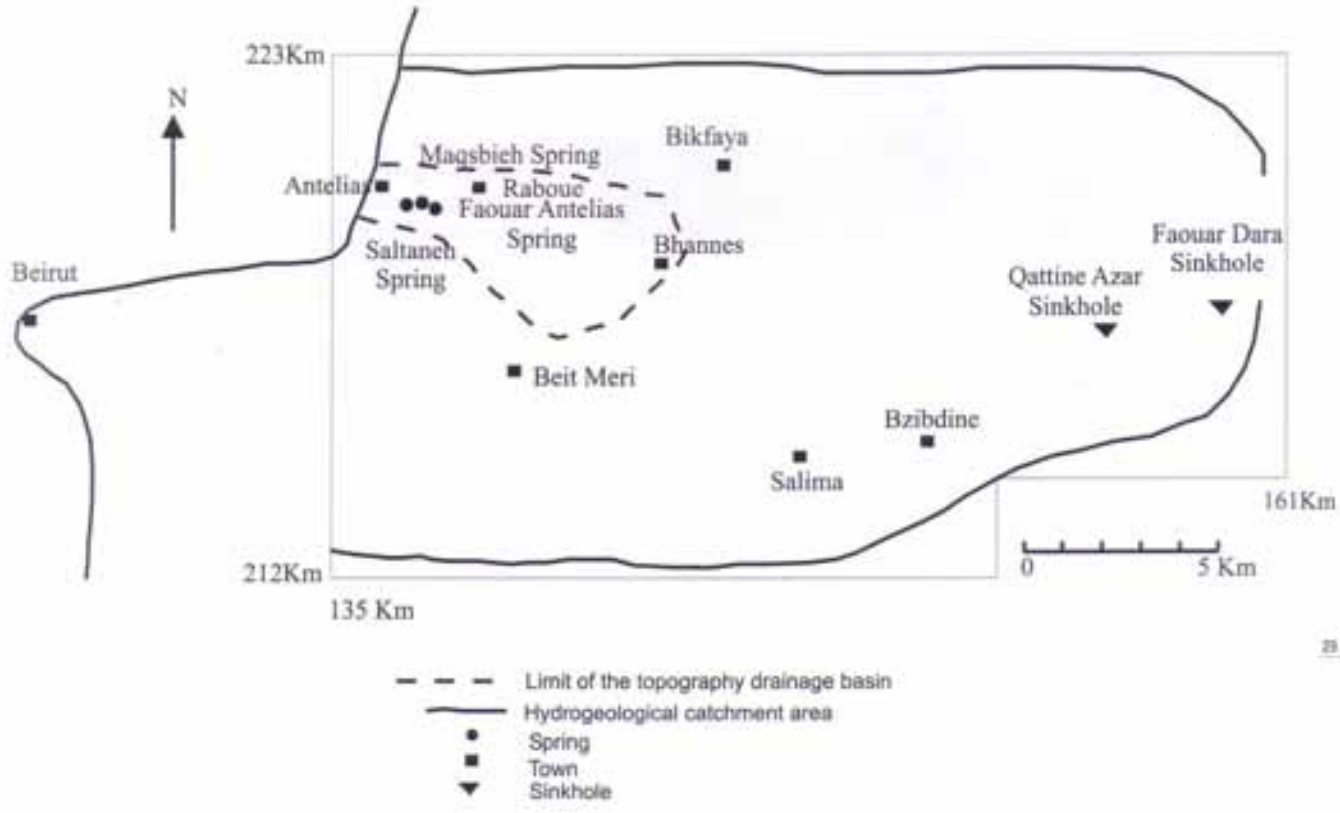

Figure 1
> Location maps of the study area

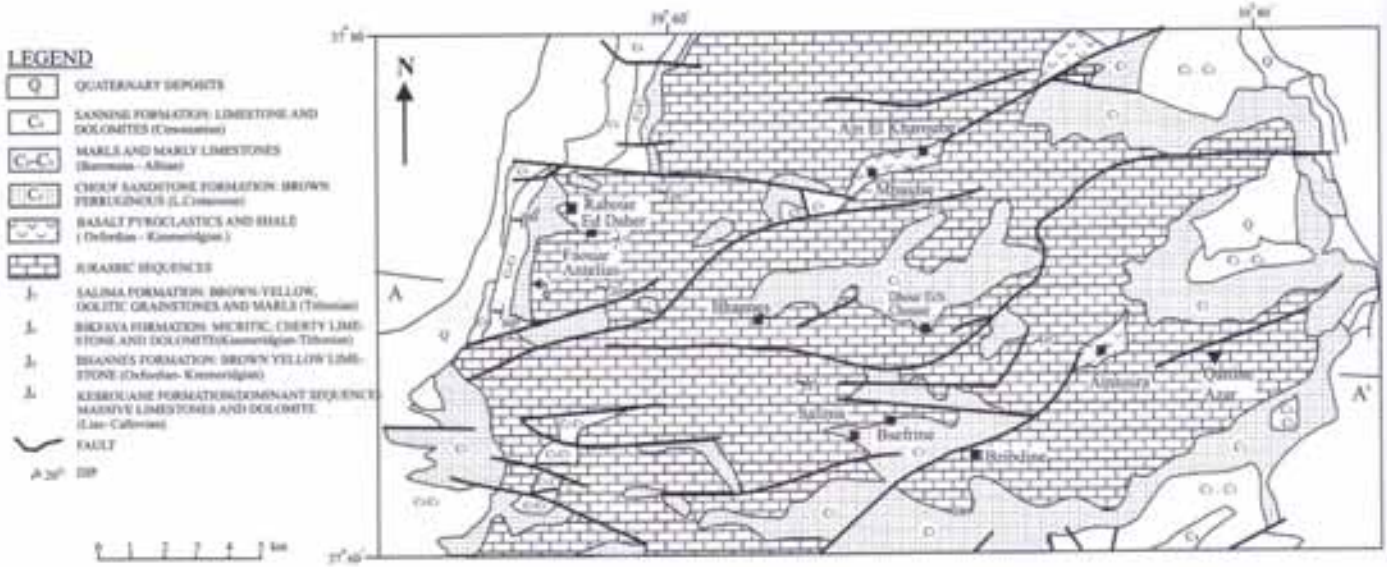

Figure 2
> The geological map of central Mount Lebanon

> Faouar Antelias after the tracer test (Photo by Sami Karkabi)

Geology of the Area

The area under investigation lies between latitudes 37° 60' and 37° 80' and longitudes 39° 60' and 39° 80' (Figure 1). The main geological units in the study area include the Middle Jurassic Kesrouane Limestone Formation (J4), the Upper Jurassic Bhannes Volcanic Formation (J5), the Bikfaya Limestone Formation (J6) and the Salima Limestone Formation (J7; Figure 2). The Jurassic sequences (J4 – J7) cover the majority of the area but outcrops of sandstones from the Chouf Formation (C1) can be seen in the central and peripheral portions of the study area. The eastern and western borders also include marly and marly limestone formations from the Lower Cretaceous (C2-C3) as well as some Quaternary deposits (Q) formed mainly of loose alluvial material.

Out of the above geological rock-sequences, the Kesrouane and Bikfaya Limestones are the primary water-bearing formations in the Faouar Antelias drainage basin. Water has carved sizeable conduits throughout the Kesrouane Limestones, leading to the formation of many caves and sinkholes. The Faouar Antelias spring issues from the Bikfaya limestones (J6) while the Maqsbieh and Saltaneh resurgences emanate from the Salima Limestones (J7). However all three outlets receive recharge from the Kesrouane Limestone Formation (J4) through the structurally complicated system in the area.

The Jurassic formations are generally dipping westwardly by an amount varying between 8 and 22°. Closer to the coast, the dip of the overlying Cretaceous formations significantly increases to 60 – 80°. Structurally speaking, the area is intersected by several East -West and East - South-West trending faults. The correlation between the fault systems and the conduits/cave system at Faouar Antelias was not fully addressed during the study. However, considering that the cave also extends in the East-West direction between Qattine Azar sinkhole and Faouar Antelias spring (Figures 3a and 3b), it would not be surprising if the two systems overlapped, albeit intermittently, across the study area. As such, the conduit system would have developed from the dissolution process along the major fault lines in the area.

Literature Review

A review of earlier work related to the Faouar Antelias drainage basin and to the surrounding areas was conducted prior to the start of the study. For the sake of simplicity, only the publications most related to the present topic will be presented. Geological maps by Dubertret (1945-1963) were used as a starting point for the study of the various aquifer formations. The geological maps were complemented by field surveys of the area at the 1/20,000 scale by geologists from the Bureau Technique pour le Développement (BTD). Unlike the

neighbouring Jeita spring which benefited from extensive characterization studies - Bakic (1972) being just one example - quantitative assessments of the Faouar Antelias spring or its drainage basin were much less common. The UNDP report (1970) briefly mentioned the spring in its review of the major Lebanese karstic springs and estimated its drainage coefficient and its discharge. Hakim and Karkabi (1988) described three tracer experiments conducted in 1965, 1967 and 1969 at Faouar Dara, which had established the link between the sinkhole and Faouar Antelias spring. Prior to this study, the only known (to the author) fully quantitative analysis of a tracer test in Lebanon was conducted by Majdalani (1988) for Baatara and Balaa springs. In order to address a more general readership, the following article will present a semi-quantitative description of the dye tracing experiment between Qattine Azar sinkhole and Faouar Antelias that was succeeded in October 1996.

The Tracer

Uranine ($C_{20}H_{10}Na_2$), better known as fluorescein, was used during the study. The dye is visible to the naked eye at 10^{-7} kg/l (Mangin et al.,1976), which is quite convenient for many experiments studying the interconnection between conduit systems or for monitoring the flow path of water streams. Uranine is commonly used in speleology because of its high solubility in natural waters and its detectability at concentrations as low as 10^{-8}-10^{-9} kg/l (Atkinson and Smart, 1979). Uranine can also be trapped by activated charcoal, increasing the detection threshold by about 1000 times (Mathey, 1971).

In spite of all the advantages listed above, the use of uranine is subject to two main limitations. These include sorption to argillaceous surfaces and organic materials such as ferric oxides and the liability to photochemical degradation. Because of the high flow velocities in karstic systems, the time of contact between solutes and the solid medium is usually quite low. This leads to a reduction in the extent of sorption, making the use of the tracer less prone to error. Moreover, in the case of Faouar Antelias spring, the entire flow path was subterranean; consequently, the tracer was protected against photochemical degradation during its travel between the point of release and the sampling stations.

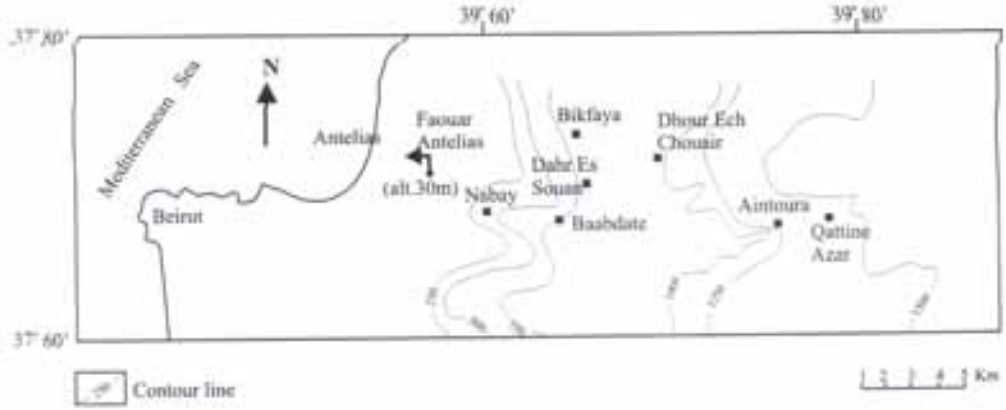

Figure 3a
> Topography of the study area

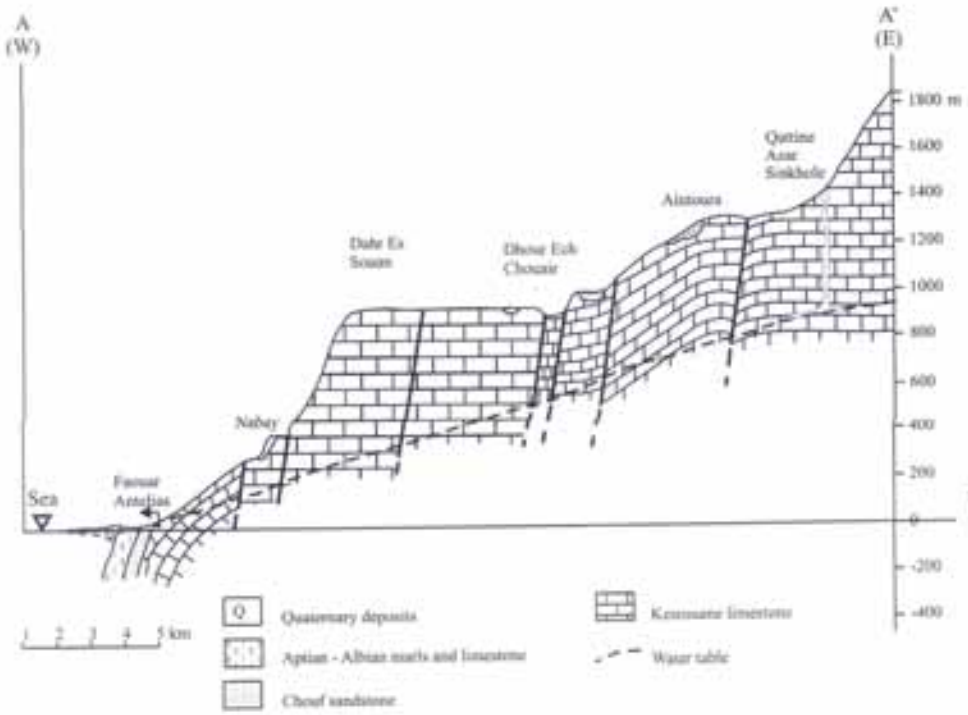

Figure 3b
> Geological section across the study area

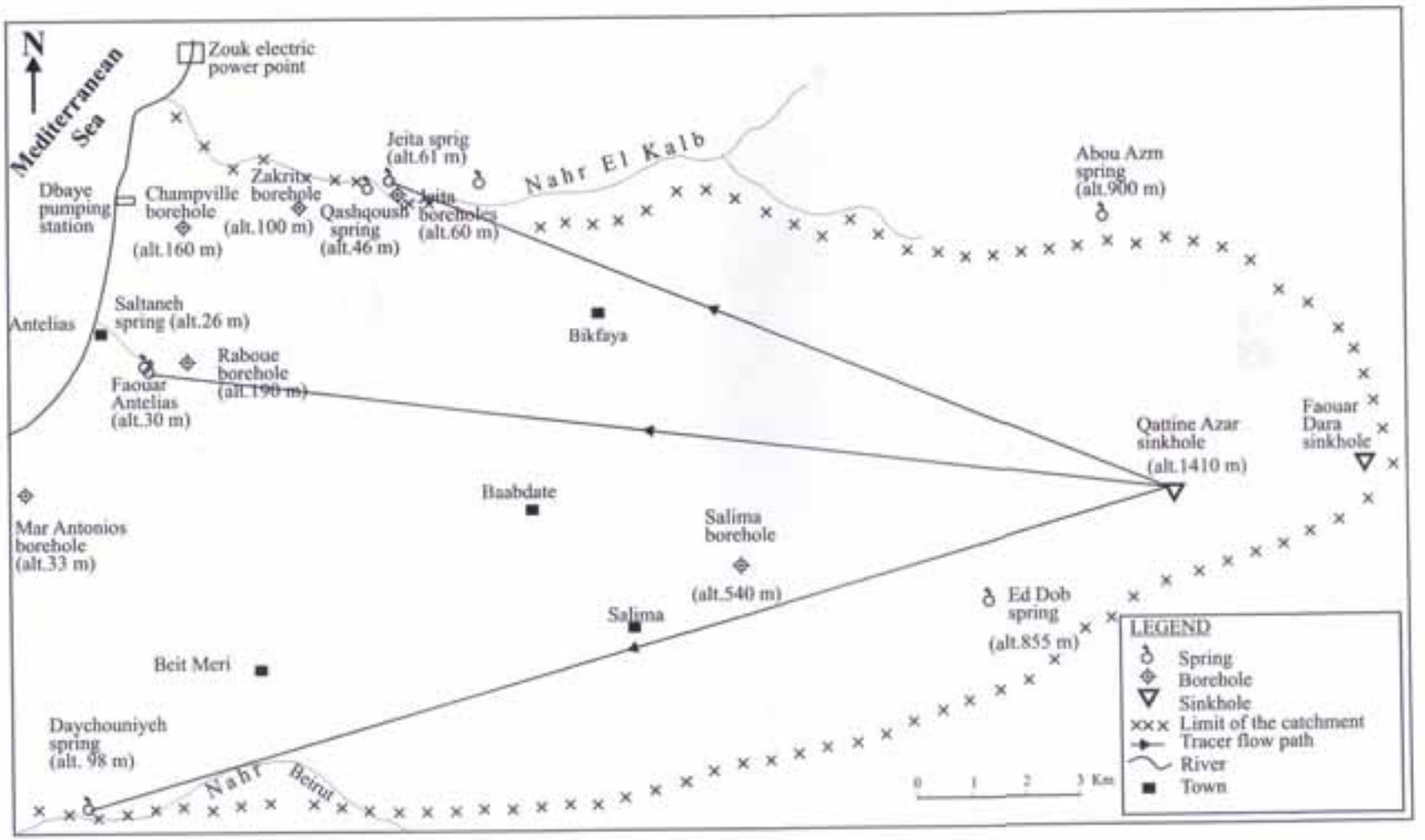

Figure 4
> Sampling stations for the dye tracing experiment of 12 October, 1996

Field Procedures

The tracer was released at the end of the cave below Qattine Azar sinkhole (Figure 3b). The tracer solution consisted of 25 kg of fluorescein and 25 litres of isopropyl alcohol dissolved in 200 litres of background water. The use of the alcohol was necessary to increase the solubility of the tracer. The mixture was homogenized in an impermeable canvas container attached to the walls of the cave by support ropes. Instantaneous injection was achieved by releasing the support ropes. The release took place on Saturday 12th October, 1996 at 17:00 o'clock.

A total of seventeen sampling stations (Figure 4) selected as likely points of resurgence were monitored throughout the duration of the test. The most important sites in terms of flow discharge were monitored by round the clock shifts. Sampling was done every six hours at first and was intensified to once an hour after the first tracer arrival.

Sites that were considered secondary due to their low discharge or to their remoteness from the main structural axes were monitored with charcoal detectors and daily sampling. The detectors were positioned in shady spots away from vegetation which has the ability to sorb fluorescein. The detectors were also kept away from areas of rapid flow to allow for adequate sorption time.

Aerial surveillance of the coast line between Nahr El Mot and Nahr El Kalb was also considered in order to ensure that no main outlets to the sea go unnoticed. The first flight took place on October 19, but later flights had to be cancelled due to bad weather conditions.

Prior to the release of the tracer, blank samples were collected from all the monitoring stations to be used for measuring background fluorescence and for sample dilutions in the laboratory. The monitored springs (Figure 4) were Faouar Antelias, Saltaneh, Jeita, Qashqoush, Daichouniyeh, Abou Azm, Ed Dob. The boreholes were Salima, Mar Antonios, Zakrit, Rabouè, Champville, Jeita and Antelias. Additional stations were set at the electricity power plant in Zouq, the water pumping station in Dbayé and at the sea outfall of the Faouar Antelias stream.

Samples were collected in 150 cc flasks that were labelled and protected from exposure to sunlight by dark plastic bags kept inside closed cardboard boxes. Flow measurement with current meters was undertaken in parallel with the tracing experiment at selected sections in order to obtain an independent estimate of discharge.

Laboratory Procedures

Two techniques were used for the fluorescein identification; these were fluorometry and charcoal extraction. The fluorometer used was a Jenway 6200 equipped with a BG28 filter permeable only to UV radiation which is used to excite the sample solution. A VG9 screen exclusively passes outgoing waves in the visible spectrum, which are a function of the fluorescence of the sample.

Calibration of the apparatus was done using background waters sampled from each site before the

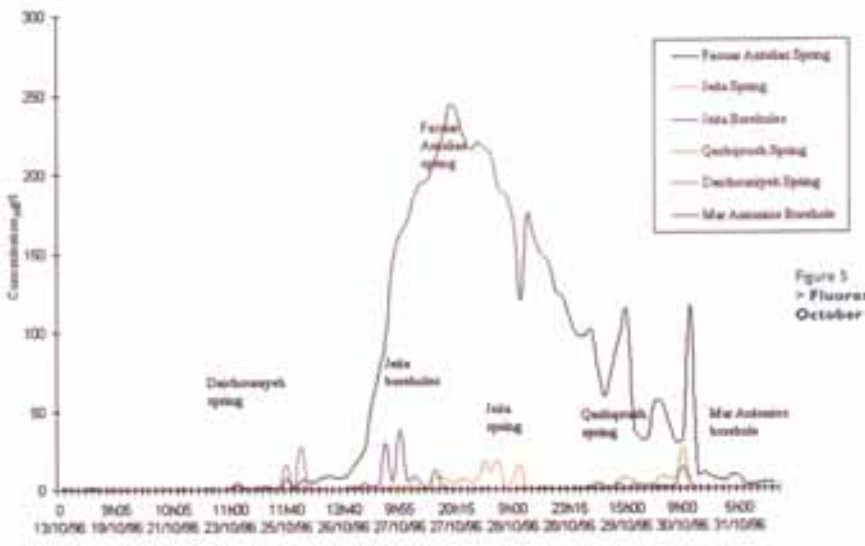

Figure 5
> **Fluorescein recovery at the points of resurgence, October 1996**

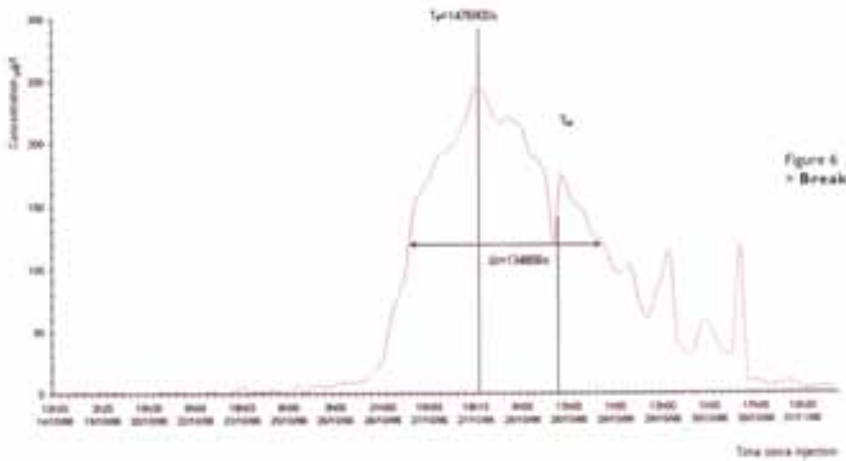

Figure 6
> **Breakthrough curve at Faouar Antelias Spring**

start of the experiment and from a sample of the tracer solution. Samples of background water were used to eliminate natural fluorescence from plants and algae.

The charcoal extraction technique makes use of uranine's higher affinity for KOH than charcoal. A 5% KOH solution was used to desorb the tracer from charcoal detectors. However, results from charcoal extraction can only be qualitative in nature since it is impossible to recreate the equilibrium conditions of the solution at the time of arrival of the wave of tracer in contact with the charcoal (Atkinson an Smart, 1979). Results from detectors were therefore either "positive" or "negative".

Results and Interpretation

Breakthrough curves at the monitoring stations were plotted (Figure 5). The stations where the tracer was recovered were Faouar Antelias, Daichouniyeh, Jeita and Qashqoush springs as well as Jeita and Mar Antonios boreholes. The first traces of uranine were detected at Faouar Antelias spring at 11:00 AM on October 23, 1996, approximately 11 days after the injection of the tracer. This was shortly followed by a complete breakthrough at the Daichouniyeh spring. The bimodal curve at Daichouniyeh peaked at around 18:45 on the 25th of October. Another bimodal breakthrough curve was recovered two days later (27th October) from the Jeita boreholes. The breakthrough curve at Faouar Antelias spring peaked around 19:15 on October 27, 1996 followed by the Jeita spring on the 28th of October. The last breakthroughs occurred simultaneously at Qashqoush spring and Mar Antonios borehole on October 30, 1996.

It is evident from the recovery curves (Figure 5) that the largest quantity of tracer was recovered at Faouar Antelias spring. Establishing a mass balance for uranine was made difficult by the change in the flow regime as a result of a major rainstorm event between October 27 and 29. The discharge had in effect risen overnight from a baseflow value of 0.3 m^3/s to about 1.1 m^3/s, thus hampering any simple mass flux calculation. However, even without mass balance calculations, it can safely be said that the majority of the tracer mass was recovered at the Faouar Antelias spring, considering that there were no other major resurgence points. The finding clearly establishes the spring as the main outlet for the entire drainage basin, thus corroborating results from earlier experiments at Faouar Dara sinkhole.

The extent of the tracer recovery is a clear testimony to the difference between topographic and hydrogeologic drainage basins. While the topographic catchment area of the Faouar Antelias spring is around 25 km^2 (as determined from a regular topographic map), the area delineated in Figure 4 covers approximately 280 km^2. Thus any water resources development or environmental assessment schemes on the spring have to be conducted at the scale of the hydrogeologic drainage basin. The recovery of uranine at Daichouniyeh spring and Jeita (boreholes and spring alike), which belong to the adjacent Nahr Beirut and Jeita drainage basins respectively, highlights another property of karstic aquifers. This is the interconnection between adjacent basins. In effect, it is quite possible that overflooding of a drainage basin as a result of a major rainfall event may result in the spilling of the water into the adjacent watersheds. During the process, the rise of the water may lead to a reactivation of otherwise dry conduit network systems. This finding adds another complication to the simplistic environmental protection schemes that tend to address watersheds individually.

The breakthrough curve at Faouar Antelias (Figure 6) was remarkably complete for such a large-scale field experiment. Tailing in breakthrough curves is usually an indication of heterogeneity or retardation. However in karstic systems, it can also result from a slowing of the flow regime as a result of a rapid decrease of the water level in the aquifer such as in the aftermath of a storm event (Smoot et al, 1987).

The mainly unimodal curve suggests that most of the tracer mass followed the same general pathway or several highly interconnecting conduits acting as a single one. The few isolated and narrow peaks on the falling limb of the breakthrough curve may be due to a repeated return of solutes to the main flow channel or to the tracer's advance through conduits of different lengths and capacities which eventually discharge in the Faouar Antelias spring. It is not possible to determine from a single test which of the two scenarios took place and in case both did, which was the prevalent one. However, both phenomena can be explained within the contest of a heavy rainfall event. Flooding of a karstic system may reactivate conduits which are otherwise dry at that time of the year. Some of these conduits may be connected to the main flow path further on, but other conduits may not be. This can cause temporary storage of flood water and its load of tracer within the dead end conduits (Mangin et al., 1976). The return to the main stream can only take place when the head in the main path has decreased, hence the occurrence of the peaks at after the passage of the bulk of the tracer.

The rise in the height of water is also likely to have speeded the resurgence as a result of the increase in hydraulic head. The time of peak arrival (TP) was 1476900s or roughly 17 days after the injection. However, the time of arrival of the centre of mass (TM) was about half a day later. This is due to dispersion where different layers of water in a conduit move at different speeds depending on their distance from the walls of the conduit.

An average flow velocity can be calculated based on the length of path x, the time of peak arrival and the time during which the concentration exceeds half of the maximum concentration (Δt; Jamier, 1976):

$$v = \frac{x}{T_p + \left(\frac{\Delta t^2}{16\, T_p \ln 2}\right)}$$

For x = 18 km which is the approximate distance between Faouar Antelias and Qattine Azar sinkhole, TP = 1476900s and Δt = 134856 s, v = 1.2 cm/s. This in an intermediate velocity for karstic systems where values can reach up to 20 cm/s (Drogue, 1971).

While the above calculated velocity was most likely affected by the rainfall event which took place during the course of the experiment, it nevertheless gives an idea of velocities that can be seen in the Faouar Antelias system during the wet season. A velocity of 1.2 cm/s (approximately 1 km/d) is of significant environmental importance. It places the entire system as well as neighbouring basins in a vulnerable situation in front of incidental or prolonged spills along the drainage basins. This finding calls for strict environmental practices to be implemented throughout the entire capture zone. Such practices include abstinence from releasing untreated sewage or industrial wastes into the valleys and sinkholes within the entire basin.

Conclusions

The large-scale tracer experiment in the Faouar Antelias drainage basin has revealed the existence of a highly developed karstic system covering an area of approximately 280 km². Located some 18 km downgradient from the point of release of the tracer, the Faouar Antelias spring constitutes the main outlet for water in the entire basin. Groundwater velocity was found to exceed 1.2 cm/s during the wet season, and water was found to spill over to the adjacent watersheds of Nahr Beirut and Jeita. The above findings underline the vulnerability of the entire system and its surroundings to incidental and regular releases of untreated wastes.

The hydrogeologic results complement earlier tracer experiments at the Faouar Dara sinkhole. These experiments had established the connection with the Faouar Antelias spring. However, the relationship between Faouar Dara and Qattine Azar sinkholes remains a missing piece from the big puzzle. A tracer test between the two sites would provide a great insight in the understanding of the karstic system of the Faouar Antelias drainage basin. SO GEAR UP EVERYONE!

Acknowledgement

Many thanks are addressed to the numerous volunteers from the SCL and ALES for their invaluable contribution to the success of the study; many of them spent long hours outdoors in difficult weather conditions. Acknowledgements also go to Hughes Badaoui for his assistance in the flow measurements undertaken throughout the study area.

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ARCHEOLOGY

DAHR EL MOGHR • Kefraya, Bekaa

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> Hypog e i (Photo by Sami Karkabi)

Les cavités artificielles creusées dans le calcaire sont fréquentes au Liban : mines de fer, de cuivre, de bitume ..., galeries à la recherche de cours d'eau souterrains ou encore celles à but militaire et défensif. Nous n'oublierons pas aussi les hypogées destinés à devenir le dernier refuge de l'homme. Il nous a semblé intéressant d'en publier un aperçu destiné à illustrer un thème non encore abordé dans notre revue, qui indirectement s'inscrit dans le cadre du domaine du karst.

Artificial cavities carved into limestone rock are common in Lebanon; mines of copper, iron, bitumen ..., galeries searching for undergroud water, in addition to those cavities of military or defensive use. Not to forget tombs carved in rock, destined to become the last refuge of man.

This is a study illustrating a theme that hasn't been approached yet in our journal which indirectly enters into the karst domain.

> Situation g ographique de Kefraya

Caractéristiques générales des Hypogées

Les hypogées sont des tombeaux souterrains creusés de main d'homme. L'accès se fait soit par une trappe ouvrant dans le plafond soit par une façade à laquelle on accède par un escalier ou un dromos à pente douce. Nous avons identifié ces deux types à la fois parmi les hypogées de Dahr el Moghr.

Outre ces caractéristiques d'accès, nous distinguons aussi ceux dont l'intérieur, après dégagement de la roche ou de la terre ont été appareillés avec soin au moyen de blocs de pierre et ceux qui sont restés sans aménagement particulier, ce qui est le cas de Dahr el Moghr

Nous devons aussi distinguer les hypogées qui font partie de constructions monumentales qui ont été creusés sous la surface du sol et ceux qui plus modestement constituent à eux seuls un monument dans la mesure ou ils ne sont surmontés d'aucune construction. C'est à cette dernière catégorie qu'appartient le site de Dahr el Moghr.

Ce type de tombeaux souterrains se rencontre dans plusieurs régions du Liban et de Syrie et par conséquent n'est pas caractéristique uniquement de la région de Kefraïya. Dans la Béqaa nous signalerons particulièrement ceux de Dakwé, Hammara et Ferzol.

De nombreuses techniques ont été utilisées pour surélever la tombe par rapport à son environnement et lui conférer le prestige d'être bien vu. La plus simple est celle de choisir un affleurement rocheux comme c'est le cas des hypogées rupestres de Dahr el Moghr.

Les sites funéraires sont associés le plus souvent à un édifice religieux à une installation rurale ou urbaine. En ce qui concerne Dahr el Moghr, aucun site en proximité n'a été identifié. Notons cependant que les promontoirs rocheux qui l'entourent, sont parsemés de tessons de poterie (surtout glacurés datant essentiellement de la période médiévale) qui prouvent leur occupation ou simplement leur utilisation depuis des périodes bien reculées. Des prospections systématiques dans les environs immédiats, devraient fournir des éléments signalant la présence de lieux historiques, archéologiques en relation avec ce dernier.

Situation G ographique de Kefraia

Carte au 1/20 000e - Bâroûk (I-5)

Coordonnées Lambert
X = 150,020 km Y = 192,140 km Z = 1040 m

Présentation générale du site

a > Voies d'accès.

Deux voies d'accès mènent aux hypogées de Dahr el Moghr. La première que nous recommandons est pédestre. Elle prend naissance à la lisière sud des jardins gazonnés du complexe vinicole de Kefraïya. Elle longe un très beau vignoble, qui traversé en ouest rejoint la butte en question (Figure 1).

Figure 1
> Vue g n rale de Dahr el Moghr
(Photo by Sami Karkabi)

Figure 2
> R partition num rique des hypogees de Nahr el Moghr
(Photo by Sami Karkabi)

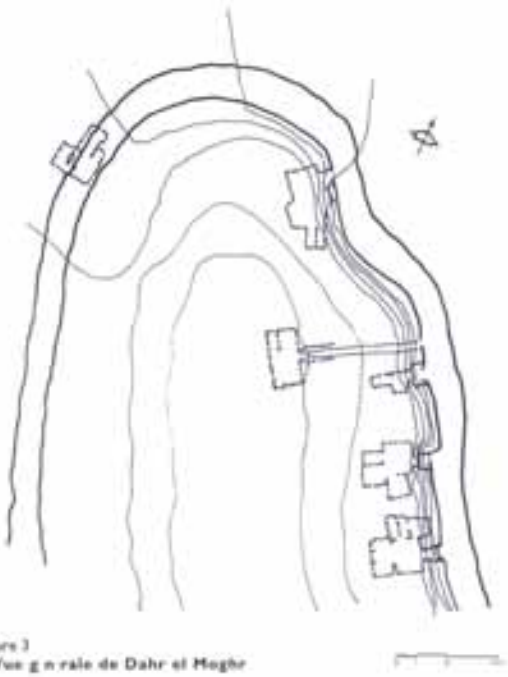


Figure 3
> Vue g n rale de Dahr el Moghr

La seconde est une piste carrossable située à gauche de la route principale menant au lac de Karaoun et qui jouxte la propriété. Elle est balisée par des écriteaux. dont le dernier annonce la direction des hypogées.

b > Les hypogées vue d'ensemble (Figure 2)

L'afleurement rocheux est creusé de six hypogées rupestres (numérotés de 1 à 6). **Ils sont tous orientés** à l'est. Un chemin contourne actuellement la butte. Les hypogées 1,2,3,6 s'ouvrent directement sur la route qui longe la base du promonoire en nord-sud, l'hypogée 4 se trouve en son milieu et l'hypogée 5 au bord du chemin qui contourne le site.

Situation Générale (Figure 3)

Les hypogées 1,2,3, 4 et 6 sont creusées parallèlement à la surface du sol. l'hypogée 4 se situe légèrement en hauteur au milieu de la bute. L'accès se fait par une entrée creusée dans le roc au niveau de la façade, précédée d'un *dromos*.

I > Les hypogées à accès par la façade
(Hypogées1,2,3,4,6)
Hypogées 4 (Figure 7) - hypogées 6 (Figure 8)
(Voiz page - 42 et 43, figures 5 à 9)

a > Les hypogées 1,3,4,6, ont une entrée rectangulaire.

b > L'hypogée 2 a une entrée en arcade.

Ces ouvertures, qu'elles soient du type *a* ou *b*, sont munies d'un encadrement toujours taillé dans le roc.

II – Hypogée à accès par trappe : L'hypogée 5.

Il est creusé perpendiculairement à la surface du sol. La verticalité du dispositif d'accès à ce type de tombe nous amène à considérer qu'il serait d'une certaine façon, le résultat d'une évolution avec des proportions plus importantes de la tombe à fosse élargie à la base.

Origine des Types d'entrée.

La porte d'entrée de l'hypogée, rectangulaire ou en arcade est une tradition gréco-romaine, alors que l'entrée en trappe est une tradition orientale ancienne, aménagée quant il s'avère difficile de faire autrement.

Mode Principal de Sépulture : Les *loculis*

Les *loculis* sont creusés dans les parois des hypogées du site. Ceux sont des niches quadrilataires à fonction sépulcurale. Ils peuvent être superposés donnant l'idée de tirroirs en plusieurs rangés Hypogée 1 (Figure 4) ou creusés dans le sol de l'espace central Hypogée 2 (Figure 5) de manière à gagner plus de place.

La première explication qui vient à l'esprit est celle de la taille des familles et du nombre de gens susceptibles d'être accueillis dans la tombe.

Le *loculus* creusé perpendiculairement aux parois sur une ou plusieurs rangées en hauteur, permet de déterminer un plus grand nombre de places et d'inhumer un plus grand nombre de personnes, que si l'on dispose des sarcophages parallèlement aux trois côtés de la pièce.

C'est pour cette raison pratique que le *loculus* paraît l'aménagement le plus adapté.

Les Hypogées à Dromos

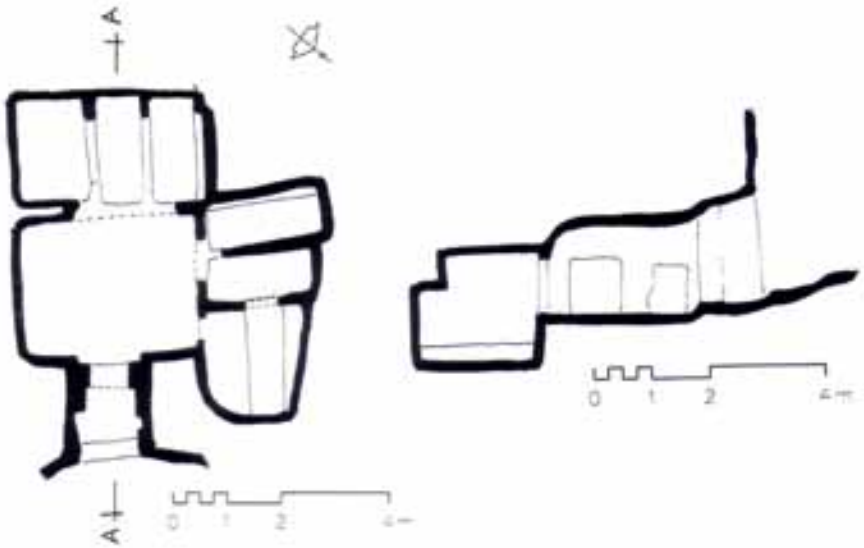
Les banquettes funéraires (Figure 6) :
Une installation caractéristique de l'hypogée 3

La porte d'entrée de l'hypogée 3 est flanquée de deux bancs rocheux nettement en saillie. Ces sièges ou banquettes rupestres sont des installations rituelles parmi les plus fréquentes.

Parents et amis du défunt venaient s'asseoir sur ces banquettes de roche pour célébrer sa mémoire et effectuer les gestes et les offrandes requises pour ces commémorations. Elles sont momentanément rendue confortable par l'apport de coussins.

L'apparition de ce type monumental peut être assez bien précisé par l'épigraphie qui montre qu'il devient habituel à partir du premier quart du IIIe siècle.

Figure 4
> Les loculis superposés (hypogée 1)
Photo by Sami Karkabi



> Plan et coupe

Les Hypogées

a > Origines du type.

L'individualisation des sépultures dont la forme courante est l'hypogée à puits apparaît sous influence perse en Phénicie. L'hypogée à dromos, avec une grande chambre à four ainsi que les tombes à loculis (à l'instar de celles de Dahr el Moghr), constituent une nouveauté importée. Elles peuvent avoir pour origine des formes indigènes antérieures (grottes trilobées de l'âge du bronze, hall à fours) ou simplement inspirés de prototypes de catacombes romaines.

Qoiqu'il en soit, cette forme de tombe n'a pas été affectée par le changement de religion et persiste en Phénicie sans transformation du 1er au 6ème siècle. Parfaitement appropriée aux sites rupestres, elle est beaucoup plus courante dans les campagnes que dans les villes.

b > Datation des hypogées.

Généralement les tombes à loculis datent de la fin du 1er siècle av. J.-C. et du début du 1er siècle ap. J.-C., donc de la période romaine. Leurs datations peuvent s'étendre à la période romano-byzantine, jusqu'au 5ème siècle ap. J.-C.

Par conséquent, il est difficile de les dater d'une manière précise en se basant simplement sur la technique de leur aménagement. Toute datation exige le recours à l'épigraphie, au matériel trouvé in situ et finalement aux fouilles archéologiques dans l'hypogée.

Mais ajoutons que certains éléments architecturaux peuvent également préciser la datation tels les banquettes qui flanquent l'ouverture d'entrée de l'hypogée 3 et qui remonte au début du IIIe siècle après J.-C.

Ce type de tombes a été souvent remplacé au fur et à mesure par les tombes à arcosolia (sachant que l'arcosolium est une tranchée creusée en forme d'arc) qui datent surtout de l'époque byzantine et qui sont généralement plus tardifs que les hypogées à loculis.

Une période de transition est discernable avec des loculis plus larges et l'apparition de fosses sous arcosolia.

c > Pratiques funéraires.

A en juger du moins par les monuments funéraires conservés jusqu'à nos jours, les habitants des campagnes de la région et selon la tradition en Orient, ont été des pratiquants exclusifs du rite de l'inhumination ou de la disposition du corps au sol.

Le mode de l'incinération des morts importée de Rome, n'eut pas de prises sur ces populations rurales.

d > Les fermetures des hypogées.

Bien qu'aucune trace de fermeture ne fut trouvée sur le site, on suppose que chacune des entrées de ces hypogées était fermée par une dalle en pierre amovible. Cette dalle de fermeture est roulée ou simplement appuyée sur la paroi rocheuse.

Rappelons que la fermeture de l'entrée arrête les regards, interdit les indiscrétions, dissuade les velléités de pillage, freine, voir empêche les agressions des agents atmosphériques : la lumière et l'eau qui menacent la qiétude des morts.

Quant aux couvertures des compartiments et des cuves sépulcurales, elles témoignent à leur tour de la nécessité de rouvrir la tombe pour y placer de nouveaux occupants. Il fallait par conséquent disposer de couverture plus ou moins aisément amovible.

On ignore s'ils étaient occupés par des sarcophages qu'ils soient de pierre, d'argile, de bois ou de plomb, puisqu'on n'y a trouvé aucun témoignage.

Par ailleurs, on n'y a trouvé aucune trace de couverture, mais on peut supposer d'après d'autres exemples du même type et qui étaient mieux préservés, qu'elle étaient faites de simples dalles de pierres, taillées pour déborder les strictes dimensions de l'ouverture. Ce qui explique la présence fréquente d'un rebord latéral sur lequel reposaient ces dalles de fermeture. On peut suggérer également les demi-couvertures dont l'utilisation réduisait au minimum la manipulation.

Rappelons finalement que la pratique des inhumations successives dans une même cuve sépulcurale était normale, ce qui nécessitait par conséquent leur réouverture.

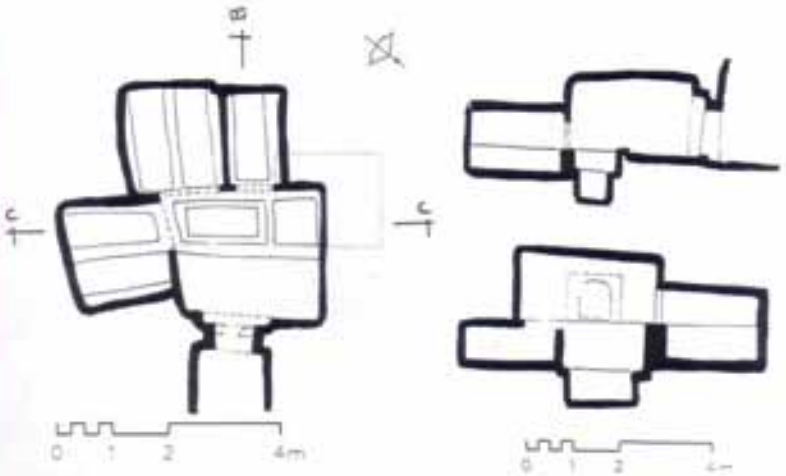


Figure 5
> **Locul i et cuves s pulcrales (Hypog e 2),** Plan et coupe (ch 1/80e)
(Photo by Sami Karkabi)

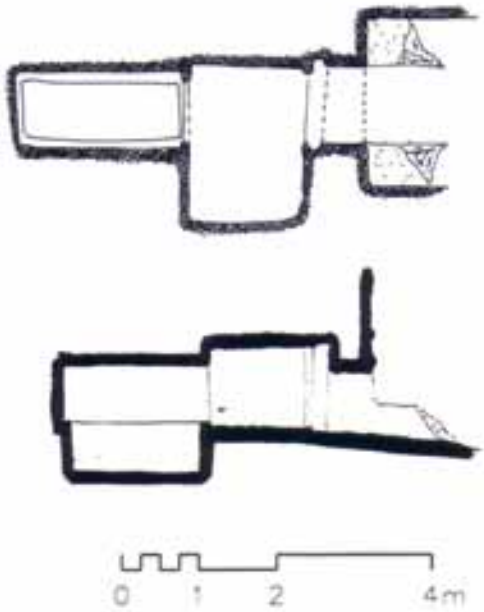


Figure 6
> **Hypog e 3,** Plan et coupe (ch. 1/50e)
(Photo by Sami Karkabi)

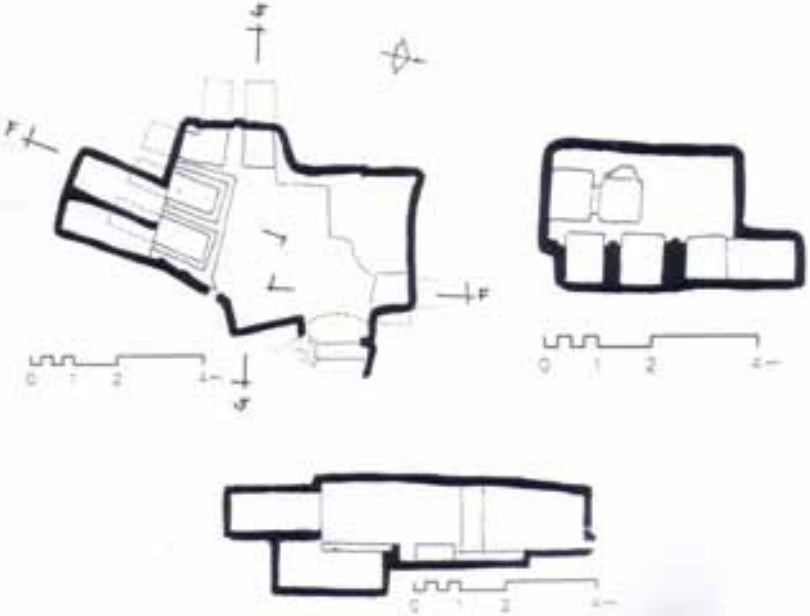


Figure 7
> **Entr e de l hypog e 4,** Plan et coupe (ch 1/80e)
(Photo by Sami Karkabi)

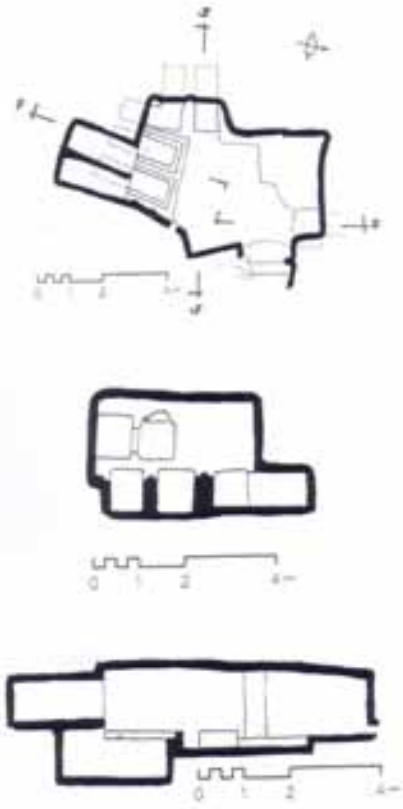


Figure 8
> **Hypog e 6,** Plan et coupe (ch. 1/50e)
(Photo by Sami Karkabi)

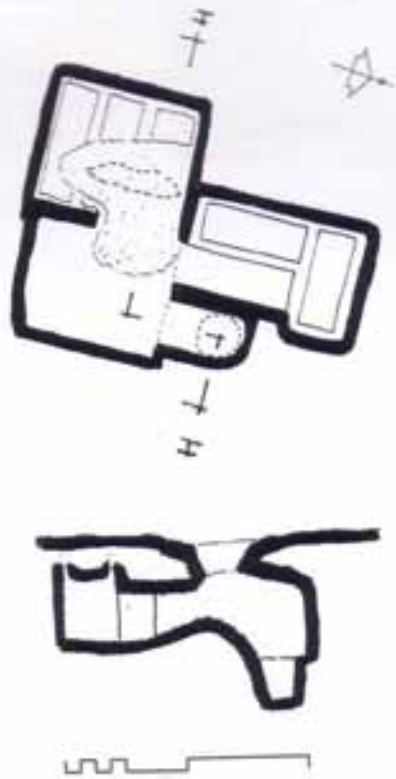


Figure 9
> **Hypog e 5 trappe. D tail de la structure int rieure**
Plan et coupe (ch 1/80e)
(Photo by Sami Karkabi)

Figure 10
> Une lampe byzantine
(Photo by Sami Karkabi)

e – Le caractère religieux attaché aux tombeaux en général.

Pour les anciens et particulièrement à l'époque romaine de la quelle dateraient les hypogées de Dahr el Moghr, la liaison de l'âme et des corps persiste jusqu'après la mort.

Il s'ensuit que le corps ou les cendres ne peuvent être traités comme purement matérielles. C'est en eux et par eux que le défunt poursuit une vie d'outre-tombe. Tant qu'il n'a pas été rendu à la terre, le mort n'est donc que lui-même, mais frappé d'une épouvantable impureté. Il n'est pas encore retranché de ce monde. Sa personne demeure liée à sa dépouille si bien qu'elle peut être victime d'un délit impur.

Avec l'inhumation, c'est-à-dire la disposition à titre définitif du corps ou des cendres dans le sol, une situation nouvelle va surgir. D'une part le défunt a rompu avec le monde des morts et des vivants, il entre dans le royaume des morts '*dit Manes*' dont il escompte un accueil favorable. D'autre part, les dieux Manes, au nombre desquels appartient à présent le défunt, ont pris possession du sol où il repose et leurs droits opposent désormais une barrière infranchissable aux droits et interdits des vivants.

C'est à cette conception qu'est dû le rapprochement entre les atteintes portées aux morts, le crime et le sacrilège. Le caractère religieux n'est que la manifestation de la puissance que le mort exerce sur l'emplacement où son corps et où ses cendres reposent.

f – Le matériel d'accompagnement des morts.

Nous n'avons trouvé à l'intérieur des hypogées que des fragments de poterie byzantine et surtout ottomane, témoignant des différentes phases d'occupation, ainsi que du verre, faute au pillage qu'ils ont subi. Cependant une lampe en argile (décrite plus bas) fut ramassée proche du site. Nous penssons qu'elle aurait pu être une offrande et qu'elle se trouvait originairement dans un de ces hypogées.

En général, on relève dans les tombes la présence de matériel domestique pour la cuisine ou en rapport avec la parure : plats et flacons réalisés en divers matériaux tels que la terre cuite ou le verre. Ces objets usuels témoignent de l'habitude de placer dans les tombes, le matériel dont le mort se servait durant sa vie terrestre.

g – Quelques objets trouvés dans les environs du site.

1. *Lampe à huile*

C'est une lampe en argile ovoïde avec disque ou médaillon central, prolongé jusqu'au trou de la mèche par une large dépression en forme de trapèze. Nous remarquons un décor torsadé au niveau des épaules avec de petits motifs floraux sur le médaillon et peut-être aussi des symboles chrétiens comme le chrisme, caractéristique de ce type de lampe byzantine (Figure 9).

D'autre part, nous identifions un tenon triangulaire, plutôt symbolique, sur le côté arrodi de l'épaule en face du trou de la mèche.

Nous n'avons pas relevé des traces de brûlure, ce qui laisserait penser qu'elle faisait partie du mobilier funéraire dans un des hypogées du site. Elle est de fabrication locale, moulée sans engobe et propre au lampe de ce type datée de la fin du IIIe jusqu'au Ve siècle ap. J.-C.

2. Un éclat de silex.

Patine couleur caramel. Très légèrement roulé. Cet éclat a conservé une petite réserve corticale à sa partie distale. Le talon facetté et le bulbe qui est plus ou moins accentué.

Les deux tranchants sont retouchés :
> Tranchant droit retouché : partie fonctionelle grattoir, retouche semi-abrupte (partie distale) et en racloir, retouche légèrement scalariforme (partie proximale)
> Tranchant gauche retouché de façon abrupte (disposition d'emmenchement ?)

3. *Une pièce de monnaie* (Figure 11)

Figure 11
> Une pi ce de monnaie

Nous remercions vivement monsieur Michel de Bustros pour nous avoir autorisé à publier l'intégralité de cette étude.

ARCHEOLOGY

THE ENDANGERED ARCHEOLOGICAL SITE OF WADI EL-MUGHER

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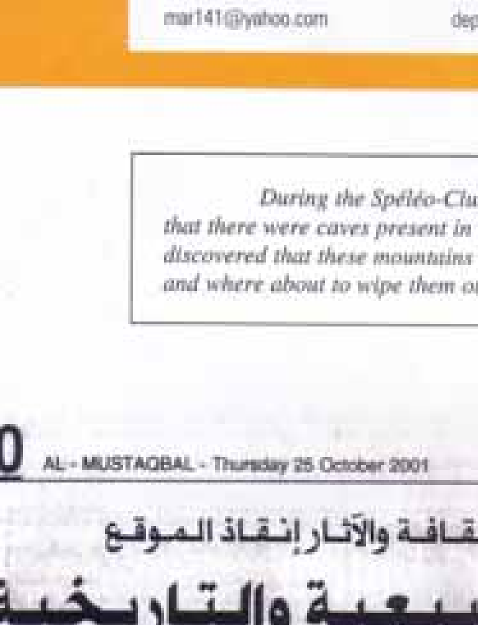
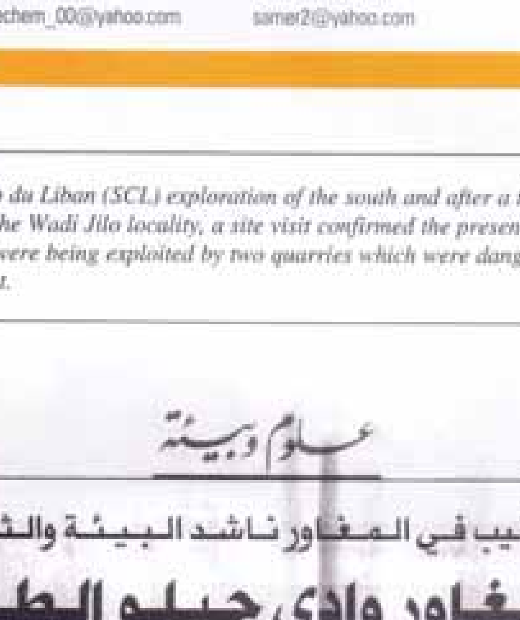
During the Spéléo-Club du Liban (SCL) exploration of the south and after a tip from one of its members that there were caves present in the Wadi Jilo locality, a site visit confirmed the presence of these caves. It was also discovered that these mountains were being exploited by two quarries which were dangerously close to the caves and where about to wipe them out.

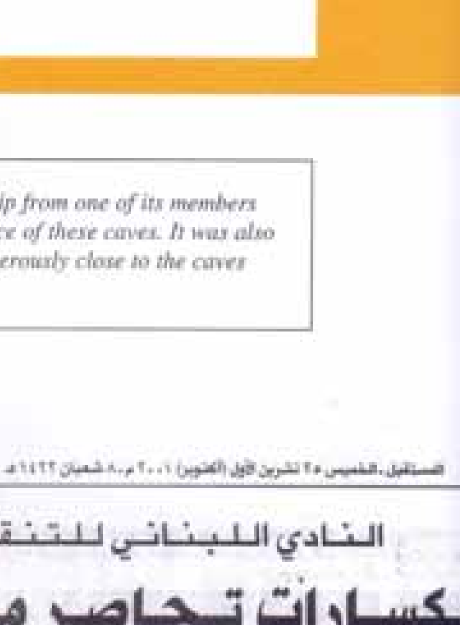
علوم وبيئة
AL - MUSTAQBAL - Thursday 25 October 2001
المستقبل - الخميس ٢٥ تشرين الأول (اكتوبر) ٢٠٠١ م - ٨ شعبان ١٤٢٢ هـ

النادي اللبناني للتنقيب في المغاور ناشد البيئة والثقافة والآثار إنقاذ الموقع

كسارات تحاصر مغاور وادي جيلو الطبيعية والتاريخية







نبيل أبو غانم

opposite
> A newspaper article on the issue, Al Moustaqbal 25th October 2001
(Photo by Bakri Kanarfuli)

left
> The general location of the quarries of Wadi Jilo
(Topographic Sheet, Jouaiya)

below
> The general view of the quarries of Wadi Jilo
(Photo by Bakri Kanarfuli)

Based on preliminary information regarding the presence of some caves nearby the village of "Wadi Jilo" in South Lebanon, the Spéléo-Club du Liban prospected the Valley of "Wadi El Mugher" located to the South-East of "Wadi Jilo".

The explored valley is predominantly mountainous, steep-sided with rugged topography. On the North-Western side of the valley, a series of man-made chambers carved into the rocks were found. The area where the chambers are located, at an elevation raging between 160 and 250 meter above sea level is sandwiched between two quarries from the South-East and South-West. Moreover, quarries were harshly eroding the valley and subsequently endangering the surviving chambers.

Site evidences confirmed that these man-made cave-like chambers are of great historic significance. The scattered ceramic charred, abundantly found inside many chambers, date back to the Hellenistic (200 B.C), Bysantine (A.D. 5th and 6th Century) and Islamic periods (Mamluk and Ottoman) and bear witness to the significant and historical aspects of the archeological site.

Nevertheless, further archeological studies need to be conducted in order to substantiate and elaborate on these basic finding. It is worth noting that the site was mentioned and described by Ernest Renan in his famous book 'Mission de Phenicie', when the French orientalist visited the Levant (1860-1861).

The newly rediscovered archeological site is composed of around 40 chambers carved into the rock on a very steep cliff. The chambers size varies from about 1 to 20 m² with an average height of 2m. Some chambers

are linked to each other by internal passageways. The chambers, which are carved at different levels, are accessible by a series of foothold notches especially chiseled to make climbing possible. The chambers doorways are almost of constant size, their width is about 70cm whereas the height reaches 100cm. The chamber floor is lower than the doorways by two steps carefully carved into the rock. On both sides of the doorway circular slots were found which suggest that the chambers used to have an entrance door with, say, wooden joist to lock it from the inside. Most of the small size chambers contain circular basins carved into the rock at either side of the entrance with a layer of line-based plaster. Some of these basins are fed with rainwater through a collection drainage system. Few chambers were found heavy damaged and demolished by Israeli air raids as reported by several witnesses from the village of "Wadi Jilo".

The valley also contains a natural cave and a sinkhole. The cave is approximately 60m long and consist of two galleries connected to each other by a tight passage of two meters wide and less than one meter high. The ceiling of the last chamber opens up vertically and leads outside the cave forming a 15 m-height shaft. It was noticed that the cave is the habitat of a huge number of bats.

The findings revealed that "Wadi Jilo" or "Mugher Valley" is of significant importance and requires urgent action to safeguard and protect it mainly from the expansion of surrounding quarries as well as uncontrolled access. The Speleo Club du Liban launched a successful campaign during the summer of 2001 to save this valuable archaeological and natural heritage. A brief report was submitted to the Ministries of Tourism and Environment as well as the Directorate General of Antiquities. As a result, quarrying activities were suspended. Unfortunately, no further measures were taken to improve the condition of the site or guarantee long-term protection.

References

-Al Moustaqbal newspaper, 25 October, 2001.

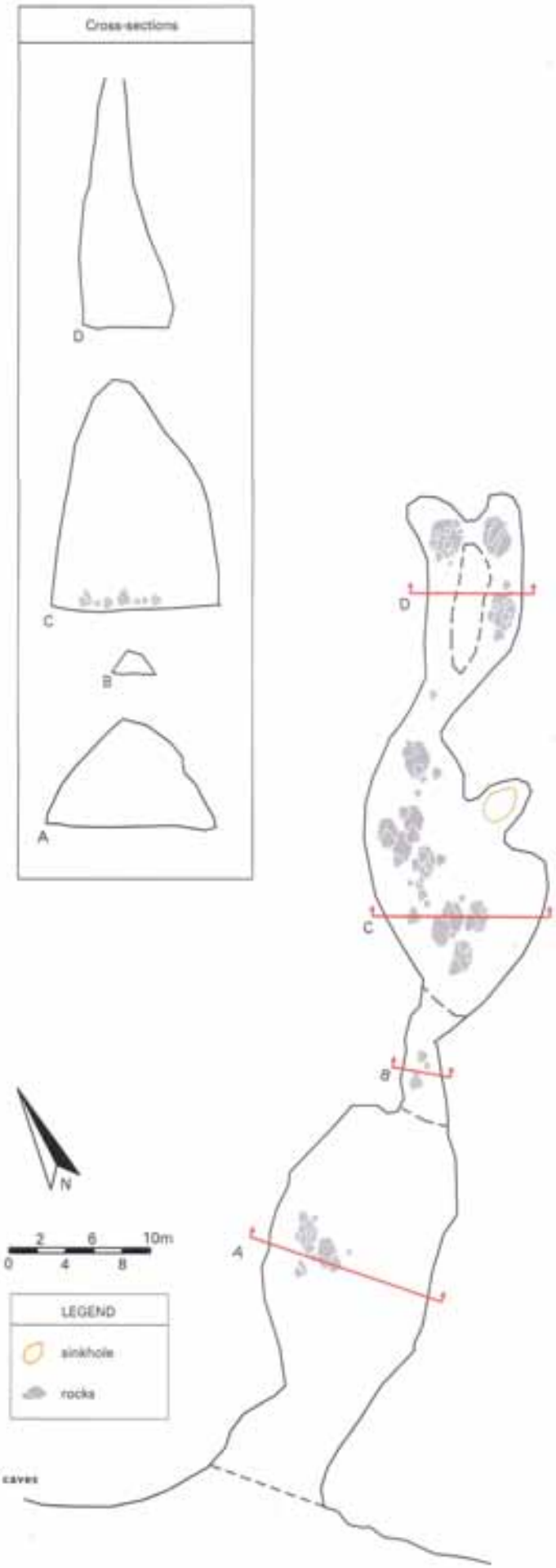


Figure 3
> A survey map of one of the archeological caves
Surveyed by Bekri Kronfol, Marwan Sinno and Samer Hdaifi
Drawn by Bekri Kronfol, Marwan Sinno and Samer Hdaifi
Computer application by Johnny Tawk

> An interior of one of the chambers.
(Photo by Bairi Kanaafi)

> Surveying by Marwan Sinno, a member of the SCL.
(Photo by Bairi Kanaafi)

> An entrance to one of the archeological rooms. Pictured is the caver Samer Mudallal.
(Photo by Bairi Kanaafi)

SPELOLOGICAL EXPLORATION

GHAR ALISADR • The longest cave of Iran

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> The Southern Dry Section of Ghar Alisadr
(Photo by S. Brooks)

Ghar Alisadr belongs to the precious natural heritage of Iran. It is currently one of the 10 most important show caves of the world.

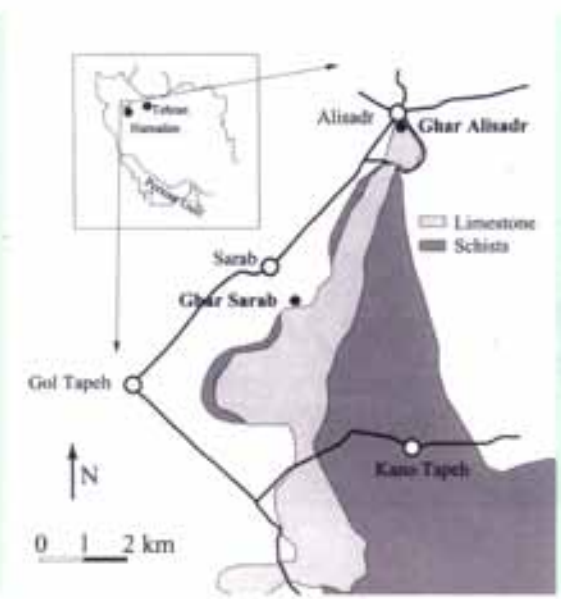
The speleological project "Topography of Ghar Alisadr (Hamadan, Iran)" was conducted in two phases that took place in December 2000 and August 2001. It involved participants from the Geological Survey of Iran (GSI), the Alisadr Tourist's Company, the Hamadan Mountaineering Club SINA and a German team as well as one British speleologist. The major aim of the project was to survey Ghar Alisadr (Alisadr Cave) and produce a map of the cave passages.

Several written sources had indicated that the accumulated length of all the cave passages of Ghar Alisadr is supposed to be around 11-14 km. However, the length quoted was merely an orally stated value that has never been verified by a proper survey of the entire cave according to international standards. Before this project took place, only an incomplete map of the touristic section of the cave was available, based on the work of Hamadan mountaineers (published in Forti 1998). Further discoveries were merely sketched.

The successful 2000 and 2001 projects resulted in 11.440 m of mapped passage length for Ghar Alisadr and have left the cave with only some minor open leads. Hence, Ghar Alisadr is currently by far the longest cave of Iran (see Table 3) that is surveyed according to international standards.

Difficult weather conditions with heavy snowstorms during the 2000 project prohibited extensive field excursions at that time, which were instead done during the 2001 project. Besides an examination of the area close to Ghar Alisadr a number of other caves (Ghar Sarab, Ghar Soobashi and Ghar Gamasiab) were studied as well as karst springs and volcanic occurrences.

The observations led to a supposed model of karstification and cave development in the Alisadr regioject (in English language) is available from the author (for details see www.speleo-berlin.de)



for left
> Location map of Ghar Alisadr

left
> Topography of Alisadr range and adjacent ranges, the tectonic shear zone, and the limestone outcrop, according to Thorabi-Tehrani (2000). The plan of Ghar Alisadr is superimposed onto the map.

Geological and Hydrological Setting

Ghar Alisadr is located 60 km NNW of Hamadan in the Zagros Mountain Range, Iran (co-ordinates: N = 35°18'15,3''; E = 48°18'08,0''; 1980 m a.s.l.). The geological map "Kabudar Ahang" scaled 1:250,000 released by the Geological Society of Iran (GSI) covers the area. The region itself is characterized by a semi-arid climate, with an annual rainfall of approximately 300 mm/yr.

Alisadr Range is part of the western structural units of Iran, the Sanandaj-Sirjan Formation (Dumas et al., 1993; Torabi-Teherani, 2000). This formation is of Jurassic origin, with alternating bands of schists and sandstones along the base, a blackish-grey band of claylike limestone interspersed with thin layers of schist, and a lighter crystallised limestone on top, which is a result of the high-temperature, high-pressure metamorphosis related to the volcanic activity in the west of the Alisadr Range.

The Alisadr Range itself is a large anticline, with its principal axis oriented in N-S direction. The dip of the layers in the vicinity and within Alisadr Cave is 40°-45°, and the length of the Alisadr Range is around 2 km. The range peaks at 2180 m, while the cave entrance is at an altitude of 1980 m situated in the north of the Alisadr Range.

To the south, the limestone outcrop continues for about 30 km with the Tehalehkand and Sarighayeh Ranges. However, the anticline axis in these southern parts is oriented in N115E direction. Hence, the Alisadr Range has been sheared off from the main range along a large shear zone between Mt. Alisadr and Mt. Tehalehkand, and the northern part has rotated anticlockwise about 25° (Torabi-Teherani, 2000).

According to Torabi-Teherani (2000), the fracture density in the Alisadr Range is high, with 2-3 fractures per meter. Additionally, several funnel-like sinkholes with a diameter of 2-3 m have been observed. These features facilitate rapid infiltration of surficial water.

Alisadr Cave is developed along the stagnant karst water table. More than 4 km of the cave passages expose the water table (August 2001), with large lakes of crystal-clear water reaching depths of around 15 m. The temperature of the water is around 12°C, and with a pH-value of 7 the water is almost saturated with calcite. The level of the water table fluctuates annually by around 0.5-1 m, with a maximum in late spring to early summer. At this time the water may emerge as a spring.

The underground reservoir is recharged by both diffuse surficial infiltration along joints and fractures, which are channelled into blind avens guiding the diffuse recharge down to the lakes, and a small stream entering the cave through the main sinkhole. The second entrance, which is the main tourist entrance of Alisadr Cave, is a large gallery (5 to 10 m wide) leading down to the water level, which is around 12 m below. The nowadays-dry gallery has been interpreted as an ancient vauclusian spring (Dumas et al., 1993; Torabi-Teherani, 2000).
Throughout the entire cave, a sequence of up to nine calcite/aragonite ledges can be found, which are located approx. 2.5 m above the current water table. These rims indicate a phase, in which the water table in the cave has been much higher, probably due to a wetter climate (e.g. during the last glacial maximum).

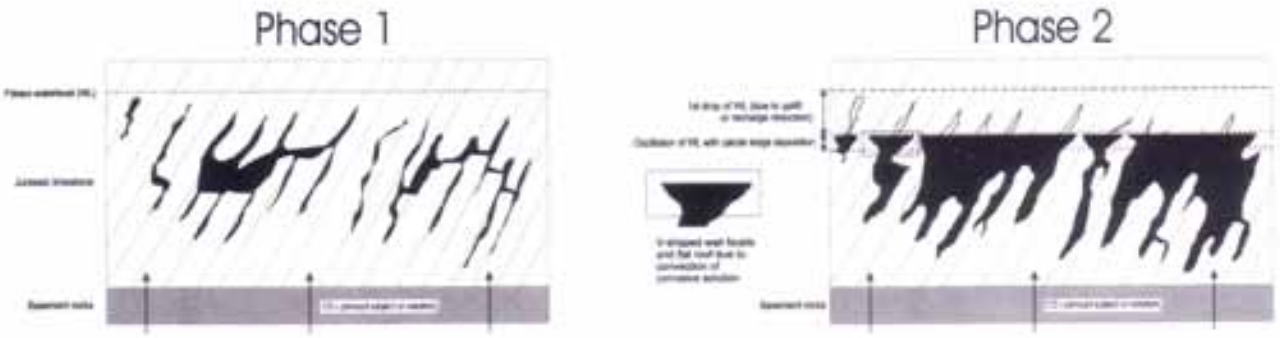
Three main directions guide passage enlargement in Alisadr Cave: N-S, NE-SW, and NW-SE-oriented fractures. The passage evolution has been described as phreatic (Dumas et al., 1993; Torabi-Teherani, 2000), with an almost flat ceiling throughout the water-filled passages, numerous ceiling pockets, and an intense corrosion along the cave walls.

Speleogenetic Model

The afore mentioned observations raise the question of how Ghar Alisadr was formed.

After deposition of the Jurassic limestone on top of a schist sequence, which is relatively impermeable, tectonic folding has uplifted the limestone body.
The folded Jurassic limestones and schists are uncon-

Figure 3, below
» Speleogenetic model of Ghar Alisadr



formably overlain by unfolded, horizontally bedded limestones and marls of Eocene to Oligocene age. Therefore the folding must have taken place at some point during the Cretaceous to Early Tertiary. The region has been affected by a period of volcanism, starting in the Late Tertiary and remaining throughout the Pleistocene.

The uplift of the limestone sequences created the above-mentioned main fracture directions, which determine the pattern of cave passages in Ghar Alisadr, predominantly following the strike of the bedding. These fractures and joints were water-filled in the beginning and enlarged by phreatic solution but became dry with continuous uplift and remained small in size.

Approximately 20 km south of Alisadr (located near Gol Tapeh at N 35°11'49,5''; E 048°15'03,7''; 2220 m. a.s.l.) in close vicinity to a military radar station is a major spring called Gorgoloh. Its water emerges from a small pond in the middle of the plain, expelling about 30 l/s. A peculiarity is the large amount of CO_2 that emerges together with the water from a several meter deep rock fissure. The cold water seems to "boil" above the fissure, torn and twisted by the constant stream of gas, and makes a bubbling sound. Most likely volcanic CO_2 is the driving force for the cave development in the Alisadr region. The similar character of Ghar Alisadr, Ghar Sarab and Ghar Soobashi supports our hypothesis, as all of the caves are formed within the ground water body – strictly limited by the water table.

Classic karstification doesn't seem to play an important role in this cave area as no caves or karst features can be found above ground-water level. An explanation might be the semiarid climate, which didn't allow for a considerable amount of vegetation to grow and form a thick layer of soil – generally the prime source of CO_2 for rainwaters that seep into the ground. This would make Ghar Alisadr a highly interesting scientific object as cave development under the influence of ascending CO_2 can easily be studied in this cave.

The presence of aragonite mineralisation inside Ghar Alisadr appears to support the hypothesis of volcanic influence as these kind of minerals need a relatively warm environment to develop (>12° C).

The ascending CO_2 mixed with the water that filled the small fractures in Ghar Alisadr to create a weak carbonic acid that rapidly dissolved wide passages predominantly along the cave walls. This process was supported by the underlying sequence of schist that is basically impermeable to water.

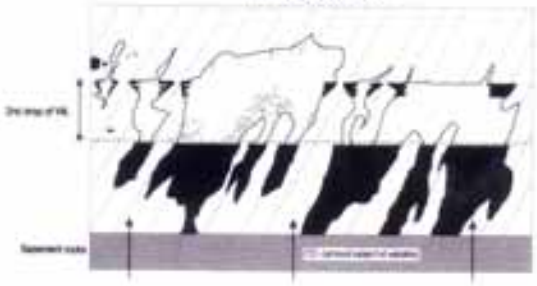
The aquifer of Ghar Alisadr always has been characterised by a stagnant water table. The cave lacks all features related with any water flow (e.g. passages with tube-shaped or canyon-like cross-sections). Instead of that corrosion facettes are present in nearly all the passages indicating slow convection movement of karst water. No evidence at all was found for a punctual recharge of the aquifer. Thus, the wide passages of Ghar Alisadr developed under phreatic conditions (under water) and consequently form a diffuse maze of galleries. It is doubtful whether the passages near the artificial entrance of Ghar Alisadr can be interpreted as a former vauclusian spring as mentioned above.

At the surface of these wide passages, where the former fracture passages still remained dry, extensive calcite and aragonite mineralisation has taken place.

Oscillation of the water table due to climatic changes has created up to nine of these calcite ledges, indicating nine different former water levels.

At some places in Ghar Alisadr the enlargement of wide passages have made the overlying rocks unstable and breakdown has occurred that has either created high rift passages or chambers on top of the water-filled galleries. This process is responsible for the creation of the big room (Large Chamber) in Ghar Alisadr, called "Freedom Hall" (100 x 60 x 15 - 40 m).

With the last phase of uplift the passages of Ghar Alisadr became dry in the upper parts and were then accessible to man. The situation occurred that the current water table inside the cave is higher than the surrounding area. Consequently, the water tries to find its way out of the given aquifer, which results in two karst springs, one of which is west of the entrances of Ghar Alisadr (N



> Microformations in Ghar Alisadr (Photo by S. Brooks)

35°17'59,2''; E 48°17'32,5'') and the other south of the Alisadr Ridge at N 35°17'31,4''; E 48°17'46,2''.

Less than 30 km SW of Alisadr there are areas with extensive outcrops of Late Tertiary to Early Pleistocene volcanic rocks. The strong production of CO_2 can be interpreted as a post volcanic phenomenon. The large amount of authigenic CO_2 provides the subterraneous waters with an extensive potential to dissolve carbonate rocks. It can be seen in the stream that flows from the Gorgoloh spring that this process continues today: For several kilometers from the spring itself, the stream precipitates travertine, incrusting moss, cyanobacteria and other organic material in the water. This proves that the acidic waters forming new cave systems at the present time are dissolving carbonate.

On the Gorveh quadrangle of the Iranian geological map there are huge amounts of travertines that were precipitated from cold and hydrothermal springs, many of which are highly enriched in sulfuric acid and CO_2 – both potential solvents for the carbonates. These travertines are associated with Pleistocene volcanism.

History of Exploration of Ghar Alisadr

The natural (main) entrance to Ghar Alisadr is a sinkhole that takes melt water during the winter months and the early spring - certainly known for a long time to the locals. Fritsch (1995) and the Internet (www.bubis.com/showcaves/english/misc/showcaves/AliSadr.html) say that 2.500 years ago locals have already used the karst water emerging from the cave's large static subterranean aquifer for agricultural purposes. The aforementioned date is reportedly proven by an inscription referring to the Archaemenid king Dareios I (521 – 485 B.C.) at this site, who ordered an artificial tunnel to be dug to fetch water from the cave. However, no evidence of an inscription or an old tunnel was seen during either the 2000 or 2001 speleological projects. It is most likely that there might be confusion with an existent famous ancient inscription site at Hamadan.

Access to the cave through the sinkhole was difficult in the past as the cave was blocked by boulder. The SINA Mountaineering Club from Hamadan discovered Ghar Alisadr.

Hajiloo (1998) refers to the archives of the club: On a Friday in mid-October 1964 a group of 14 club members managed to enter the cave. By using truck inner tubes they made a first 5 hours trip in Ghar Alisadr. At the time of discovery the water level inside the cave was significantly higher than today and progress was much more difficult for the first explorers bearing in mind that the equipment available did not include wetsuits or any other standardised caving outfit.

According to further sources (Dumas, Mietton & Maire, 1994; Fritsch, 1995 & Forti, 1998) the principal phase of exploration of Ghar Alisadr took place right after the discovery. A subsequent phase of exploration undertaken by the SINA mountaineers commenced in 1966/1967. In the course of these explorations most of the passages of Ghar Alisadr were explored, even the galleries beyond the section of the cave that is accessible for tourists today (dry section in the southern part of the cave). In 1968 SINA officially announced the discovery of the cave that subsequently has been made accessible for tourists during the early seventies.

In the early nineties further exploration work in Ghar Alisadr was done by the Tehran Mountaineering Club KAVOOSH. An article on the results of their investigation has been published in the Iranian newspaper Ettela'at on 13th December 1994 (Fritsch, 1995). KAVOOSH added a sketch of the southern dry sections of Ghar Alisadr to the SINA map. The sketch is of suboptimal quality as the passages are pretty well out of scale and appears to be made without the use of measuring instruments. The resulting map, which has the north arrow erroneously showing in the reverse direction, led to an over-estimation of the total length of Ghar Alisadr in various publications (e.g. Fritsch 1995; and in the Internet under www.netiran.com/Htdocs/Clippings/Social/950000XXSO0

left:
> The entrance (Photo by I. Dorner)

right:
> Plan of Ghar Alisadr

1.html). Several huge inscriptions with red varnish inside Ghar Alisadr remained from the KAVOOSH investigations giving witness of the exploration of the cave (and of the necessity to protect it).

Ghar Alisadr as a Show Cave

Today the cave is operated and protected by Alisadr Tourist's Company (Hamadan). The today's annual number of visitors of Ghar Alisadr exceeds 400,000.

During the summer up to 5,000 visitors per day have to be accommodated by Alisadr Tourist's Company. Thus, Ghar Alisadr currently ranks amongst the ten biggest tourist show caves of the world (Fritsch, 1995; Forti, 1998) and is the most visited tourist site in the Iranian Zagros Mountains. Tourists are guided into plastic boats at the entrance and these are pulled through the cave by paddling boats (Pedlo's) paddled and steered by the guides. It was found that the regular tourist trip in Ghar Alisadr is about 2,100 m long including a 1,470 m long underground boat trip that is extended for an extra fee to a 2,010 m long boat trip, including the "Wedding Room". With the latter Ghar Alisadr offers the longest public underground boat trip of the world. Table 3 shows the length of the boat course in a worldwide scale.

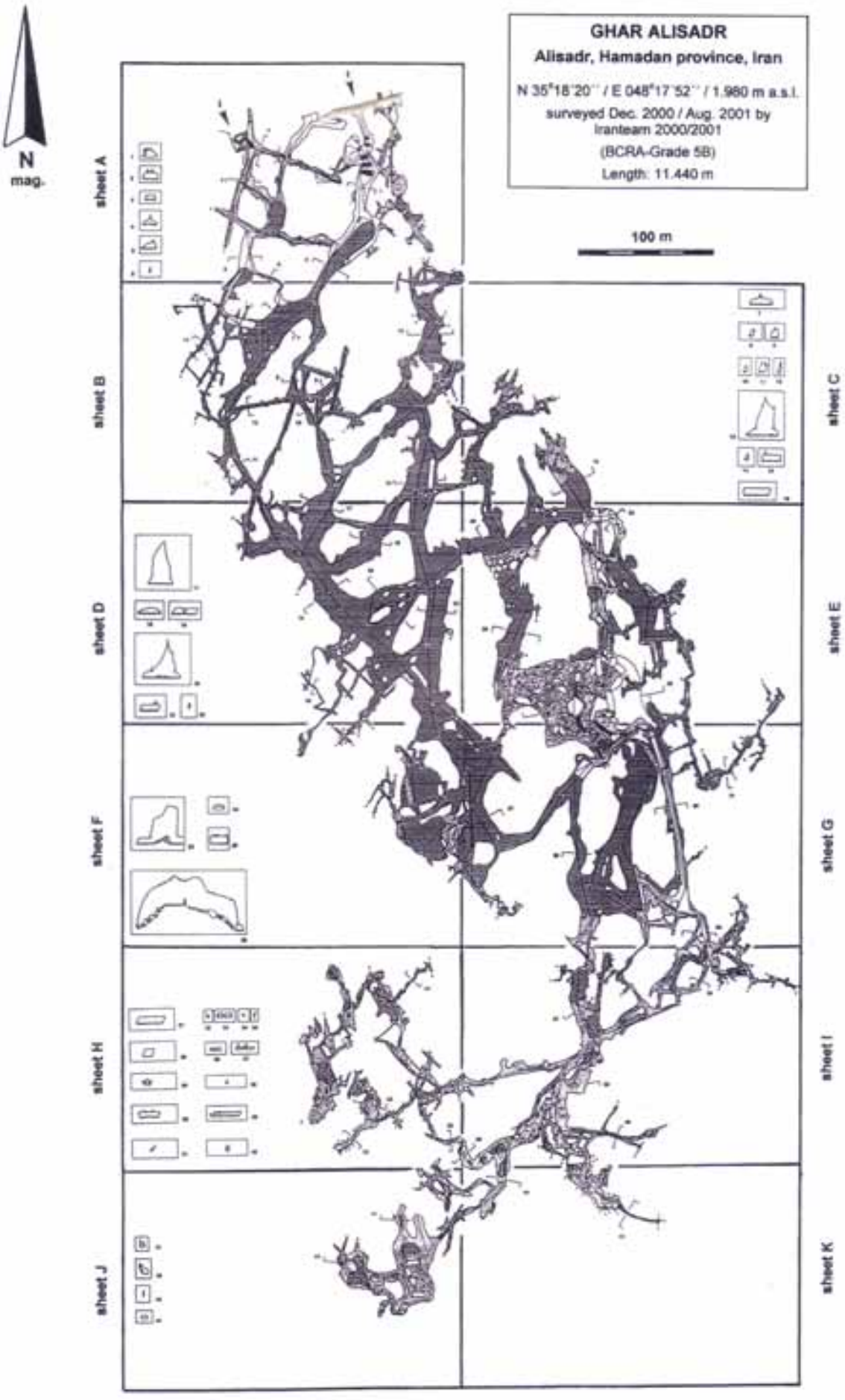
Biospeleological Observations

It has been stated (e.g. Hajiloo, 1998) that there is no life inside the cave. However, Etemad (1967, 1969) and Deblase (1980) reported the existence of the small bat species Miniopterus schreibersi pallidus (THOMAS, 1907) from Alisadr Cave, where one male has been found inside the cave. During the 2000 investigations a skeleton of the same bat species was found in the new parts of the cave. A second bat skeleton of comparable size has been found under a possible bat hibernation site (abandoned during the investigations in December) in the new part of the cave. The place is located at a distance of about 1 km from the cave's entrances. Unfortunately, it was not possible to recover the second skeleton due to its brittleness. The 2001 project revealed three more skeletons of the same species and the discovery of a skeleton of the small bat species Myotis nipalensis transcaspicus (OGNEV & HEPTNER 1928) from nearby Ghar Sarab . The latter bat species has not been described from Iran up till now.

Furthermore, a number of very small white insects have been observed on the stairs in the large chamber of Ghar Alisadr. A detailed biospeleological study will certainly yield interesting results and is highly recommended.

Since this article was received by the editorial team of Al Ouat'Ouate, another speleological project to Iran has been carried out by the author in autumn 2003.

This project yielded 12,860m of passage length in Ghar Katalehkhor (Zanjan province), another superb Iranian show cave. Hence, Ghar Katalehkhor is now established to be currently the longest cave of Iran.


GHAR ALISADR
Alisadr, Hamadan province, Iran
N 35°18'20'' / E 048°17'52'' / 1.980 m a.s.l.
surveyed Dec. 2000 / Aug. 2001 by
Iranteam 2000/2001
(BCRA-Grade 5B)
Length: 11.440 m
100 m
N
mag.
sheet A
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sheet J
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Table 1
List of the longest surveyed caves of Iran

No.	Name	Province	Length	Date of survey and surveyed by, references, remarks
1	Ghar Alisadr	Hamadan	11,440 m	2000/2001 joint Iranian, German, British projects. Dumas et al.(1994); Forti (1998) ;Laumanns et al. (2001)
2	Jeskyne Tri Nahacu	Hormoz	5,010 m	1997 - 2000 Czech project Bruthans (2000), cave formed in salt
3	Ghar e Danesju ("Students Cave")	Hormoz	1,909 m	Czech project 1997 - 2000 Bruthans (2000), cave formed in salt
4	Ghar Sar-Ab	Hamadan	1,700 m	1973 British project, Napier College (1973)
5	Ghar Parau	Kermanshah	1,364 m	Joint British / Iranian projects 1971/72 Judson (1972)
6	Ghar Shahpour	Fars	1,229 m	Raeisi & Kowsar (1997)
7	Ghar Shaban Kale	Kermanshah	650 m	French project of Spéléo Club Lyon 1977 Courbon et al. (1989)
8	Ghar Golezard	Tehran, Manzarjeh	560 m	Austrian report referring to a visit in 1978 (Schleich 1980)

Table 2
List of deepest surveyed caves of Iran

No.	Name	Province	Depth	Surveyed by, references, remarks
1	Ghar Parau	Kermanshah	-751 m	See above
2	Ghar Shah Bandu (Ghar Shabanou)	Kermanshah	-315 m	French project and British project 1977 Courbon et al. (1989) Cave is connected to nearby Ghar Se Rah
3	Ghar-i-Cyrus	Kermanshah	-265 m	French project 1975 by J.P. Farcy & G. Cappa Spelunca, 1974 (4); Paris / Courbon et al.(1989)
4	Ghar Ben Dwr	Kermanshah	-200 m	British Project 1977 Trans. Brit. Cave Research Assoc., 6 (3), 1979
5	Ghar-e-Morghan	Kermanshah	-240 m	Polish project 1974 - Courbon et al. (1989)
6	Ghar-e-Mariz	Kermanshah	-132 m	Polish project 1974 - Courbon et al. (1989)
7	Ghar-e-Boland	Kermanshah	-120 m	Polish project 1974 - Courbon et al. (1989)
8	Ghar Garun	Nahavand	-112 m	French project 1973 Spelunca, 1974 (4); Paris / Courbon et al.(1989)
9	Ghar Acker	Kermanshah	-110 m	British project 1971 Yorkshire Ramblers Club Journal, 1973, 36. Courbon et al. (1989)

> A typical boating passage in Ghar Alisadr (Photo by S. Brooks)

Table 3
Most important show caves according to the length of public underground boat tour

Name	Location	Length of boat tour	Remarks
Ghar Alisadr	Iran	2,010 m	References: own survey. Regular trip includes 1.470 m. The operator offers an extended boat trip of 2,010 m length for an extra fee.
Spook Cave	USA(Iowa)	over 1,600 m	According to it's website the cave has "the world's longest underground boat tour". However, no exact length of the course has been given. As the longest known boat tour in the U.S. is 1,6 km (see below under Penn's Cave) it is esti mated that the boat tour of Spook Cave exceeds 1,600m. Website:www.mononaiowa.com/Activities/Tourism/tourism_2.html/
Penn's Cave	USA (Pennsylvania)	1,600 m	The entire length of this cave is toured by boat. Website: pennscave.com/cavern.htm
St.Paul's Cave	Philippines (Palawan)	1,600 m?	This information is based on oral communication. It has been reported that the public tour follows a huge under ground stream for about 800 m and then turns around.
Rivière public	France(Pyrenees) de Labouiche	1,500 m	References: Aellen & Strinati Souterraine (1977). The length of the boat trip appears to be dependent on the source of information: www.showcaves.com published a length of 1,500 m while the above-mentioned booklet gives a length of 2,500 m.

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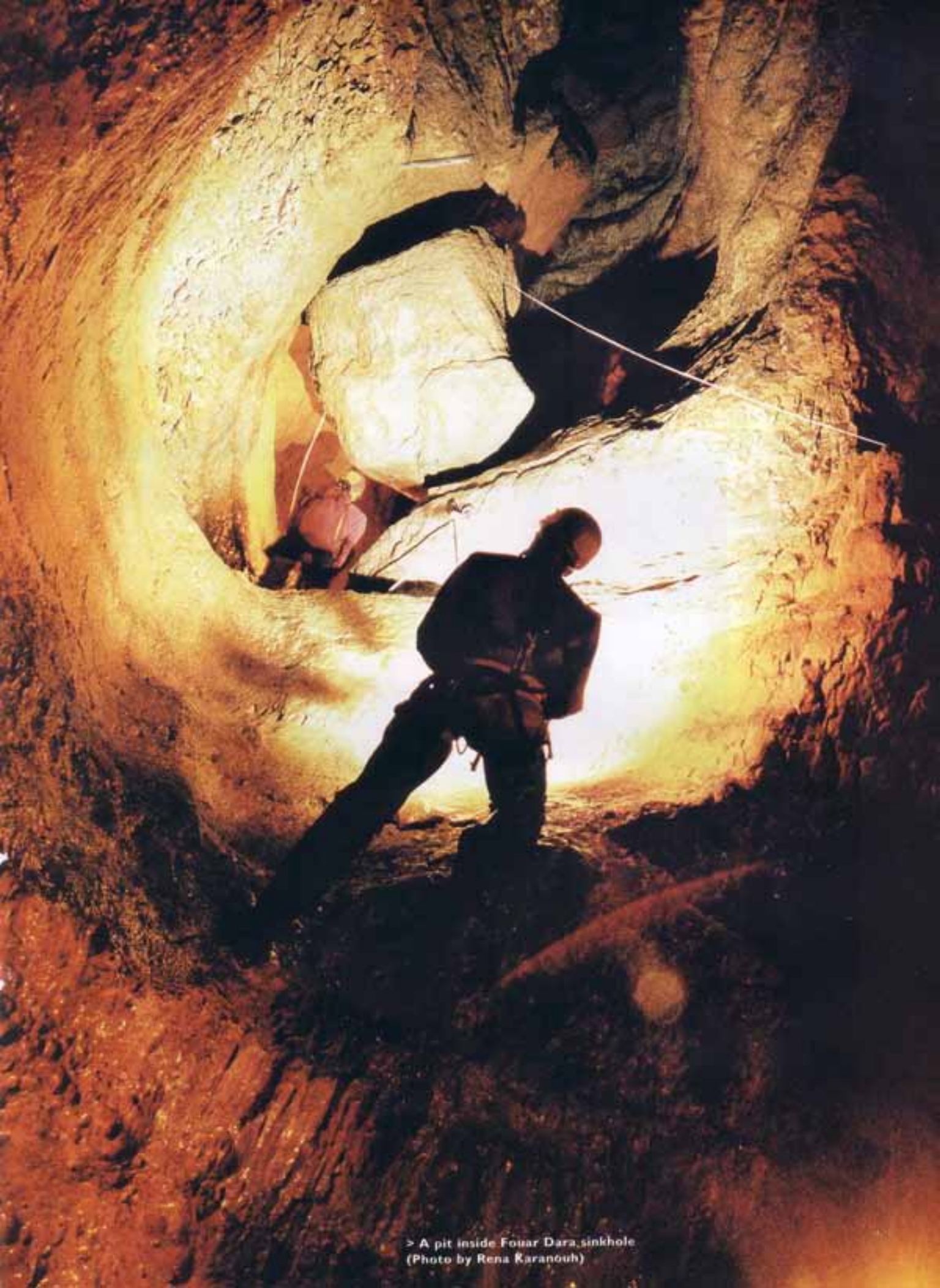
> The Whale Tail in the southern dry section of Ghar Alisadr (Photo by S. Brooks)



> A pit inside Fouar Dara sinkhole
(Photo by Rena Karanouh)

Photo 1
> **The early development of cave fans in Mgharet el Kassarat**
(Photo by Issam Bou Jawdeh)

Photo 3
> **Popcorn decorations on cave fans in Mgharet el Kassarat**
(Photo by Rana Karanouh)

Photo 2
> **The fan wall of Mgharet el Kassarat**
(Photo by Rana Karanouh)

Photo 4
> **The fans of Mgharet el Moutran**
(Photo by Issam Bou Jawdeh)

1> **Cave Fans** of Mgharet el Kassarat and Mgharet el Moutran

Sub-type of Conulites

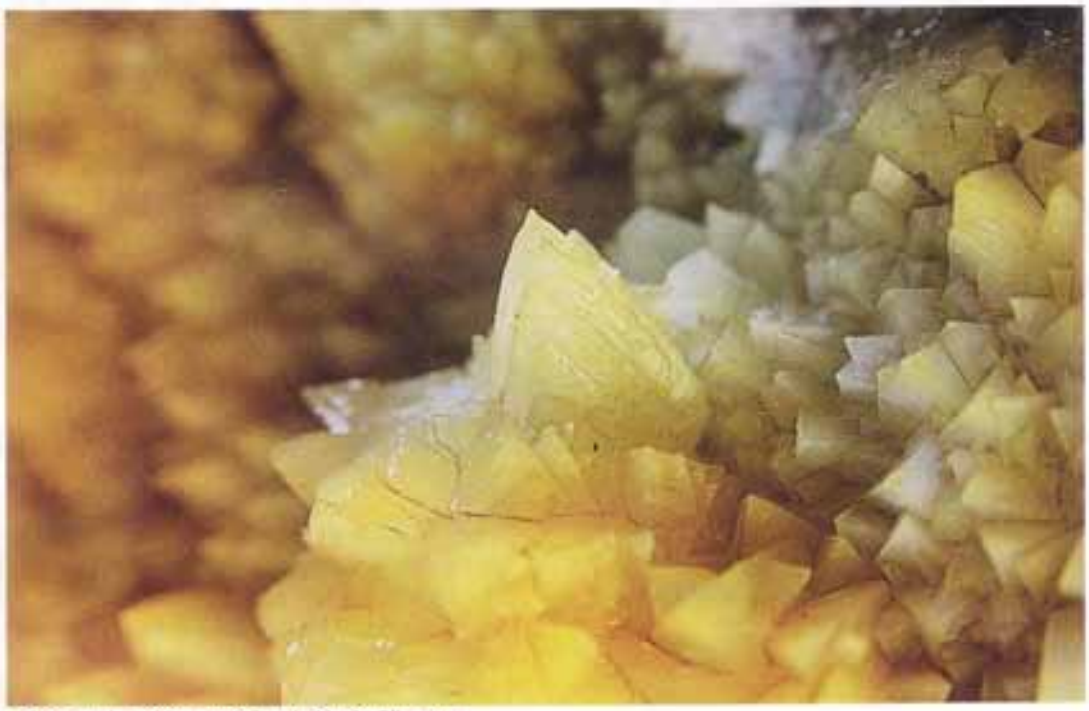
The cave fans of Mgharet el Kassarat (Antelias locality, Mount Lebanon) can be found at two different locations.

The first location consists of a terraced sand slope, 2km into the cave in a large room. The cave fans were found to be growing from a horizontal base of sand and mud and measured 10cm high and 10cm wide. The cave fans were found to be in the early stages of their development because they had no ornamentations or bands and they were not concave in shape (Photo 1).

The second is located as a 'fan-wall' deeper inside the cave (approx. 3km from the entrance). The wall, the cave fans were found growing on, is 10m high and 2m wide. The individual cave fans measure between 2cm and 10cm long. The wall is completely covered with the fans in various stages of development (Photo 2). The fans were growing from a vertical base and formed like half cups against the wall. They are thinner at their base and flare out as they grow upwards. They are folded vertically with horizontal bands that range from deep brown to light grey in colour. The bottom quarter of the cave fans are decorated with cave corals (Photo 3). The lower we got towards the ground the more mud and less calcite cave fans were found.

In Mgharet el Moutran (Toual Village, North Lebanon) fans were found towards the end of the cave. They were growing on a steeply inclined wall that spread over a 100m² area on both sides of the cave walls (Photo 4).

> The dog tooth Spar inside the Rihan cave
(Photo by Issam Bou Jawdeh)

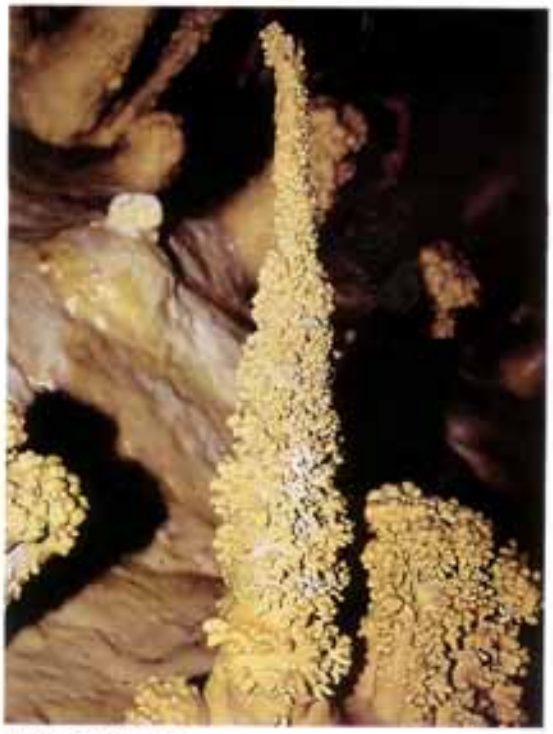


> Close-up view of dog tooth Spar inside the Rihan cave
(Photo by Issam Bou Jawdeh)

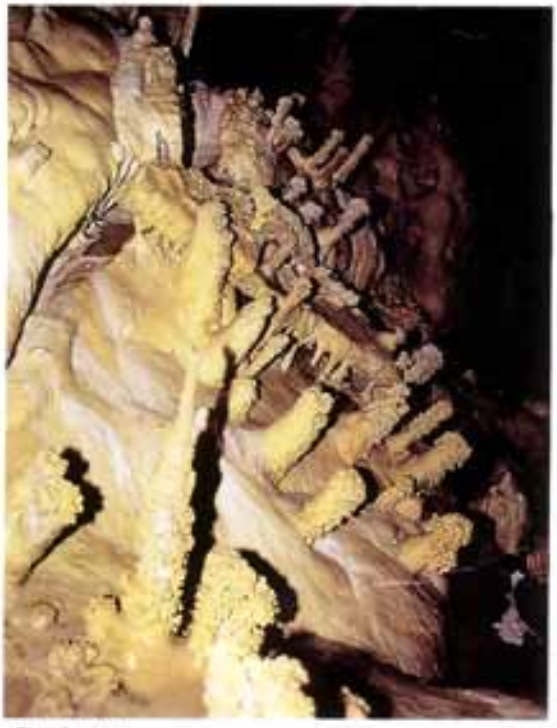
2 > **Dog Tooth Spar** of Mgharet el Rihan

In Mgahret el Rihan (Rihan Village, South Lebanon) dog-tooth spar was found and is worth mentioning bacause of their size and structure. The dog-tooth spar was found, in a small room, towards the end of the cave, 100m from the entrance, on the roof and walls.

The different spar crystals measured from 0.3 to 5cm long. They are transparent to translucent, crystalline and yellowish in colour. Euhedral and subhedral crystals were identified.



> The Christmas Tree
(Photo by Issam Bou Jawdeh)



> The Canons
(Photo by Issam Bou Jawdeh)

> The tree-like stalagmites
(Photo by Issam Bou Jawdeh)

9 > The Tree-like Stalagmites of Qana cave II

Cave Coral Decoration on Stalagmites

In a small cave in the Qana Plateau (Hrajel village, Mount Lebanon) these tree-like stalagmites were located 20m from the entrance. They measured approximately 25cm high. Some had a smooth base with the cave corals forming at the top in a bush-like formation. Others had the corals all over in a tube like structure.

> **The Autumn Trees of Mgharet Jeita** (Photo by Issam Bou Jawdah)

10 > **The Autumn Trees** of Mgharet Jeita

These stalagmites were found at the end of the upper galleries in Jeita Cave. The tallest stalagmite measures 1.5m with branches varying in lengths. They are mostly calcite white with a tint of brown contamination. Some are smooth, others rough and some had corals growing on them. The constant thickness of these branching stalagmites is probably related to a combination of dripping water and the slight movement of the base floor.

> **The boxwork of Qana cave II**
(Photo by Issam Bou Jawdah)

11 > **The Boxwork** of Qana cave II, Mgharet Nabaa el Mghara & Seraaya cave

A subtype of Blisters

The calcite boxwork of the Qana II cave are found in the first 50m of the cave. The marly limestone walls weather more rapidly than their calcite filled veins and fractures. This results in 1 to 3 cm protruding interlocking blades, forming boxlike structures. These are then ornamented and covered with popcorn and calcite crusts respectively.

Boxwork are not exclusively restricted to calcite they are formed also from gypsum as described in the caves of Nabaa el Mghara, Mgharet Nabaa el Shatawie and Seraaya cave (AlOuat'Ouate N°.12, 2002)

> A shield in the Salle de President (Mgharet El-Kassarat)
(Photo by Hughes Badaoui)

> A shield in the Salle de President (Mgharet El-Kassarat)
(Photo by Issam Bou Jawdeh)

13 > **The Shields** of Mgharet el Kassarat (Antelias)

Subtype Disc

Clusters of shields are located in the upper galleries of Mgharet el Kassarat in the Salle de President, the largest measuring approximately 1m by 0.5m. The one pictured in the center, where the curtain around the disc is yellow to red in colour bands, shows an early stage of development as opposed to the one on its right which is advanced and has started to develop long stalactites. This type of shield is termed 'Parachute' by Hill and Forti (1998). The cluster of shields in this area were found to range in colour from pure white to brown and yellow.

Further investigation in Mgharet Nabaa el Shatawie lead to the discovery of a shield. Measuring 40cm in diameter this white coloured shield was found in the first 200m of the main axis on the roof. This is the 14th calcite speleothem found in this cave and the 18th identified speleothem (Gypsum and calcite included).

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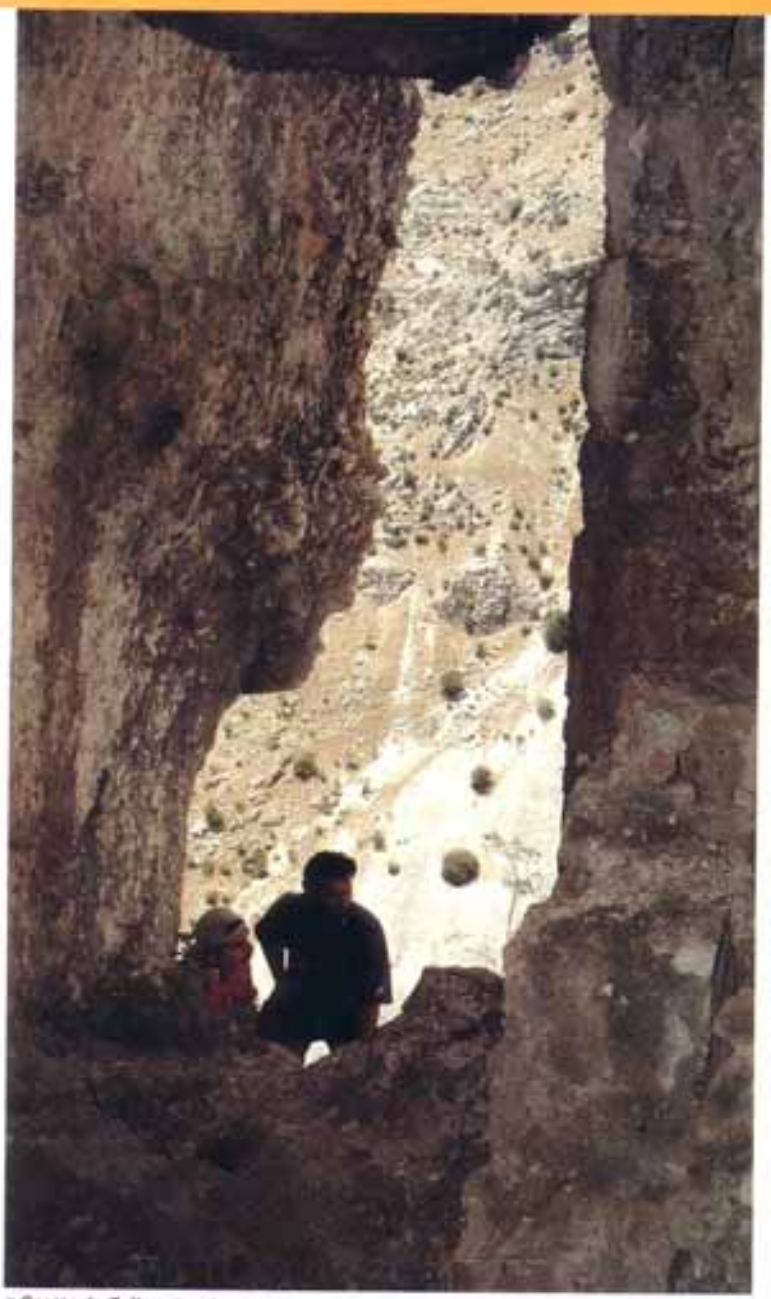


> Grotte de Zeil ya (Photo Sami Karkabi)

À l'occasion du Symposium 2001, les "grottes et abris fortifiés du Liban" ont fait l'objet d'une importante communication par Boutros Abi-Aoun archéologue et spéléologue (MES 2001 – pp. 166 à 171). La grotte-forteresse de Zellâya signalée mais non décrite par l'auteur, a été ré explorée en 2004 par Aoun Abi-Aoun, Boutros Abi-Aoun, Fadi Baroudi, Falah Wakim, membres du GERSL et Sami Karkabi du S.C.L. Ce complément d'information nous fait découvrir, sans toutefois résoudre clairement son approche historique, une installation médiévale relativement bien conservée et totalement négligée jusqu'ici sur le plan archéologique.

Coordonnées Lambert de Grotte Zellâya[1]
X= 143,440
Y= 169,550
Z= 733m
Carte d'état-major 1/20000, Yohmor, feuille F-5

Situation

La grotte se situe au bas de la falaise, à l'intersection de la verticale (de la falaise) et de la pente raide de la rive gauche du contrefort du Litani à une altitude de 733m.

Accès

A partir du village de Zellâya, un sentier raide, et par endroit vertigineux, mène à la grotte-forteresse (Photo 1). En fin de chemin, un système de défense assez complexe, exécuté en utilisant au mieux la sinuosité du relief, rend l'arrivée aléatoire et franchement difficile; ce système comprend des marches-encoches taillées dans le rocher, et un fossé de 2x3m de 2m de profondeur creusé à quelques mètres de l'entrée, juxtaposé à un passage étroit et inévitable de 40cm de large taillé à flanc de falaise.

Description

La grotte de Zellâya – niveau supérieur compris – couvre une superficie de 280m² ; sa configuration est en forme de L. La façade est orientée N-O. (Photo 2). A l'est, elle est limitée par la falaise, et à l'ouest surplombe le fleuve Litani et contrôle les versants gauche et droit.

Cette grotte se caractérise par une fortification médiévale: façade imposante en pierres de taille, archères, etc. Les phases d'occupation (croisée, mamlouk) sont pour le moment incertaines : une recherche archéologique est nécessaire pour leur identification. D'une manière générale la grotte se divise en trois parties principales : l'entrée, la grande salle et un étage à 10m environ du niveau du sol de la grande salle

a- l'entrée : elle est constituée par une voûte en pierres de taille au-dessus de l'ouverture de la porte, aujourd'hui disparue (Photo 3) ; la porte est protégée par deux éléments d'arrêt, un assommoir dans la voûte (30x30cm) et un trou de barre dans le jambage gauche de la porte. A gauche de l'entrée, 2 niches avec embrasure ou fenêtre de tir (archères) contrôlent la zone nord de la grotte. Les linteaux monolithes des fenêtres sont taillés en forme d'arc en contre-plongée. Une petite partie du sol est effondré, et celui-ci est la voûte d'une cellule taillée dans le rocher.

Une construction postérieure est visible dans la façade nord de l'entrée ; un joint entre 2 phases de construction (appelé « coup de sabre » dans le jargon du métier) est nettement apparent sur le mur gauche de l'ouverture de la porte (Photo 3). Les deux niches dans l'épaisseur du mur ont été rajoutées ultérieurement.

b- la grande salle (photo 5) : est composée de plusieurs éléments architecturaux placés tout autour d'un puits central en forme de cloche à ouverture circulaire de 70cm. En longeant le mur est, on découvre 1 bassin taillé dans le rocher suivi d'une cellule circulaire, puis

Photo 1
> **Sentier menant la grotte forteresse** (Photo Sami Karkabi)

Photo 2
> **Fa ade ouest est rieure** (Photo Sami Karkabi)

d'une banquette taillée comportant des encoches circulaires de 28 cm de diamètre et d'une certaine de profondeur probablement destinées à de grandes jarres. Cette banquette précède un creux rectangulaire de quelque 12m², profond de 70cm, ne comportant pas d'enduit nécessaire pour préserver l'eau.

Ce creux est suivi d'un bassin taillé dans le rocher et présentant une profondeur non négligeable de 175cm dont la partie supérieure (qui déborde du sol) est construite en bloc de terre cuite d'une dimension moyenne de 23x14x4cm ; cette partie est recouverte de plusieurs couches d'enduit de chaux. Actuellement le bassin est rempli d'eau (50cm). Des encoches de 10x10cm sont creusées dans la paroi au dessus du bassin, et sont distants l'un de l'autre de 40cm environ. Viennent ensuite 2 petits bassins de 35x60cm et une banquette de 200x40cm taillés dans la paroi.

Le mur de la façade ouest d'une épaisseur de 90cm environ, est percé de plusieurs ouvertures (photo 5) (archères) à différents niveaux. Des alignements horizontaux de trous sur trois niveaux se remarquent sur le mur, ce sont les encoches (situées à 225cm du sol) des poutres en bois des planchers. Le parement extérieur du mur est construit en pierre calcaire bien équarrie. Le parement intérieur est de moellons de pierres enduites avec de la chaux et de la terre. Une bonne partie de cet enduit est toujours en place sur le mur.

Des rainures ont été taillées dans le rocher aux endroits des infiltrations pour la collecte d'eau.

Le niveau supérieur: l'accès à ce niveau a nécessité une escalade difficile avec l'utilisation du matériel adéquat (corde, coinceurs, mousquetons, descendeur, etc.), (Photo 4). Une grande ouverture verticale et rectangulaire, complètement taillée dans le plafond de la grotte et comportant des marches, mène à l'étage supérieur qui est une grande cavité plane, contenant une cellule avec 1 mur en pierres grossièrement taillées, 1 four, 2 bassins et 1 grande fenêtre à feuillure (rainures dans les jambages) qui donne sur la vallée (Photo 6).

Une canalisation d'eau est taillée sur tout le long de la paroi collectant les eaux des infiltrations dans 2 réservoirs creusés dans les deux extrémités nord et sud de la cavité ; leurs diamètres sont d'environ 4 m et leurs profondeurs de 2,5m.

Le bassin nord est couvert par une voûte partiellement effondrée.

Les vestiges d'un grand four dont le diamètre est de 180cm, sont accolés sur la façade ouest ; ce four est construit par des blocs en terre cuite, de même dimension que ceux du bassin du niveau inférieur (Photo 7).

Le nombre de bassins et puits existants reflète l'importance du nombre des occupants de la grotte.

Document photographique 1 à 5, Sami Karkabi ; 6-7, Falah Wakim.

Historique

Le nom de la grotte de Zellâya apparaît dans le traité élaboré entre le sultan al-Mansour Qalaoun et les Francs de la ville de Akka en 1283 J.C. Quatremère a publié l'original et sa traduction française [2]:

"...استقرت الهدنة بين مولانا السلطان الملك المنصور ولده السلطان الملك الصالح علاء الدنيا والدين علي خلد الله سلطانهما وبين الحكام بمملكة عكا وصيدا وعثليث.. والبقاع العزيزي واعماله ومشغر امشغرة) واعمالها وشقيف تيرون واعماله والقاير جميعها زلايا وغيرها..."

Photo 3
> **Porte d'acc s de la forteresse** (Photo Sami Karkabi)

Photo 4
> **Acc s par une petite ouverture l' tage sup rieur** (Photo Sami Karkabi)

Photo 5
> **Grande salle** (Photo Sami Karkabi)

« ... Il a été conclu une trêve, entre notre seigneur le sultan Melik-Mansour, son fils, le sultan Melik-Sâleh-Ala-eddounia-ou-eddin (Quatremère a omis Ali) *(puisse Dieu éterniser leur règne !), d'une part ; et de l'autre, les gouverneurs qui commandent dans les provinces d'Akka, de Saïda, d'Athlith*... suit une longue liste énumérant les domaines du sultan Mamlouk... *le Bikâ-Azizi* [3], *avec ses districts ; Maschgar* (Mashgara) *et ses districts ; Schakif-Tiroun et ses districts ; toutes les cavernes, Zalaïa* (Zellâya) *et autres*... ».

Dans une note relative à ce traité, Quatremère cite : « *Les écrivains latins des croisades font mention de plusieurs cavernes, qui étaient devenues des forteresses. Guillaume de Tyr parle d'une caverne inexpugnable, située sur le territoire de Sidon, et que l'on appelait vulgairement Cavea de Tyrum. Ce lieu est le même qui, dans le texte de ce traité... est nommé Schakif-Tiroun* (شقيف تيرون). *Dans les chartes qui constatent des donations faites aux Hospitaliers de Saint-Jean-de-Jérusalem, nous trouvons indiquées : I-Cavea de Memboa*[4] *... Burckhardt en rencontra de très nombreuses,* (vastes cavernes creusées dans les montagnes) *dans les environs de Baalbek et ailleurs. Peut-être la caverne de Zalaïa* (Zellâya) *nous représente-t-elle le lieu appelé aujourd'hui Zahlé, sur lequel on peut voir les détails que donnent Burckhardt...* [5] ».

[1] L'orthographe est identique à la carte d'état-major.

[2]Taki-Eddin Ahmed MAKRIZI, *Histoire des Sultans Mamlouks*, traduite en français par M. Quatremère, tome second, Paris MDCCCXLV, p. 180 et p. 225.

[3]Pour la plaine de la Beqâ, l'épithète al-Azizi lui vint d'al-Malik al-Aziz fils du sultan Saladin (Salah ad-Din al-Ayyoubi).

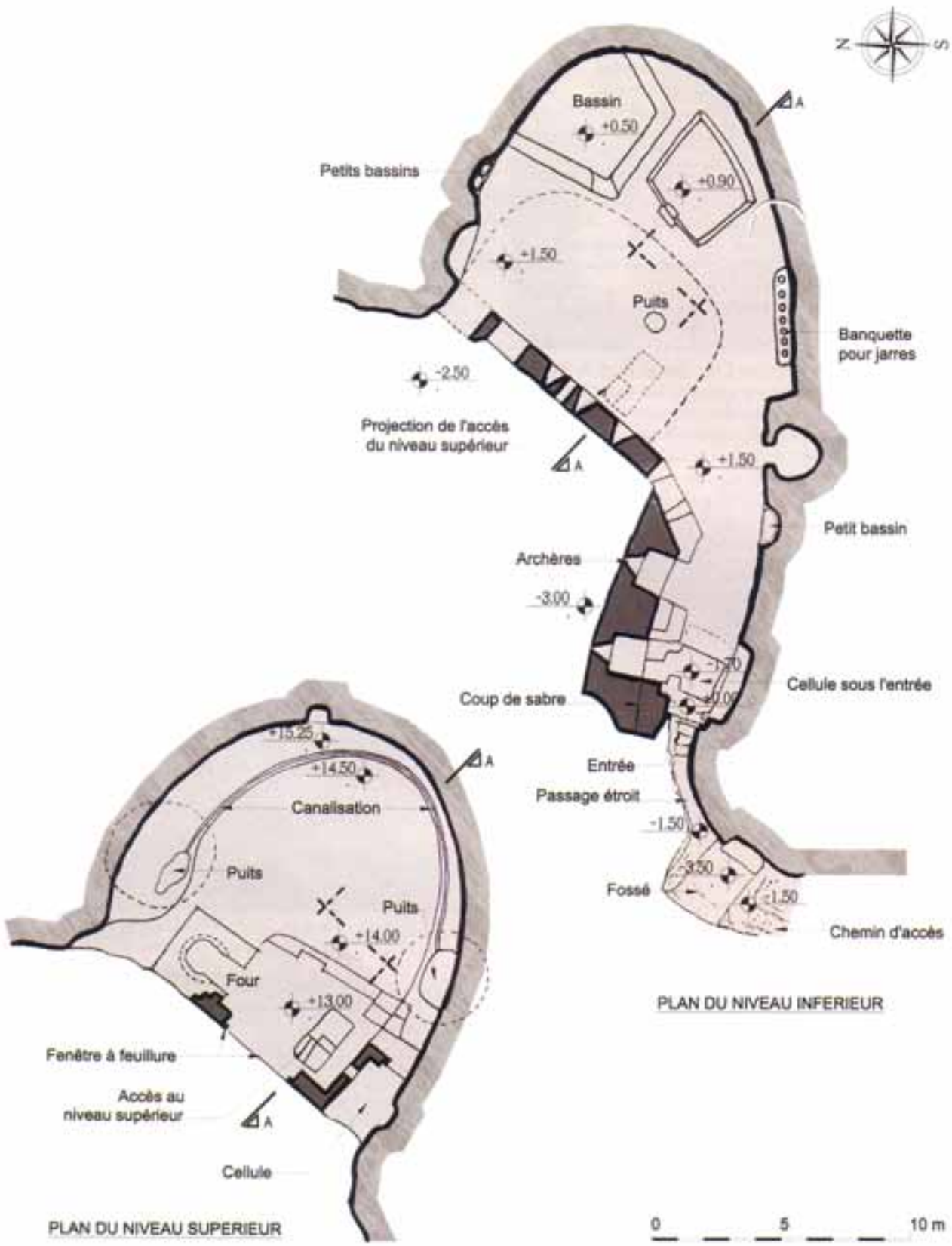
[4]Kahf al-Manbouh ou Dayr Mar Maroun près de Hermel sur al Aïn al Zarka. Ce site faisait partie du système de défense du Compté de Tripoli durant la domination Franque. Voir Paul Deschamps : Les château des Croisés en Terre Sainte, III, la défense du Compté de Tripoli et de la principauté d'Antioche : étude historique, géographique, toponymique et monumentale, 2 vol. Texte et planches. Geuthner Paris 1977.

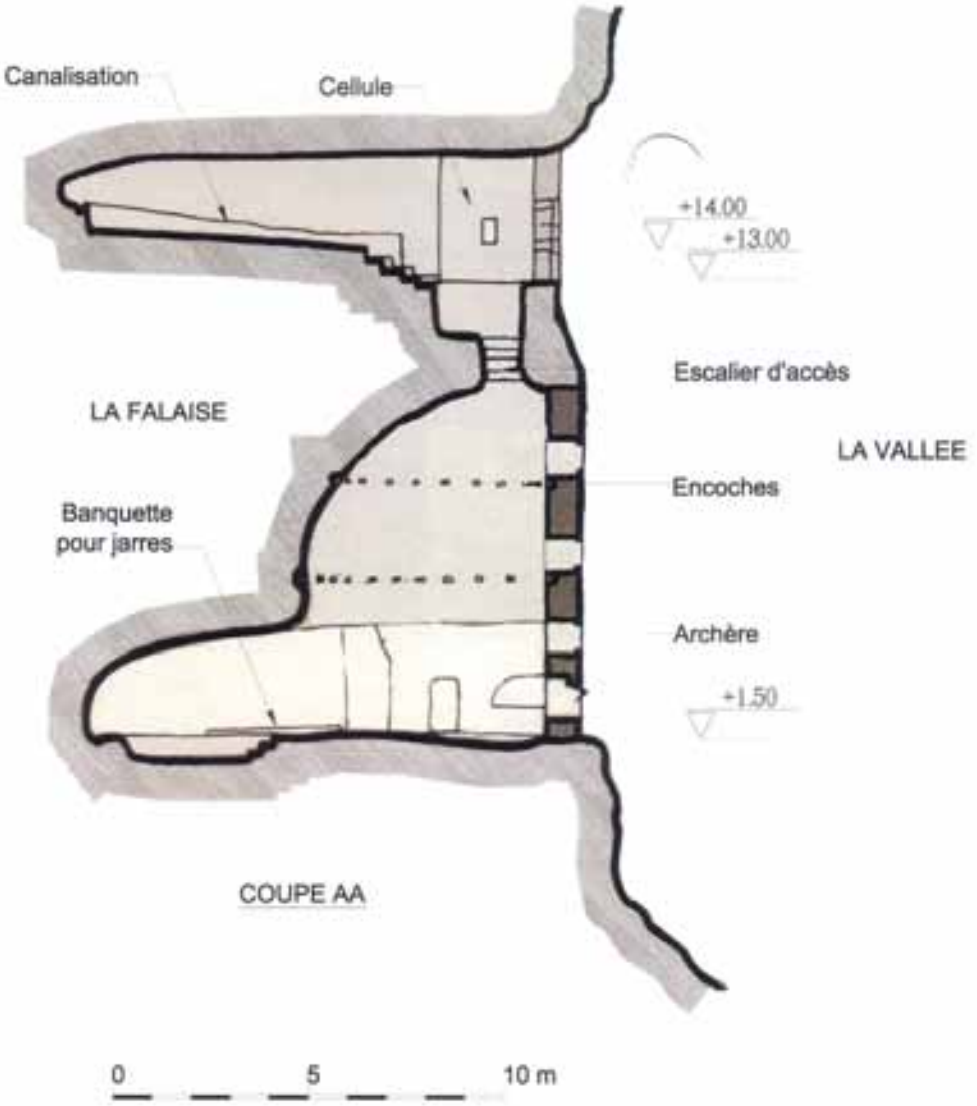
[5]M. Quatremère, *op. cit.* pp. 259-260. Il semble que Quatremère ignorait l'existence du village de Zellâya et de sa grotte.

*La topographie a été réalisée par les membres du GERSL - Plans et coupe ont été dessinés et mis à jour par Falah Wakim

Photo 6
> **Grande fenêtre de l'étage supérieur donnant sur la vallée** (Photo Falah Wakim)

Photo 7
> **Grand four de l'étage supérieur** (Photo Falah Wakim)


N
S
Bassin
+0.50
+0.90
Petits bassins
+1.50
Puits
Banquette
pour jarres
-2.50
Projection de l'accès
du niveau supérieur
A
+1.50
Petit bassin
Archères
-3.00
Coup de sabre
Cellule sous l'entrée
Entrée
Passage étroit
-1.50
-3.50
Fossé
-1.50
Chemin d'accès
PLAN DU NIVEAU INFERIEUR
+15.25
+14.50
Canalisation
Puits
Puits
+14.00
Four
+13.00
Fenêtre à feuillure
Accès au
niveau supérieur
Cellule
PLAN DU NIVEAU SUPERIEUR
0
5
10 m


Canalisation
Cellule
+14.00
+13.00
Escalier d'accès
LA FALAISE
LA VALLEE
Encoches
Banquette
pour jarres
Archère
+1.50
COUPE AA
0
5
10 m

SPELEOLOGICAL EXPLORATION

MGHARET EL KASSARAT • The Siphon Dive

Fadi Farra
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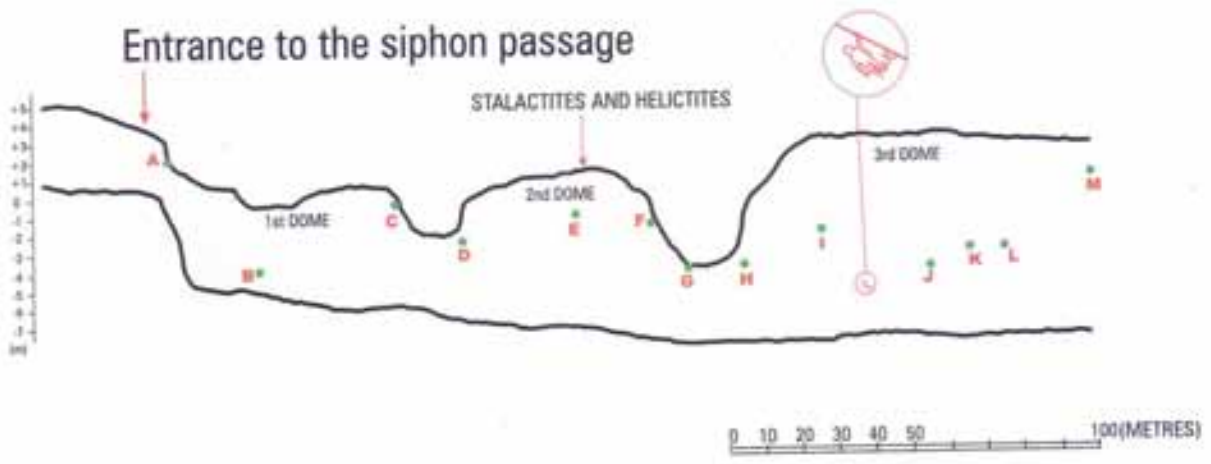
This report is translated by Fadi Farra from an original report by Antoine Comaty

ELEVATION OF THE DIVE PASSAGE

Length from point A to point M =248m



> **The path of the dive** (Figure by Antoine Comaty)

As a major continuation in Mgharet el Kassarat, the siphon dive proved to be well worth the effort, extending the cave by well over 200m.

> Antoine Comaty getting ready to dive (Photo Issam Bou Jawdeh)

> The inner sections of the siphon (Photo Antoine Comaty)

> The round ceiling with growing concretions (Photo Antoine Comaty)

In the summer of 1999 multiple cave dives took place in the Mgharet el Kassarat Antelias allowing the discovery of a development of 248m in the upstream siphon, making it the longest underwater development ever explored in Lebanon after Jeita's 275m siphon mapped by the French diver Jean-Jacques Bolanz.

The main team was made up of 10 members, carrying around 7 equipment bags and 2 dinghies. The diving equipment was made up of a single 15L air bottle with 2 regulators, one backup bottle of 5L with one regulator. Lighting, which was ensured by a traditional Ikelite backed by a Miga SubPro6 35W lamp and an emergency canyoning torch, proved to be insufficient. The same goes for the 5mm Neoprene wetsuit, a 7mm thickness will not be a waste here. For further explorations, it would be wise to use a scooter to ensure proper energy management. The undertow progression was about 20 minutes long. Water temperature was 16°C. The general direction of the siphon is N215°.

The system is composed of three consecutive bell-shaped cells, isolated from one another by successive immersed passages. The general morphology is characterized by highly eroded walls covered by a small layer of clay that appears to be much thicker in the bottom, with a sandy feel. A puffy mud cloud is formed in the water as soon as one touches any of the so-covered parts.
The overall depth of the siphon does not exceed six meters in the explored part, and emerging above the zero level is possible inside the cells.

The siphon begins with an approximately 26 meters long damped arch in which water does not hit the ceiling, and hence may be explored from the far left side with just a mask and tuba. This passage leads to the first cell, which is about 25m long by 4m deep. However the other end is completely immersed and requires full underwater progression.

The second cell is about 2m high by 50 meters of length. One can actually stand up on the left side where water does not go beyond the belt. This is due to the fact that the water current mainly passes on the far right of the siphon, which entails that the sand gathers on the opposite side. The morphology is really incomparable with the first cell. In fact, the ceiling is decorated with calcite, and many concretions, noticeably stalactites and some eccentrics, are coming down from all over the place. This is a clear sign that water level doesn't get any higher in this part of the siphon, even in flooded periods, but rather emerges directly into the cave. It's quite amazing to find such beautiful and fragile formations there knowing that, a few meters from there in the first cell, the rock are totally eroded. A clear horizontal line on the walls shows the level limit during winter, which apparently does not go beyond 50cm of variation. There are traces of some oily liquid and hydrocarbons cumulated on the water surface, which must mean that this closed space does not receive any fresh air current and that the imprisoned gas is probably not breathable.

Getting to the third cell, it is noticed that the latter is quite similar to the first one. The walls are smooth and eroded by water and without any concretion. Even underwater, grips are extremely hard to find. Just like in the second cell, there are hydrocarbons floating on the surface, jeopardizing the air quality, and the high water mark is about the same. Some traces of concretions are just starting to appear in a certain area of the ceiling. Two huge cutting edged rocks of about 3-4 meters length lie in the bottom of the water, witnessing of the extreme currents that must occur.

One must have seen the extreme unfurling that emerges in the river in winter to have a visual idea of the enormous quantity of water that traverses this passage. This may be enough to confirm the hypothesis that the underground river is only the top of a huge water table and the means to pour out its overabundance.

It also appears that the siphon extends to a longer distance and doesn't seem to reveal a close continuation of the cave, but rather leaves us with the benefit of the doubt.

LEBANON'S LOST CAVES

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Lebanon has over 500 known caves. The Spéléo Club du Liban and other caving clubs have documented newly discovered caves but no documentation has ever been made of the caves that are no longer accessible or have been destroyed.

The reasons for the loss of these caves are various, ranging from natural disasters to man-made ones. The former resulting from mud blockages, natural collapses and earthquakes and the latter reasons consisting of caves that have been used as sewage drains, re-buried, blown up or have been quarried to nonexistence.

It is a shame that we are loosing these treasures as some of the caves have yet to be fully explored and others had contained some beautiful speleothems.This is the first time the SCL lists Lebanon's longest and deepest caves (Table 1). Some numbers may vary from previously published ones because some caves, after being re-surveyed, were found to be longer, or in fact, shorter than originally thought. It is hoped that each year and with new discoveries this list will change.

The following is a list of the caves identified by SCL that are in the process of closing or are not accessible anymore :

Mgharet el Shatawie (Antelias)

This cave was discovered in the 1960's. Quarrying had caused the entrance to be lost. In 2000 SCL cavers re-discovered its location and its lost entrance was found. In 2005 the entrance was lost again because it was covered by two meters of soil.

This cave, near Mgharet el Kassarat is being filled with mud. The cave is over 800m but the only accessible part left is a small passage of approximately 200m. The thickness of the mud is over two meters and from what we see it is going to be completely filled with mud which will close the cave completely. It is believed that the activity of the nearby quarry helped increase the mud flow and thus the blocking by mud of this cave has been accelerated.

Houet Michmeche (Figure 1)

This 140m deep sinkhole was located 500m from Houet Blaitat in Zarrour just outside the village of Mrouj.

The first level of this sinkhole was filled completely by 30m of bolders and mud deposited by the river that flows through it. Local quarries had produced a lot of rock material, and the sinkhole was slowly blocked by boulders and rocks.

The sinkhole is completely covered today, without a trace on the surface, although it still exists hidden below the surface.

Houet Mar Chaaya (Photo 1)

Located near Jouret el Ballout in the Metn area this cave was destroyed when the mountain in which it was found was dynamited to open the way for a new highway. The explosion blew up the majority of the cave and now it stands half destroyed on the right side of a six-lane highway.

Houet Albert or Houet Ain el Kadah

This 85m deep sinkhole is well known to all Lebanese cavers as it is used as a training sinkhole because it has different levels of short pits.

In early 2000 a local farmer decided to terrace the area right above the cave using large rocks. This terracing is very unstable and since the sinkhole has two open-air entrances directly under the terraces it has become very dangerous to descend the cave as large rocks could tumble down on the cavers.

This terracing has rendered this cave inaccesible and it is currently closed for caving.

Houet Majdal Tarchiche

This 190m deep sinkhole filled up with sand and rocks after the river that flows through it collected the debris from nearby quarrying. It is now completely covered and no trace of the sinkhole can be seen.

Sehaile Houet

This sinkholes entrance has been blocked by a large boulder as the descent is unsafe due to unstable rocks at the surface as locals were scared that children might fall in it; especially since it is a very easily accesible sinkhole.

Ballou Balaa

This 150m open-air sinkhole is filling up with mud and closing itself. In some winters the water level becomes so high that it destroys nearby terracing.

Mgharet Nabaa el Shatawie (Khalet Khazem)

This cave is over 4km long. It has four sumps which make only the cave's first 500m accessible at the beginning of Spring and during Winter. The first sump is deep and needs to be pumped but the next two are shallow and are beginning to fill up with mud. The third sump is the most dangerous as the mud levels there have become very high and it is becoming very difficult to bypass this part of the cave as the mud is increasing in volume every year. It appears that at some point the mud will completely block this sump and we will no longer be able to access the remainder of the cave.

Mgharet el Waseeieh (South Lebanon)

This horizontal cave is found in a military camp and no-one is allowed to enter it.

Nabaa el Saqiet (Faraya)
This cave is permanently flooded due to catchment works.

Antelias prehistoric caves:
Abri Bergy (20m) and **Grotte de Antelias** (60m)
These two caves were both destroyed a result of quarrying.

Houet Ghosta (-50m).
Local roadworks have completely covered this sinkhole.

References

-SCL archives

-Karkabi, S., 1970. Le Karst Libanais, Hanon: Revue Linanaise de Géographie. Extrait du Volume 5, 1970.

Table 1

Longest Caves of Lebanon

(as of 2005, SCL archives)

1	m. Jeita	9050 m
2	m. Afqa	5260 m
3	m. Roueiss	5066 m
4	m. Al-Kassarat	4648 m
5	m. Ain al-Libné	4560 m
6	m. Nabaa al-Shatawie	4130 m
7	h. Faouar Dara	3500 m
8	h. Qattîne Azar	3100 m
9	m. Dahr al-Ain	1500 m
10	m. Nabaa al-Moutrane	1200 m

The Deepest Caves of Lebanon

(as of 2005, SCL archives)

1	h. Faouar Dara	- 622 m
2	h. Qattîne Azar	- 515 m
3	h. Ballouh Baatara	- 255 m
4	h. Jouret al-Abed	- 244 m
5	h. al-Badaouiyé	- 205 m
6	m. Ain al-Libné	- 195 m
7	h. Othman Remaïhy	- 163 m
8	h. Aaqroub	- 155 m
9	h. Ballouh Balaa	- 152 m
10	h. Tarchich	- 147 m

m = mgharet (in arabic) = cave
h = houet (in arabic) = sinkhole

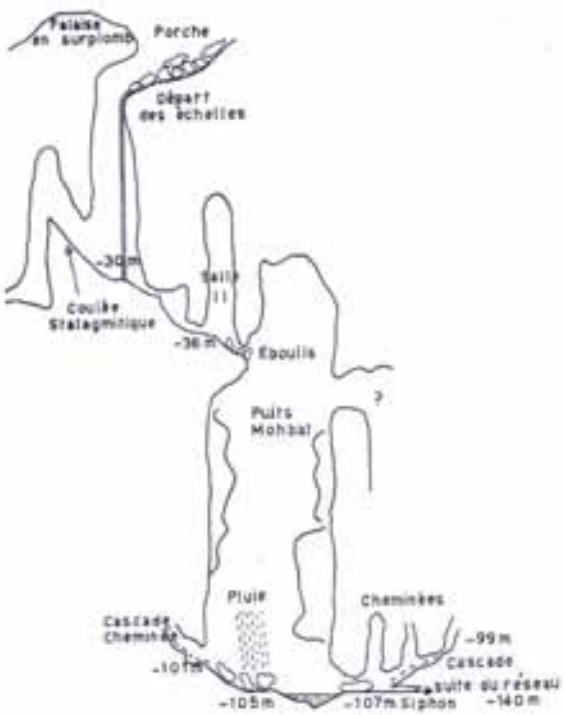


Figure 1
> The Survey of Gouffre Michmeche with the many still unexplored sections
(Karkabi,1970, SCL Archives)

Photo 1
> Houet Mar Chaya after it was destroyed by roadworks (Photo by Issam Bou Jawdeh)

NEW EXPLORATIONS AND DISCOVERIES

Texts written by Rena Karanouh *(RK)*, Issam Bou Jawdeh *(IBJ)* and Joe Mehanna *(JM)*

Houet el Jaouz
Houet Yaroun (Dkaika)
Houet Botmeh
Houet Fghal
Houet Loueize
Houet Baadarane
Mgharet Nbat
Mgharet Ain el Sit
Mgharet Snounou
Mgharet Mar Youhanna
Houet Qana Cave II
Houet Chmistar
Houet el Badawiyeh
Mgharet Achou
Houet Ksaim
Houet Sidr el Hajal
Houet Aaqroub
Houet Mechane 2
Houet Mechane 4
Mgharet el Maadan
Marjaba Mines
Sohmor Mines
Mgharet Tannourine

● The red dot on the maps shows the location of the cave

Photo 1
> **The entrance to Houet el Jouaz** (Photo by Bakri Karwabi)

Figure 1
> **The location of Houet el Jouaz**

HOUET EL JAOUZ

X = 153 040m	Lambert Co-ordinates
Y = 258 290m	Topographic Sheet:
Z = 170m	Amioun 1/20,000

Vertical development: 88m

Location

The sinkhole is located near the el Jaouz river in Kfar-Hay, Batroun area (see Figure 1).

Geology

Sannine Formation, C4

Discovery

Discovered by Michel Moufarage in 1997, this cave was explored in 2000.

The cave entrance is 50cm in width and 150cm in length (Photo 1). The first pit measures 18m and ends in a slope where there is another pit of 10m. A strong air current is felt coming from a small opening in this room. A stone was thrown inside the opening to check if there was a continuation and rattled for about seven seconds making further exploration necessary. Enlargement of the opening was thus essential to allow a person to go through.

Chiseling equipment was brought down to make the opening larger. It took a whole day to enlarge the opening large enough to allow a caver to squeeze herself through to check the continuation (Photo 2).

After this tight squeeze it was found that the cave continued for another 60m ending in a large room with eboulis. It is worth mentioning that in 2001 another Lebanese caving club (ALES) descended this sinkhole and enlarged the opening even more (Speleorient, 2004). *(RK)*

References

- Akhrass, C., Tabet, J. Matta, P. 2004. Houet el-Sadd. *Speleorient 4*. Revue de l'ALES, pp108 -109.

Photo 2
> **The tight passage before (above) and after (above left) enlargment** (Photo by Bakri Karwabi)

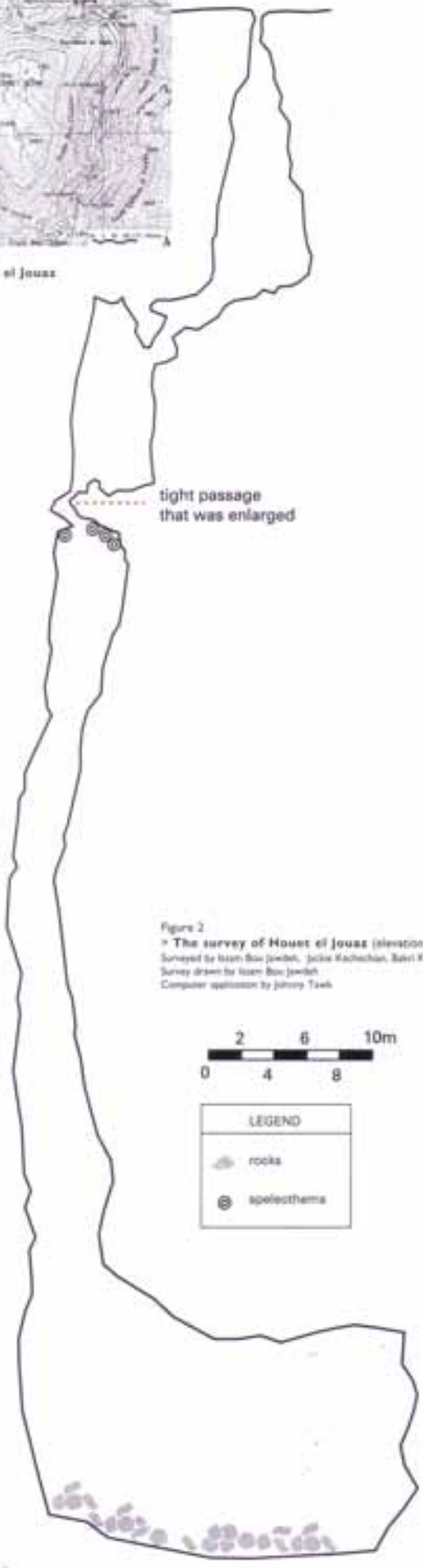


Figure 2
> **The survey of Houet el Jouaz** (elevation view)
Surveyed by Issam Bou Jawdeh, Jackie Kachachian, Bakri Karwabi
Survey drawn by Issam Bou Jawdeh
Computer application by Johnny Tawk

Photo 1
> Israeli patrols in their armored vehicles approximately 100m away (Photo by Issam Bou Jawdeh)

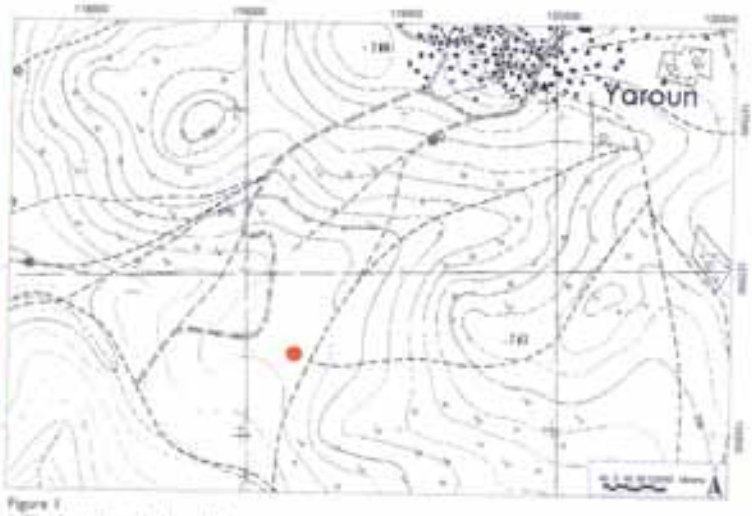


Figure 1
> The location of Houet Yaroun

HOUET DKAIKA

X = 119 103 m	Lambert Co-ordinates
Y = 126 740 m	Topographic Sheet:
Z = 690 m	Yaroun 1/20,000

Vertical development: 80m

Location

This sinkhole is located outside of the village of Yaroun in the south of Lebanon (Figure 1).

Geology

Sannine Formation, C4

Discovery

100m from the southern Lebanese border SCL cavers located a sinkhole with a tight entrance.

The entrance was enlarged using blasting equipment under the watchful eye of Israeli patrols in their armored vehicles and helicopters (every five minutes the Israeli soldiers would use their binoculars on us to try to see what we were doing (Photo 1)). The blasting was accomplished quickly and as quietly as possible (Photos 2 & 3).

After widening the entrance to fit a person through, we descended 80m putting in four bolts and just as many natural rigs. We had to de-rig before nightfall as those were the instructions issued by the UN to us before we arrived, because activities near the border are not permitted at night. At the bottom a huge room was found measuring 50m by 50m with collapsed rocks in the middle, some concretions and a few animal skeletons. *(RK)*

Photos 2 & 3
> The tight passage after blasting and a caver finally passing through
(Photo by Rana Karkoush (left), Issam Bou Jawdeh (right))

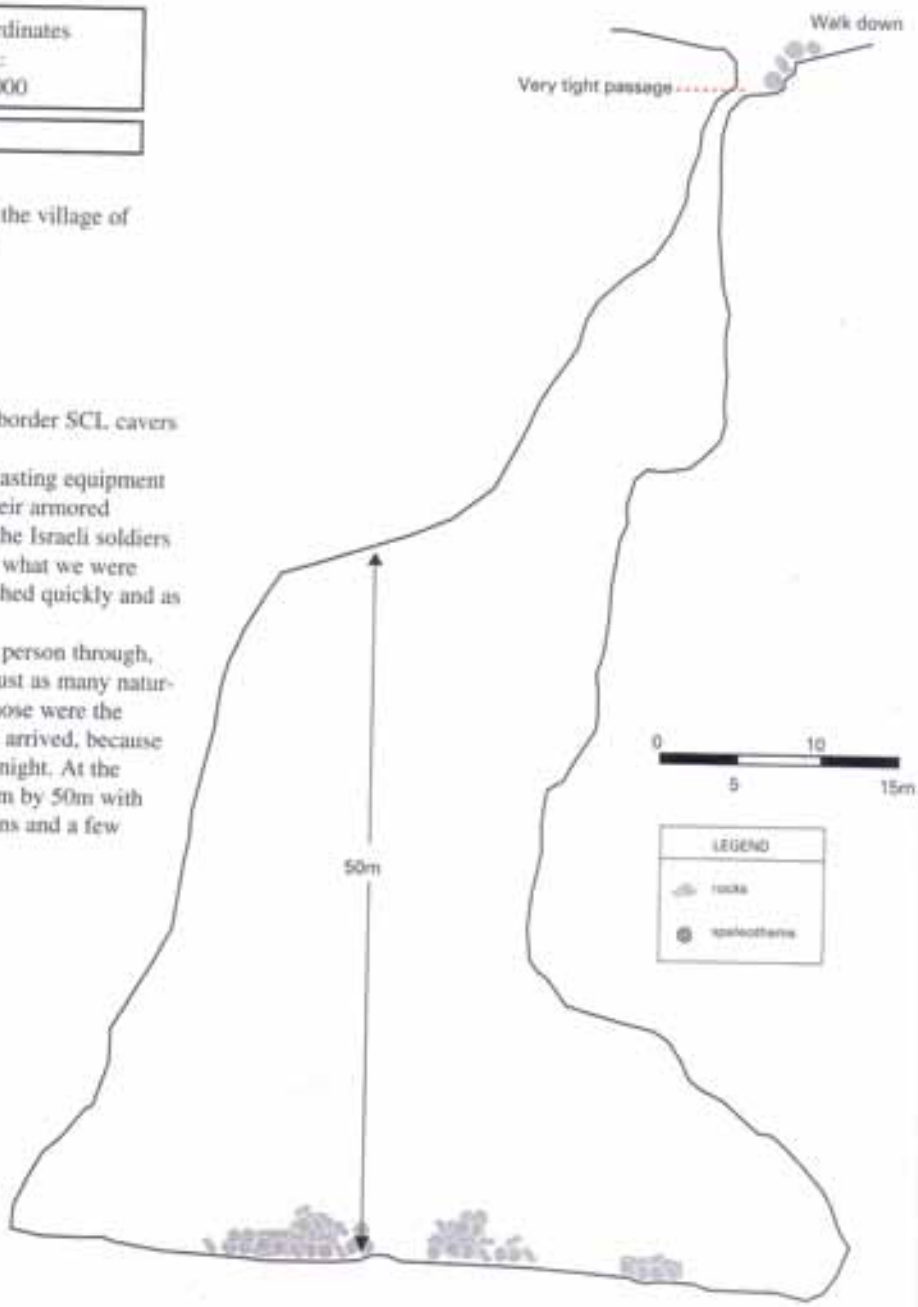


Figure 2
> The survey of Houet Dkaika (section view)
Surveyed by Issam Bou Jawdeh, Rana Karkoush and Hadi Kassamani

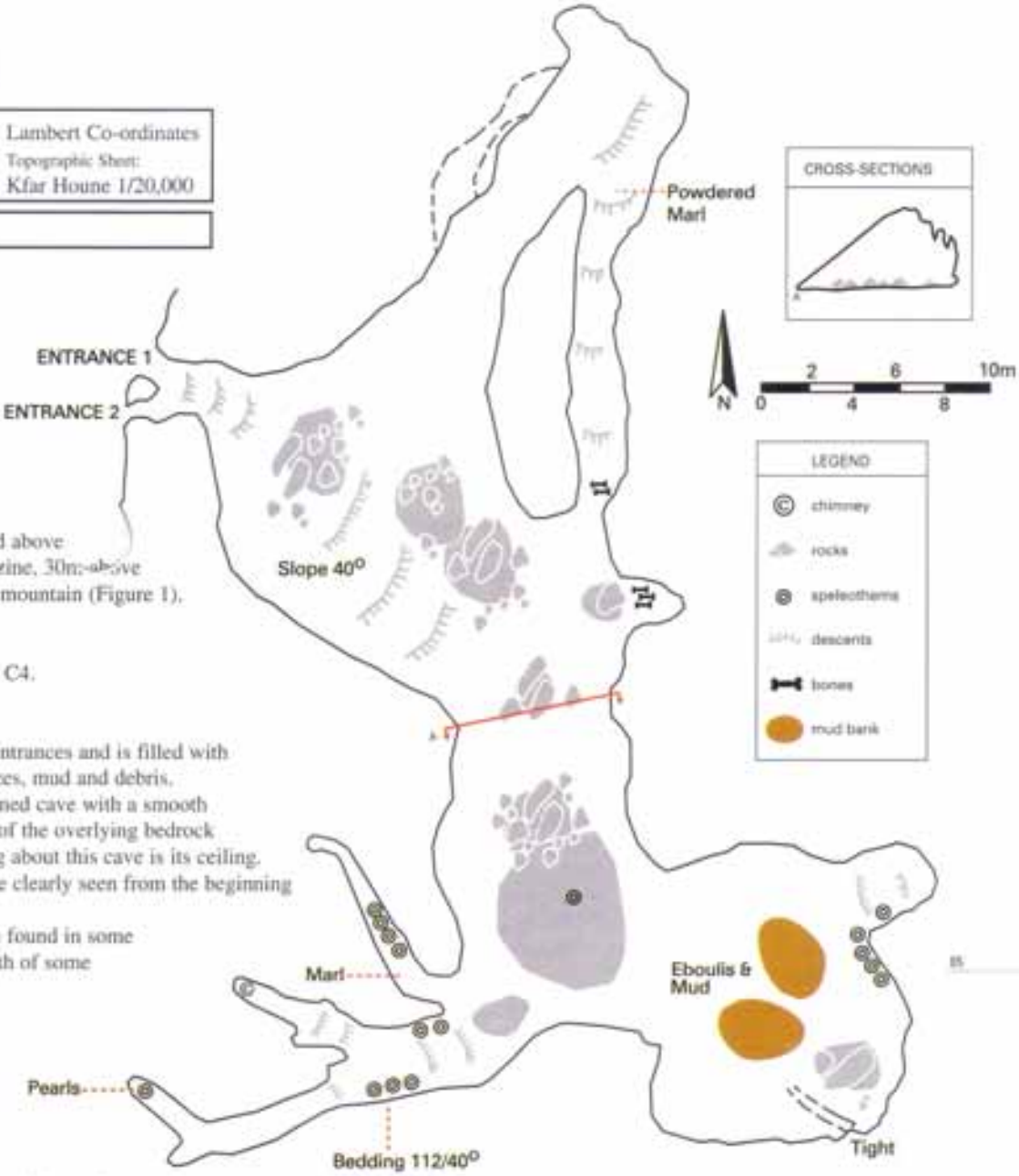
Photo 1
> **The bedding inside the cave**
(Photo by Rana Karanouh)

Figure 1
> **The location of Mgharet Snounou**

MGHARET SNOUNOU

X = 135 744m	Lambert Co-ordinates
Y = 172 018m	Topographic Sheet:
Z = 1060m	Kfar Houne 1/20,000

Development: 140m



Location

This cave is located above Kfar Houne village, near Jezzine, 30m above the metal cross on top of the mountain (Figure 1).

Geology

Sannine formation, C4.

Discovery

The cave has two entrances and is filled with rock fragments of varying sizes, mud and debris.

It is a steeply inclined cave with a smooth ceiling which is the bedding of the overlying bedrock (Photo 1). The beautiful thing about this cave is its ceiling. The dip of the bedding can be clearly seen from the beginning of the cave until its end.

Animal bones were found in some locations as well as the growth of some calcite concretions in small galleries off the main cave axis. *(66)*

Figure 2
> **The survey of Mgharet Snounou**
Survey by Rana Karanouh, Habib Haleu, Hadi Kassamani, Karen Mouradbeh and Wissam Hamdan
Survey drawn by Rana Karanouh
Computer application by Johnny Tawk

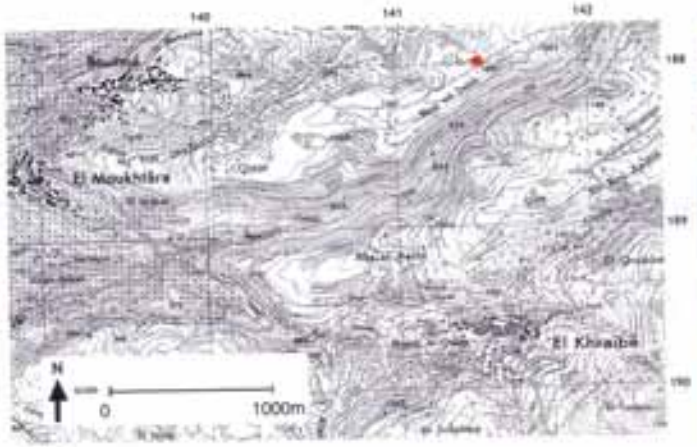


Figure 1
> The location of Houet Botmeh

Photo 1
> The vertical rigging of Houet Botmeh (Photo by Rana Karaoullah)

HOUET BOTMEH

X = 141 437m	Lambert Co-ordinates
Y = 192 012m	Topographic Sheet:
Z = 1055m	Mazraeet el Shouf Sheet 1/20 000

Vertical development: 65m

Location

The sinkhole lies approximately 2km outside of Botmeh village, 20m off the main road that connects Botmeh village with Mokhtara village (Figure 1)

Geology

Houet Botmeh is located in the Sannine Formation of the Upper Cretaceous Period (C4, Cenomanian age).

Discovery

The first outing to Houet Botmeh took place on the 27th of April 2002, followed by the final rigging on the 1st of May and finally in August 2003 SCL cavers descended and photographed the ammunition at the bottom.

The entrance to the sinkhole is small and is located to the left of the main shaft. There was another entrance from the top but it was blocked with rocks.

After rigging the rope we descended and proceeded to rig the sinkhole using bolts as there were no natural rigs available (Photo 1). Upon reaching 50m a series of five natural rigs led to the bottom of the sinkhole at 65m (Figure 2).

The cavers realised that there was a large number of live artillery shells at the bottom and did not allow their legs to touch the ground (Photos 2 & 3). The sinkhole was descended once in winter and a waterfall was observed.

Photo 2
> The bottom of Houet Botmeh (Photo by Rana Karaoullah)

Photo 3
> Live artillery shells found at the bottom (Photo by Rana Karaoullah)

Figure 2
> **The survey of Houet Botmeh**
Survey by Rana Karanouh, Hadi Kassamani, and Issam Bou Jawdeh
Drawn by Rana Karanouh
Computer application by Rana Karanouh

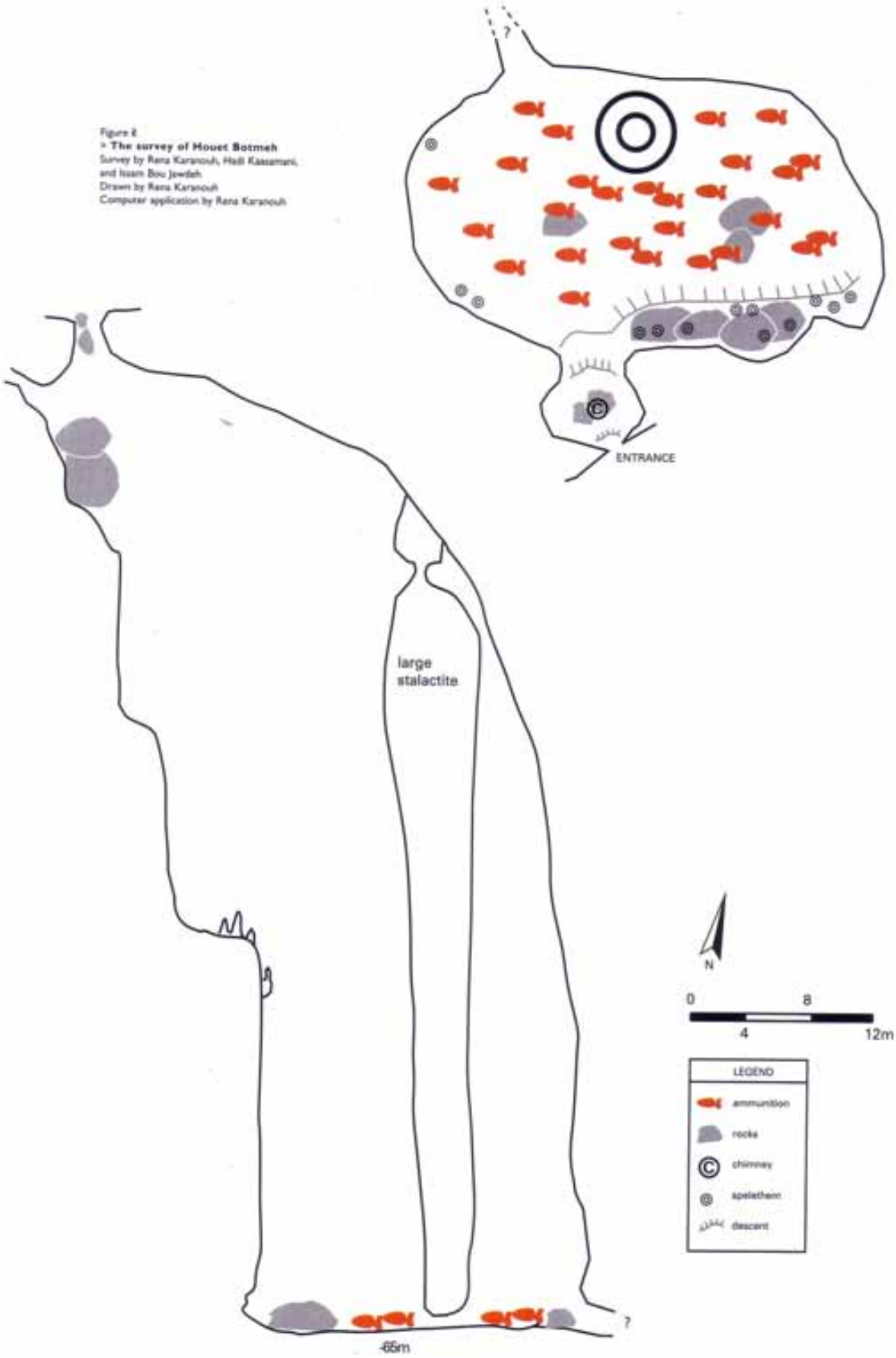


Photo 1
> **The entrance to Mgharet Kassarat Fghal. Notice the cavers at the entrance in the lower left of the photo.**
(Photo by Rana Karaouzli)

Figure 1
> **The topographic map of the location of Mgharet Kassarat Fghal**

MGHARET KASSARAT FGHAL

X = 143 340 m	Lambert Co-ordinates
Y = 252 050 m	Topographic Sheet:
Z = 125 m	Bejje Sheet 1/20 000

Development: 40m

Location

The cave is located in the Fghal Quarries. (see Figure 1).

Geology

Sannine Formation, C4

Discovery

This cave was spotted from an army helicopter in 1998 by Hughes Badaoui.

Exploration of this small cave revealed that it was home to a beautiful array of speleothems (Photos 1-7). *(BK)*

Photo 3
> **The stalactites inside Mgharet Kassarat Fghal** (Photo by Joanne Doummar)

Photo 2
> **The Bat Stalactites inside Mgharet Kassarat Fghal**
(Photo by Issam Bou Jawdeh)

Photo 4
> **The curtains inside Mgharet Kassarat Fghal** (Photo by Karen Mouarbesh)

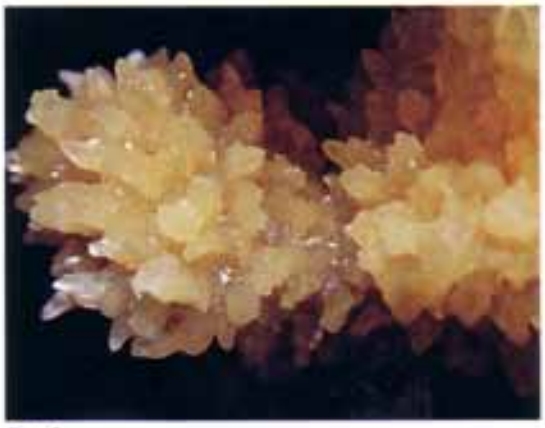


Photo 5
> **The crystal speleothems inside the cave**
(Photo by Rana Karanouh)

Photo 6
> **A curtain inside Mgharet Kassarat Fghal**
(Photo by Rana Karanouh)

Photo 7
> **A crystal stalactite inside the cave**
(Photo by Rana Karanouh)

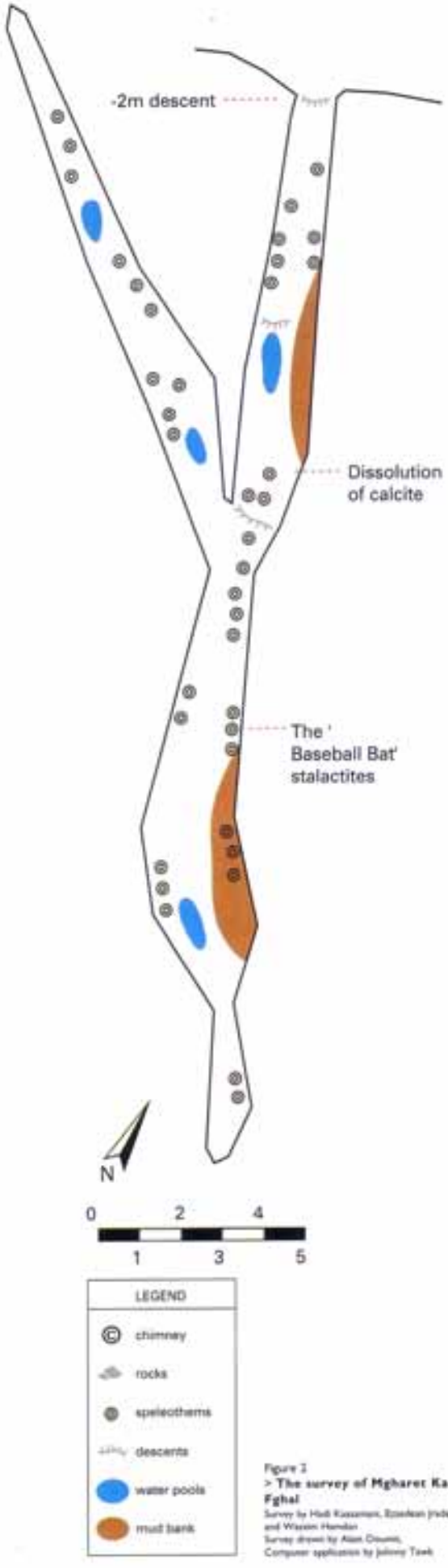


Figure 3
> **The survey of Mgharet Kassarat Fghal**
Survey by Hadi Kassarani, Ezzeldeen Jradi, Alain Doumit and Wassim Hamdan
Survey drawn by Alain Doumit,
Computer application by Johnny Tawk

Photo 1
> **The garbage at the bottom of the sinkhole**
(Photo by Issam Bou Jawdeh)

Figure 1
> **The location of Houet Loueize**

HOUET LOUEIZE

X = 131 472 m	Lambert Co-ordinates
Y = 169 336m	Topographic Sheet:
Z = 850 m	Kfar Houne Sheet 1/20 000

Vertical development: 15 m

Location

Near the Tasseh Spring in the village of El Loueize. (see Figure 1).

Geology

Sannine Formation, C4.

Discovery

The sinkhole measures 15m in depth. At the bottom, a large amount of garbage was found. (RK)

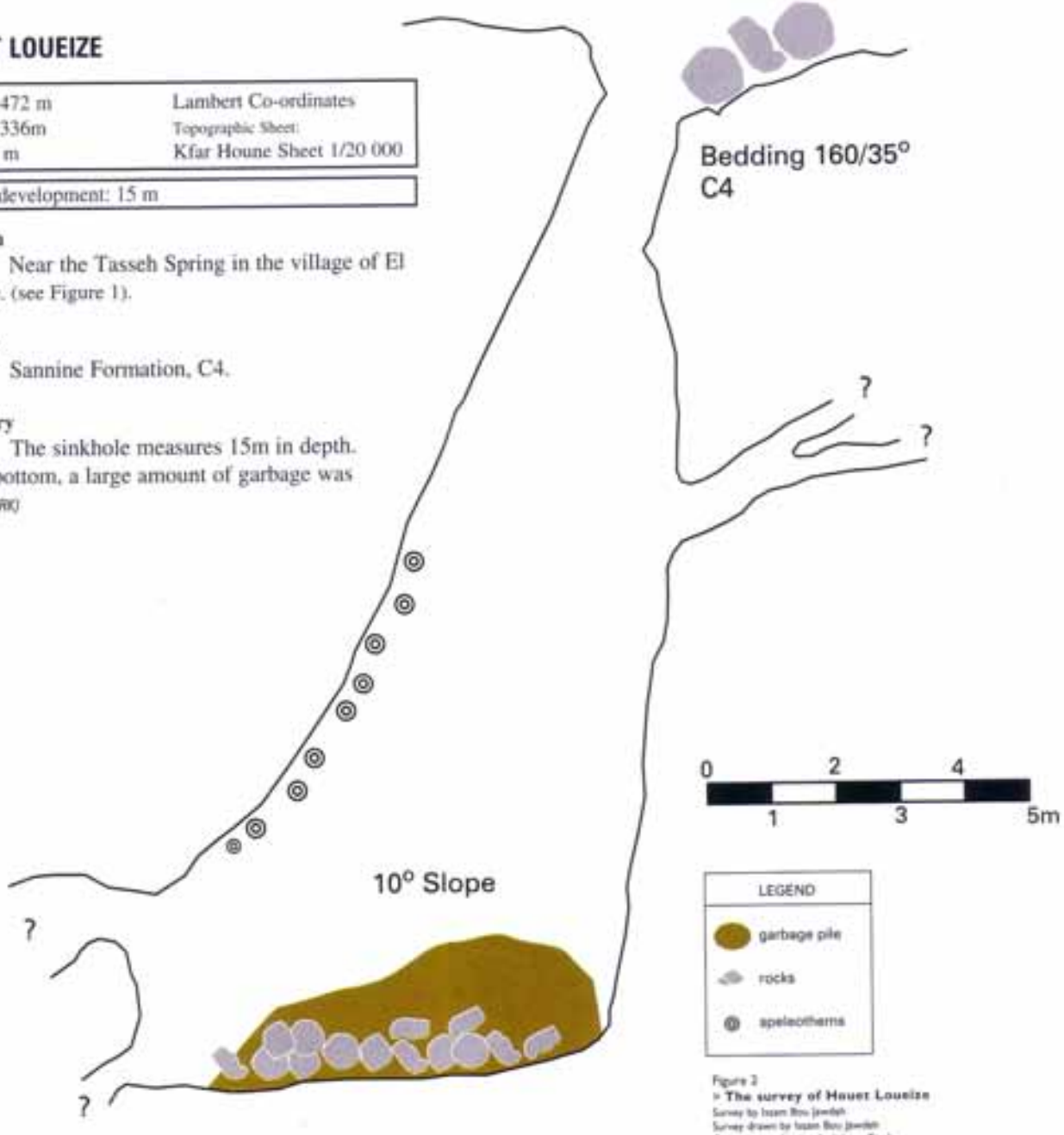


Figure 2
> **The survey of Houet Loueize**
Survey by Issam Bou Jawdeh
Survey drawn by Issam Bou Jawdeh
Computer application by Johnny Tawk

Photo 1
> **The entrance to Houet Baadarane** (Photo by Issam Bou Jawdeh)

Photo 2
> **The mortar shells at the bottom of the sinkhole** (Photo by Issam Bou Jawdeh)

HOUET BAADARANE

X = 139 890m	Lambert Co-ordinates
Y = 189 120m	Topographic Sheet:
Z = 1055m	Massraat el Shouf Sheet 1/20 000

Vertical development: 10 m

Location

The sinkhole is located just outside of Baadarane village.

Geology

Sannine Formation, C4.

Discovery

This sinkhole was found to contain mortar shells and artillery. No further exploration of this cave took place as it was too dangerous.

(RK)

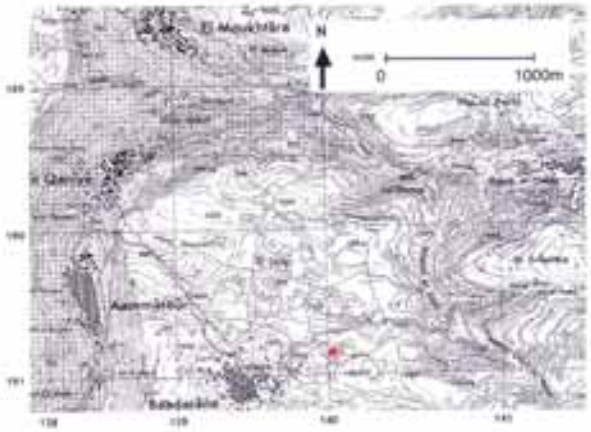


Figure 1
> **The location of Houet Baadarane**

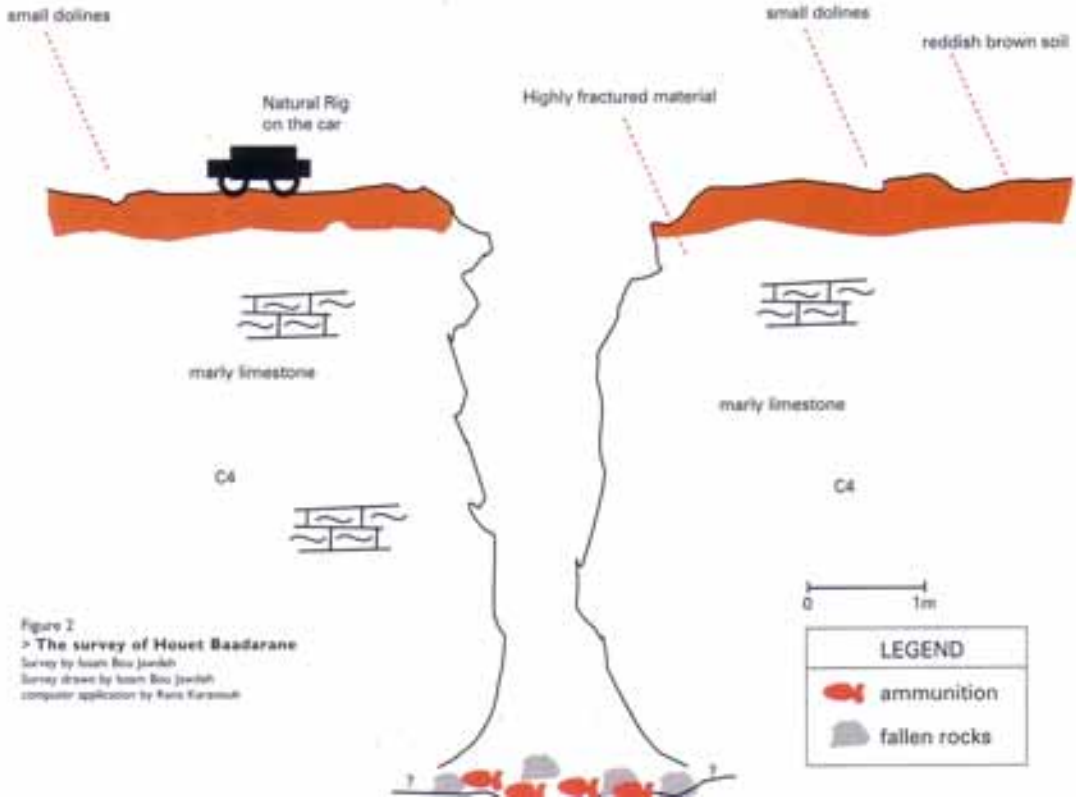


Figure 2
> **The survey of Houet Baadarane**
Survey by Issam Bou Jawdeh
Survey drawn by Issam Bou Jawdeh
computer application by Rania Karanouh

Figure 1
> **The location of Mgharet Nbat**

Photo 1
> **The entrance of Mgharet Nbat**
(Photo by Rana Karaoouli)

Photo 2
> **Crawling inside the cave** (Photo by Rana Karaoouli)

Photo 3
> **The exit from the cave** (Photo by Rana Karaoouli)

MGHARET NBAT

X = 177 773 m	Lambert Co-ordinates
Y = 257 730 m	Topographic Sheet:
Z = 1746 m	Bcharre Sheet 1/20 000

Development: 50 m

Location

This cave is located close to Nbat spring on the left side of the road connecting Bcharre Village and El Arez.

Geology

Hamanna Formation, C3

Discovery

This cave was discovered by Johnny Tawk. In winter he had noticed water coming out of a hole in the rocks. When the water dried up in the summer a full exploration of this cave was undertaken.

It is very tight and runs in between the bedding of the Hamana Formation. The entire cave has to be ramped and it is never large enough to stand in.

(BR)

Figure 2
> **The survey of Mgharet Nbat**
Survey by: Johnny Tawk and Issam Bou Jawdeh
Survey drawn by: Johnny Tawk
Computer application by Johnny Tawk

Photo 1
> **The entrance of Mgharet Ain el Sitt with a local child coming out**
(Photo by Issam Bou Jawdeh)

Figure 1
> **The location of Mgharet Ain el Sitt**

MGHARET AIN EL SITT

X = 201 705 m	Lambert Co-ordinates
Y = 290 345 m	Topographic Sheet:
Z = 608 m	Qoubeiyat Sheet1/20 000
Development : 25 m	

Location

Nearly two kilometers, due south, outside the village of Qobeiyat, approximately 20m above the Ain el Sitt spring (Figure 1). The cave lies on the right hand side of the road next to an electricity pole.

Geology

Sannine Formation, C4

Discovery

After being contacted by the Qoubeiyat Municipality and Environmental Council, the cavers of SCL inspected the cavity. A spokesman from the Qoubeiyat Environmental Council said that the cave was found while workers excavating to install a power pole. They came across a small opening, which was the entrance of a cave. After alerting the Environmental Council and with the help of the Municipality they decided to relocate the pole and conserve this cave for expert inspection.

Although the cave was small it was found to contain beautiful speleothems.

(RK)

Photo 2
> **Speleothems inside Mgharet Ain el Sitt**
(Photo by Issam Bou Jawdeh)

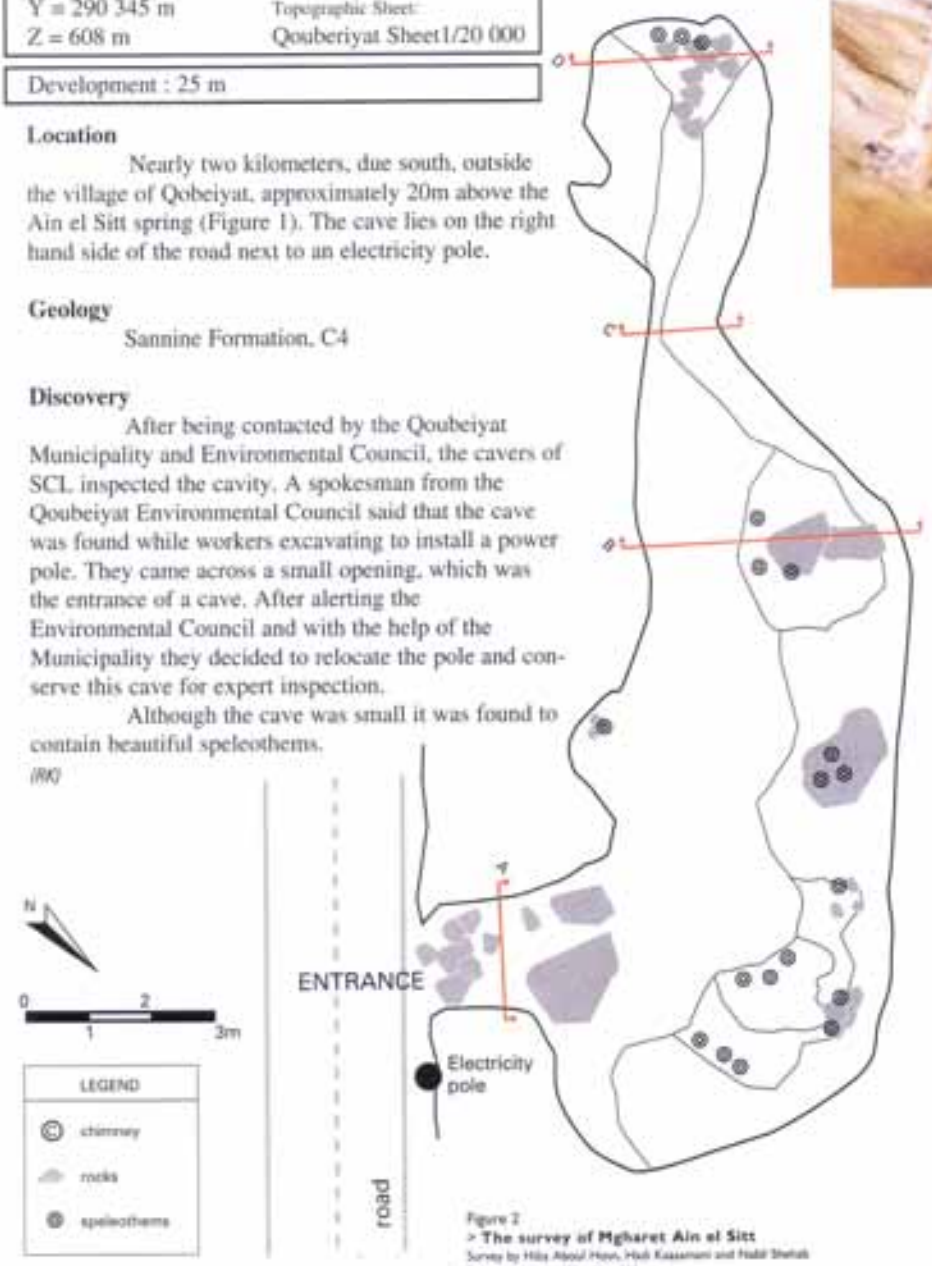


Figure 2
> **The survey of Mgharet Ain el Sitt**
Survey by Hiba Aboul Hosn, Hadi Kassamani and Hadil Shehab
Survey drawn by Hiba Aboul Hosn
Computer application by Hiba Aboul Hosn

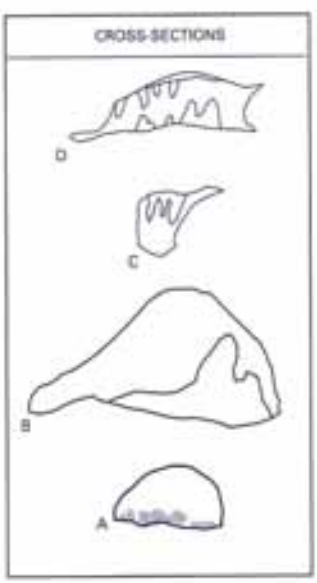


Figure 1
> The location of Mgharet Mar Youhanna

MGHARET MAR YOUHANNA

X = 167 140 m	Lambert Co-ordinates
Y = 241 020 m	Topographic Sheet:
Z = 1544 m	Aaqoura Sheet 1/20 000

Development: 1000 m

Location

The cave is located a few hundred meters above the Rouaiss cave in the Aqoura village, central Lebanon. Parking the car close to the entrance of the Rouaisss cave on the unpaved road, one can start the ascent on the talus deposits until the rock face is reached. Walking under the 30m limestone ridge above the Rouaiss cave one can find several openings forming the many entrances to this cave.

Geology

Sannine Formation, C4.

Discovery

In March 2001, and while a team of SCL cavers was prospecting the area near Mar Youhanna cave a small entrance was discovered at the same level of the existing cave a few hundred meters away. The entrance of this newly discovered cave was at the bottom of the same cliff of limestone that Mar Youhanna cave is present. The team enlarged the entrance so that it became accessible and a cave was discovered. This cave's development is about 440 m. After enormous effort from SCL cavers a connection was made with Mar Youhanna cave and the total length of the development mounted to about 1km in total. *(IBI)*

References

-Karkabi, S., 1989. Grotte de Mar Youhanna. *Spéléo Club du Liban*, Ouat'ouate, 4: pp81-86.

Photo 1
> The start of the surveying by two SCL cavers
(Photo by Issam Bou Jawdeh)

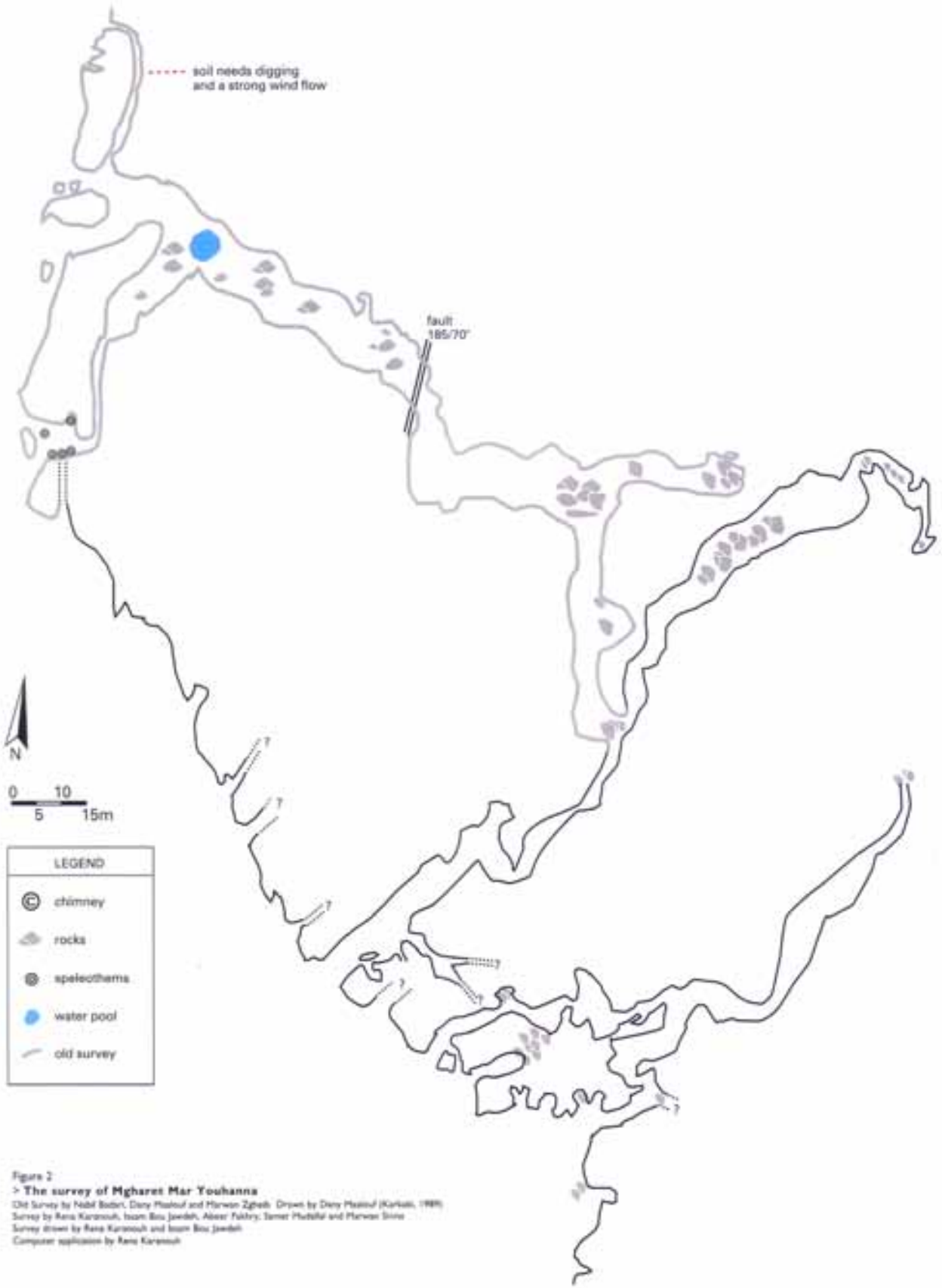


Figure 2
> The survey of Mgharet Mar Youhanna
Old Survey by Nabil Badari, Dany Maalouf and Marwan Zgheib. Drawn by Dany Maalouf (Karkabi, 1989).
Survey by Rana Karanouh, Issam Abu Jawdeh, Abeer Fakhry, Samer Mudallal and Marwan Sinno
Survey drawn by Rana Karanouh and Issam Abu Jawdeh
Computer application by Rana Karanouh

Photo 1
> **The decorated stalagmite**
(Photo by Issam Bou Jawdeh)

Figure 1
> **The general view inside the cave**
(Photo by Issam Bou Jawdeh)

QANA CAVE II

X = 159 359 m	Lambert Co-ordinates
Y = 232 845 m	Topographic Sheet:
Z = 1858 m	Faraya Sheet 1/20 000

Development: 60m

Location

The sinkhole is located on the Plateau of el Qana above Hrajel Village near Faraya in Central Mount Lebanon. An unpaved road connects the high lands of the Qana Plateau with Hrajel village. The cave is located on the side facing the site of the Chabrouh Dam.

Geology

Sannine Formation, C4

Discovery

In the year 2000 a combined geological and speleological expedition was conducted on the plateau by SCL members and AUB (American University of Beirut) students from the geology department. Several caves and sinkholes were discovered one of which was this cave. Due to its interesting cave features this cave was re explored, mapped and photographed in the years 2003 and 2004. The total development of the cave is approximately 100m and is decorated with a variety of speleothems including, propcorn, boxwork, stalactites, stalagmites, 'Christmas Trees' of stalagmites, and crusts. *(BIJ)*

Figure 2
> **The survey of Qana Cave II**
Survey by Hadi Kassamani, Nabil Shehab and Wassim Hamdan
Survey drawn by Hadi Kassamani
Computer application by Jimmy Tawk

Photo 2
> **The Canons** (Photo by Issam Bou Jawdeh)

«هوة» شمسطار لم تدرس علمياً تصدع طفيف تسببه الهزة

شمسطار ـ علي سلمان:

Figure 1
> The As-Safir article, May 3rd, 2001

Photo 1
> The rigging and descent into Houet Chmistar (The majority of the people standing were locals).
(Photo by Issam Slaiz)

Figure 2
> The location of Houet Chmistar

HOUET CHMISTAR

X = 175 373m	Lambert Co-ordinates
Y = 224 922m	Topographic Sheet:
Z = 1268m	Chmistar 1/20,000

Vertical development: 71m

Location

The sinkhole is located just outside the village of Chmistar in the Bekaa Valley.

Geology

Sannine Formation, C4

Discovery

After reading an article (Figure 1) in the Al Safir newspaper in 2001, we contacted the journalist and asked for permission to explore the sinkhole (Photos 1 & 2).

The sinkhole was found to be 71m in depth consisting of a long 43m shaft and a slope at the end with eboulis (Figure 2).

At the bottom of the sinkhole a huge pile of garbage was found (Photo 2). *(RR)*

Photo 2
> The garbage at the bottom of Houet Chmistar
(Photo by Issam Slaiz)

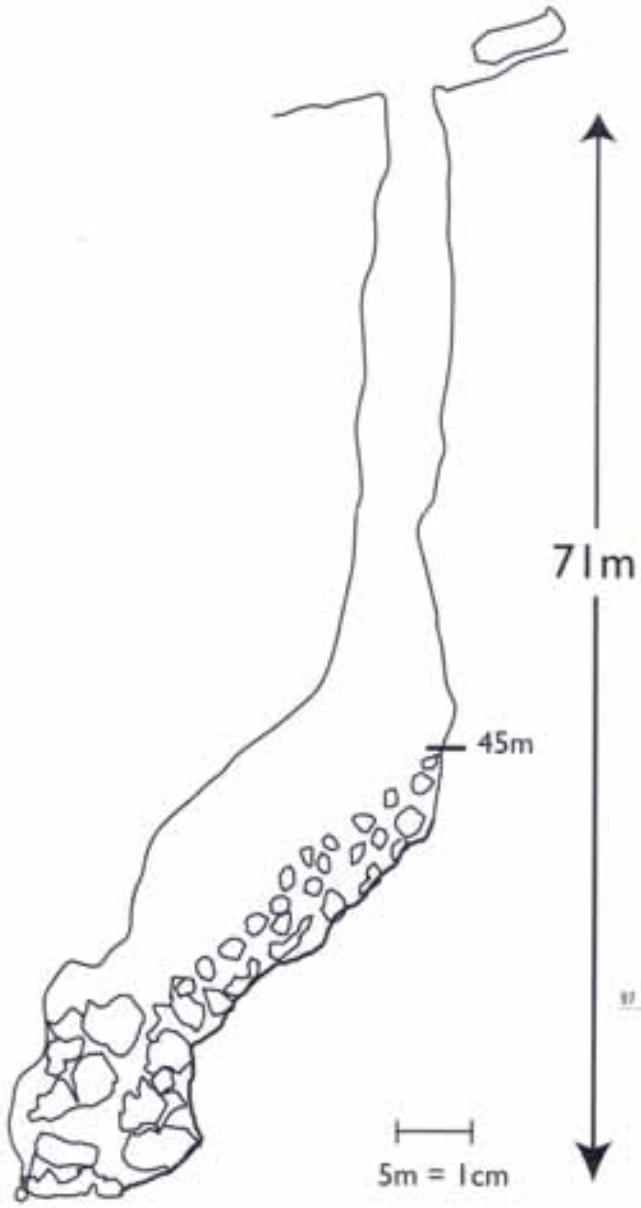


Figure 3
> The survey of Houet Chmistar (elevation view)
Surveyed by Issam Bou Jawdeh, Mohammad Helou and Issam Slaiz
Survey drawn by Issam Bou Jawdeh
Computer application by Rene Karanouh

HOUET EL BADAOUIYÉ

X = 165 911 m	Lambert Co-ordinates
Y = 233 228m	Topographic Sheet:
Z = 2005m	Afka 1/20,000

Vertical development: -205m

Location

The sinkhole is located in the 'Ouyoun el Siman area.

The sinkhole can be accessed using a 4x4 vehicle as most of the track leading to the sinkhole is off-road and a local guide is essential as the area is mined.

Geology

Sannine Formation, C4

Discovery

This cave was first discovered and surveyed in 1966 (Figure 2). The entrance to the sinkhole is a 10m wide circlular opening. The 1966 explorations consisted of using caving ladders and placing them in the middle of this circle using a lateral system of cables (Photo 1).

In the summer of 2000 this cave was re-explored and a survey was finally drawn of this sinkhole and it was finally fully rigged using bolts.

The area surrounding the sinkhole is now littered with landmines from the civil war so it is extremely dangerous to go without a local guide.

Wild pigeons are found in this sinkhole making this a way for the guides to locate the pothole. As soon as we approach the sinkhole most of the pigeons fly off.

The sinkhole consists of a 160m shaft and then three small descents. At the bottom of the 160m shaft snow was discovered during late summer. *UM*

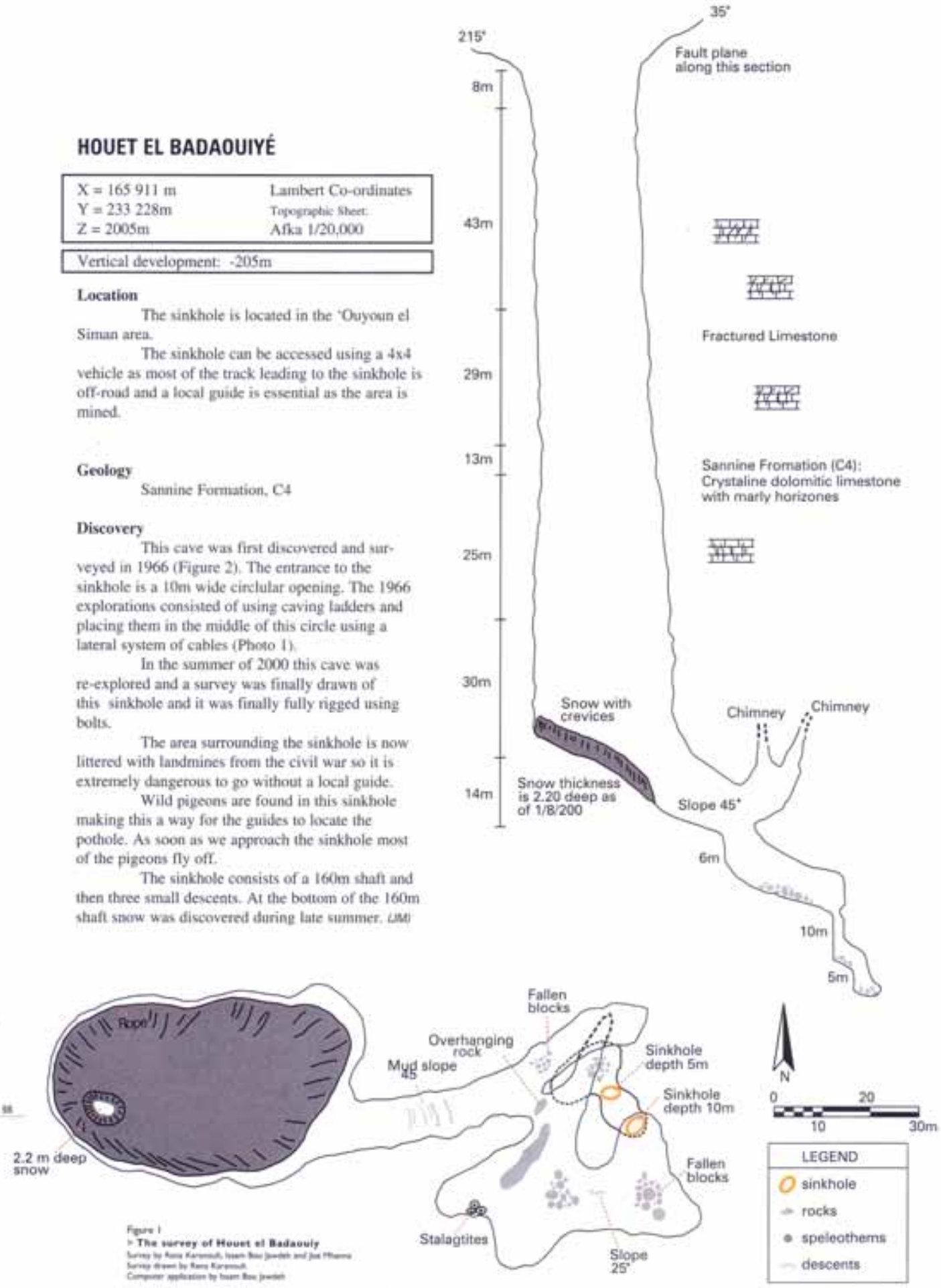


Figure 1
> **The survey of Houet el Badaouiy**
Survey by Rana Karanouh, Issam Bou Jawdeh and Joe Mhanna
Survey drawn by Rana Karanouh
Computer application by Issam Bou Jawdeh

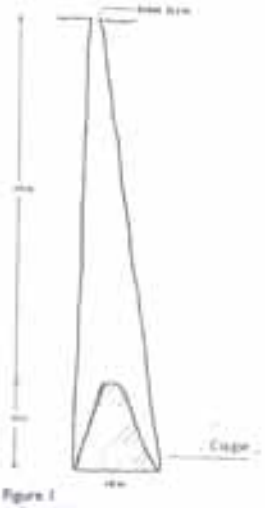


Figure 1
> An old survey of Houet El Badaouly
(SCL archives, A.Gcah thesis)

Figure 2
> The location of Houet El Badaouly

Photo 1
> Descent into Houet El Badaouly in 1966

Photo 2
> The entrance of Houet El Badaouly

Figure 1
> **The location of Mgharet Achou**

Photo 1
> **The large room** (Photo by Issam Bou Jawdeh)

MGHARET ACHOU

X = 177 790m	Lambert Co-ordinates
Y = 272 980m	Topographic Sheet:
Z = 650m	Sir ed Danniye Sheet 1/20,000

Development: 504m

Location

Sir ed Danniye caza is located at the centre of the North Mouhafaza of Lebanon. Mgharet Achou is located in Sir Ed Dinie on the eastern side of Ouadi Nahr El Bared. The cave is located on a steep flank. The cave trends in a general North-south trend with few exceptions where few passages trend in an east-west direction.

Geology

Sannine Formation, C4.

Discovery

The cave was first discovered in the 1964 by SCL members while work was being done on Nabaa Achou. It was re-explored and mapped in 1991 by SCL members for possible utilization as a tourist site (Al Ouat' Ouate, 1991). The cave was then
re-explored by SCL members in 1999 and a continuation of approximately 120m was discovered extending the development of the cave.

It must be noted that locals call this cave Mgharet el Zahlan. Technically this is wrong as another cave which lies directly below Mgharet Achou (in the valley) is known as Mgharet Zahlan and it is the cave that Nabaa Zahlan emerges from.

Mgharet Achou has been studied by SCL members at the request of the Ministry of Tourism for a potential utilization as a tourist cave. *(RB)*

References

- Al Ouat' Ouat 6, 1991. *Speleo Club du Liban.*
-Various reports from the SCL archives.

Photo 2
> **The ascent to the large room** (Photo by Issam Bou Jawdeh)

Photo 3
> **The large room** (Photo by Issam Bou Jawdeh)

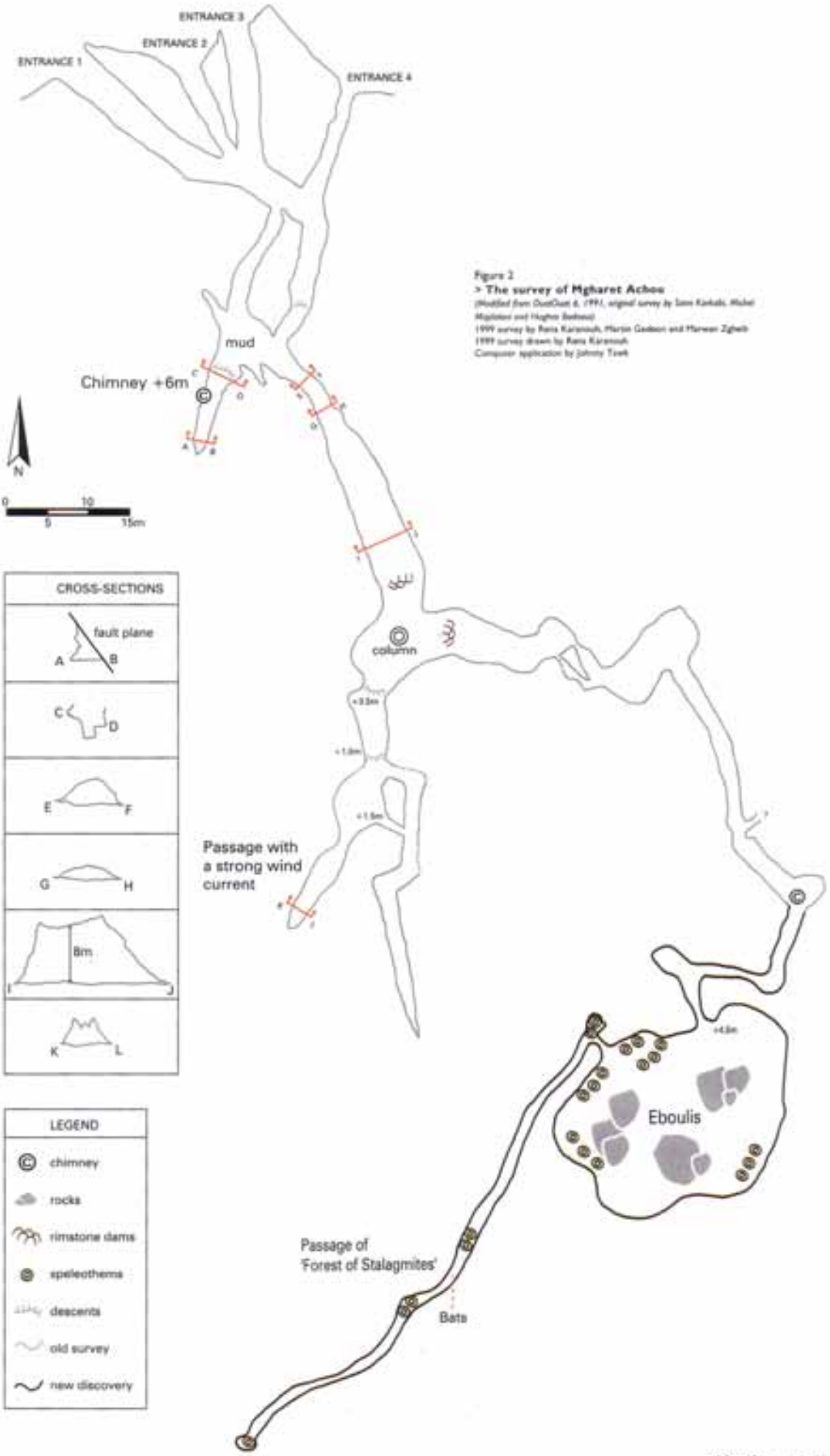


Figure 2
> The survey of Mgharet Achou
(Modified from OutOuat 6, 1991, original survey by Sami Karkabi, Michel Migliaro and Hughes Bedeau)
1999 survey by Rania Karanouh, Marion Gedeon and Marwan Zgheib
1999 survey drawn by Rania Karanouh
Computer application by Johnny Tveit

Photo 1
> **The rope ascent from the sinkhole** (Photo by Issam Bou Jawdeh)

Figure 1
> **The location of Houet Ksaim**

HOUET KSAIM

X = 178 970 m	Lambert Co-ordinates
Y = 269 880 m	Topographic Sheet:
Z = 1170 m	Sir el Dannieh Sheet 1/20.000

Vertical development: 40m

Photo 2
> **A bat inside the cave**
(Photo by Issam Bou Jawdeh)

Location

The sinkhole is located 150 m from the road connecting Bqaa Sifrine village with the Jabal el Aarbain in Sir El Dannieh area, North Lebanon. Park the car near the road at the bifurcation to Zod cave near el-Succar spring and walk 150 m on the el Succar spring covered canal and then descend approximatley 10 meters on the steep slopes towards Nabaa el Ksaim.

Geology

Sannine Formation, C4

Discovery

The cave was first located by SCL members during their works on Mgharet Zod in 1998. Exploration and mapping followed. A sketch survey first published in the Ouat'Ouate Magazine issue number 11.

In 2003 it was photographed and re-explored. A bat community was found inside the cave. This sinkhole is being used as a training sinkhole for SCL members living in the north of Lebanon. *(IBJ)*

Figure 2
> **The survey of Houet Ksaim** (plan view)
Survey by Rana Karoonah, Samer Mudallal , Abed Dayeh
Survey drawn by Rana Karoonah
(Computer application by Johnny Tawk

HOUET SIDR EL HAJAL

X = 139 313 m	Lambert Co-ordinates
Y = 179 639 m	Topographic Sheet:
Z = 1460 m	Jezzine Sheet 1/20,000

Vertical development: 20m

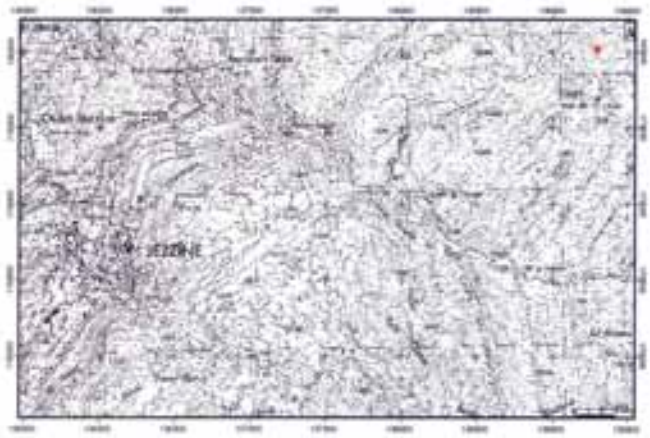


Figure 1
> The location of Houet Sidr el Hajal

Location

It is located in Jabal Niha in an area called Upper Aazibi.

Geology

Sannine Formation, C4

Discovery

Passing through the agricultural fields of the area the cars are parked where the road ends and a half hour hike passing two high hills leads us to the opening of the sinkhole. The sinkhole was found to be full of garbage and empty cans. It is around 20m deep consisting of two pits. Many speleothems were identified such as popcorn, helictites, stalagmites, stalactites, micro-pearls, and calcite curtains.

Photo 1
> The rope descent
(Photo by Rana Karnoouh)

Photo 2
> The garbage at the bottom of the sinkhole
(Photo by Hadi Kassamani)

Photo 3
> The view from the bottom

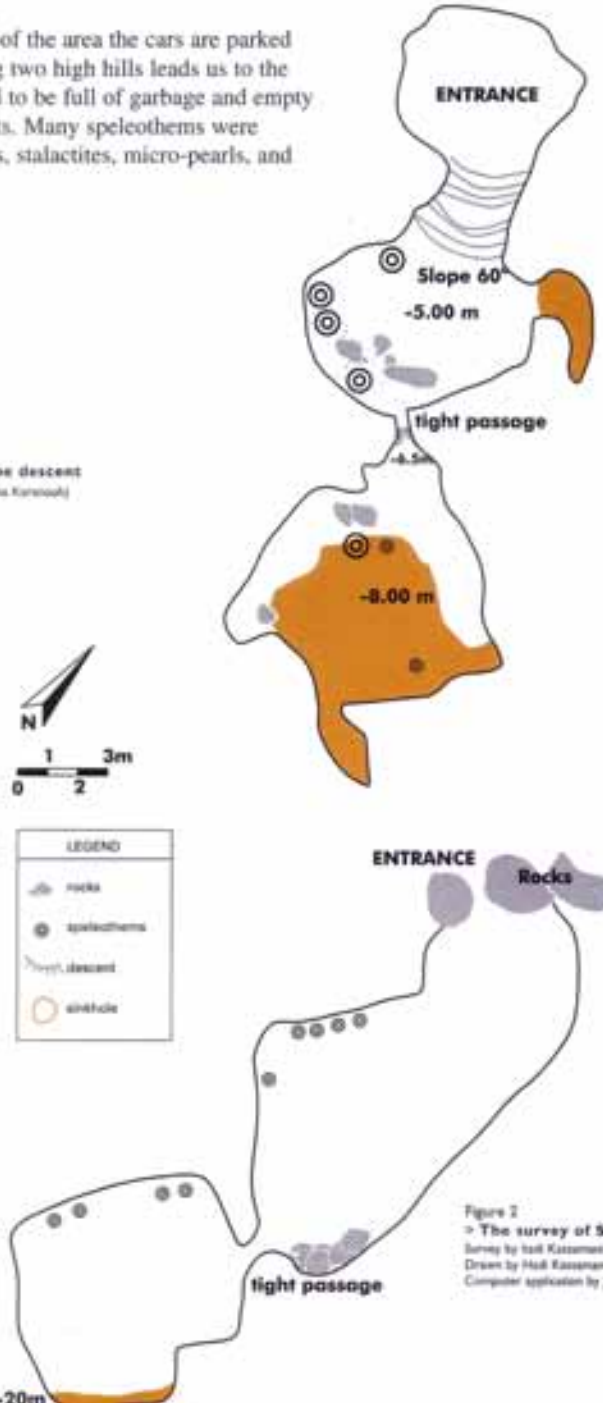


Figure 2
> The survey of Sidr El Hajal
Survey by Hadi Kassamani and Johnny Tawk
Drawn by Hadi Kassamani
Computer application by Johnny Tawk

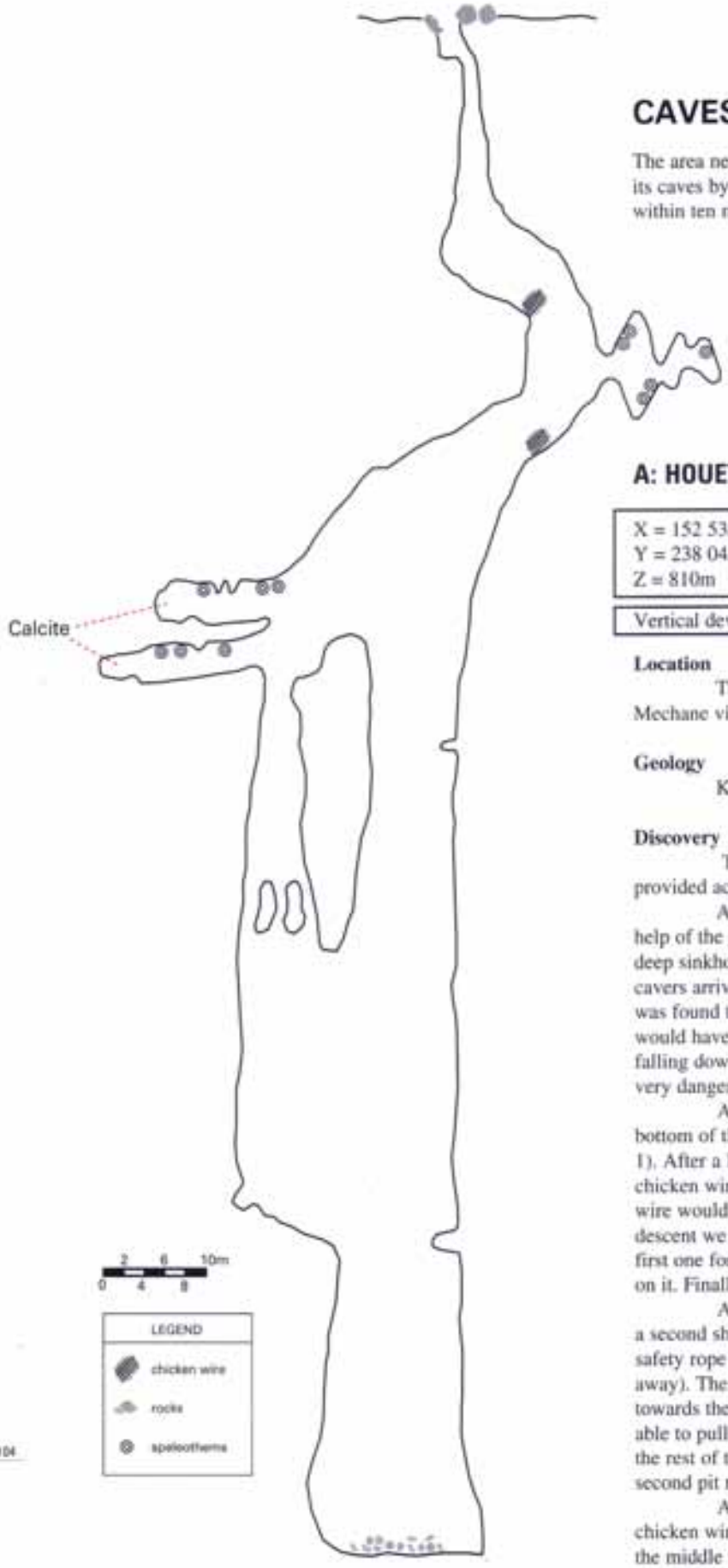


Figure 1
> The survey of Houet el Aaqroub (section view)
Survey by Fadi Nader, Tony Comaty, Hiba Aboul Hosn, Nabil Shehab, Marlon Gedeon.
Survey drawn by Fadi Nader, Tony Comaty and Rana Karanouh.
Computer application by Rana Karanouh.

CAVES OF THE MECHANE AREA

The area near Mechane village is undergoing a detailed study of its caves by the SCL. The three caves that follow are located within ten minutes of each other.

A: HOUET AAQROUB

X = 152 535m	Lambert Co-ordinates
Y = 238 045m	Topographic Sheet:
Z = 810m	Faraya 1/10,000

Vertical development: 155m

Location

The sinkhole is reached through a road track near Mechane village (See Figure 1).

Geology

Kesrouane Formation, J4

Discovery

The sinkhole was discovered when nearby roadworks provided access to the area.

After locating the entrance of this sinkhole with the help of the goat herder the SCL cavers proceeded to explore this deep sinkhole. After descending for approximately 30m, the cavers arrived at the large room with a huge amount of eboulis. It was found that if we wanted to continue our exploration we would have to block the eboulis, which lay on a 40° slope, from falling down the rest of the sinkhole as the situation would be very dangerous for anyone descending.

A plan was devised to place chicken wire on the bottom of the room to catch any rocks that might fall (see Photo 1). After a lot of effort the cavers were successful in rigging the chicken wire. A few tests were conducted to see if the chicken wire would hold the weight of large rocks. Upon continuing the descent we placed another chicken wire about 15m below the first one for extra safety as there was another slope with eboulis on it. Finally the cavers descended to find a 155m sinkhole.

At approximately 30m into the sinkhole an opening of a second shaft could be seen. One of our cavers descended with a safety rope and hook to get him to the other side (that was 10m away). The anchor-like hook was attached to a rope and thrown towards the rocks. After a few trials it caught and the caver was able to pull himself towards the other side and rig a rope so that the rest of the cavers could descend. It was discovered that this second pit reconnects with the primary shaft after about 50m.

A few years later this sinkhole was re-explored and the chicken wire was found to still be attached except for a hole in the middle where corrosion had made the wire weak allowing rocks to fall through. *(RK)*

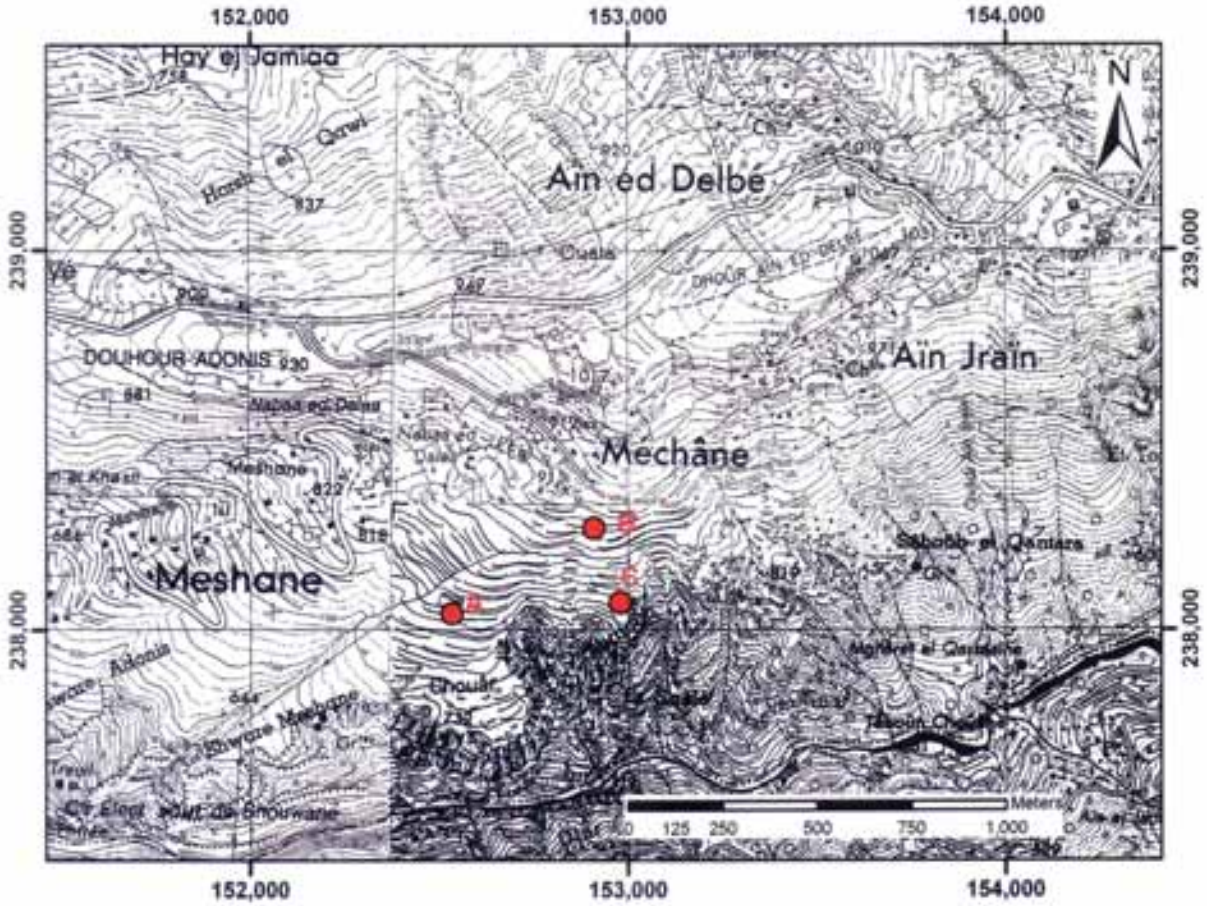


Figure 2
> The topographic map of the Mechane area:
A = Houet Aaqroub, B = Houet Mechane 4, C = Houet Mechane 2

Photo 1
> Marwan Zgheib and Elie Hankashe
(Photo by Tony Comay)

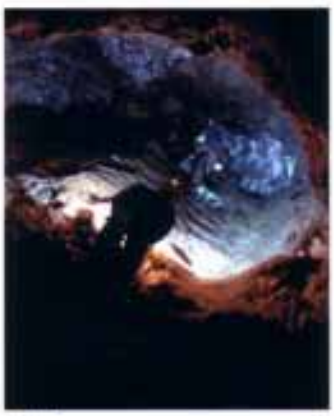


Photo 2
> The first descent of the sinkhole
(Photo by Rania Karanouh)

Photo 3
> The rocks stopped by the first chicken wire
(Photo by Rania Karanouh)

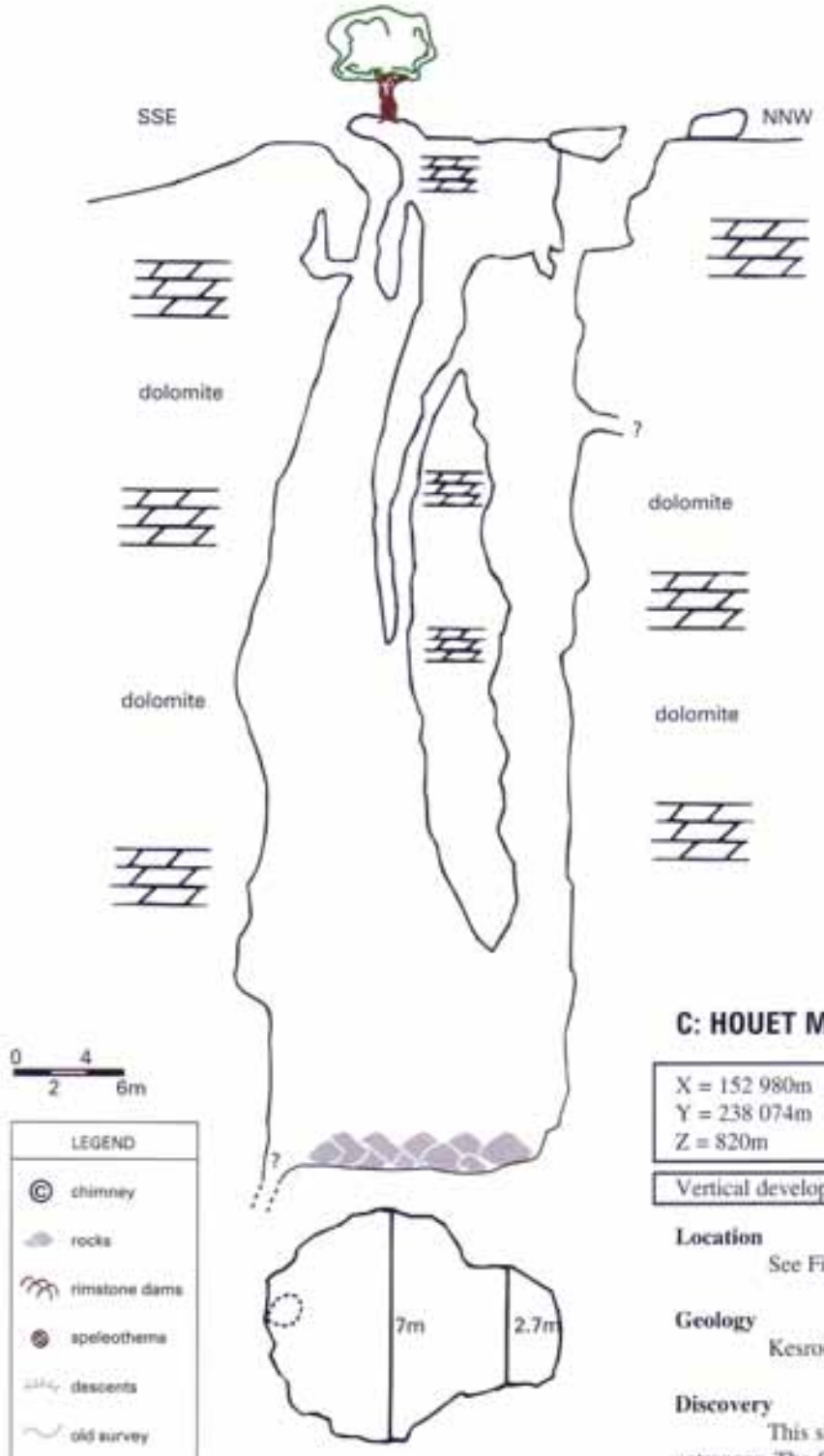


Figure 3
> The survey of Houet **Mechane 2**
Surveyed by Issam Bou Jawdeh, Bsbri Karamfol, Fadi Haidar
Drawn by Issam Bou Jawdeh
Computer application by Issam Bou Jawdeh

C: HOUET MECHANE 2

X = 152 980m	Lambert Co-ordinates
Y = 238 074m	Topographic Sheet:
Z = 820m	Faraya 1/10,000

Vertical development: 15m

Location

See Figure 1

Geology

Kesrouane Formation, J4

Discovery

This sinkhole was found to have two entrances. The first section had to be cleaned so that the accumulating debris and mud would not fall on cavers at a later stage.

The sinkhole was found to be 15m deep.

(RK)

B: HOUET MECHANE 4

X = 152 910m	Lambert Co-ordinates
Y = 238 270m	Topographic Sheet:
Z = 885m	Faraya 1/10,000

Vertical development: 40m

Location

See Figure 1

Geology

Kesrouane Formation, J4

Discovery

This cave was discovered by the SCL in the year 2000. A full exploration revealed that the cave
consisted of six levels connected by pits, the longest of which measuring 8m (figures 4,5,6).

At the bottom of the second pit a small chamber was discovered behind a man-made wall. A skeleton with broken pottery and some complete pots were found. Although falling rocks had smashed the bones some were found intact as well as parts of the skull. A single sea shell with a hole in it was also found.

Tested by Dr. Leila Badr at the American University of Beirut's Archaeology Department the pottery was found to date from the early bronze (EB I) period 3100-2900 BC or Early Bronze (EB II) 2900-2650 BC. The two complete pots discovered measured 8.5cm by 8cm and 17cm by 15cm. *(RK)*

Photo 5
> **Four different levels as seen in level 1** (Photo by Rana Karanouh)

Photo 4
> **The entrance to Houet Mechane 4** (Photo by Rana Karanouh)

Photo 6
> **The re-belay at the top of the first descent** (Photo by Rana Karanouh)

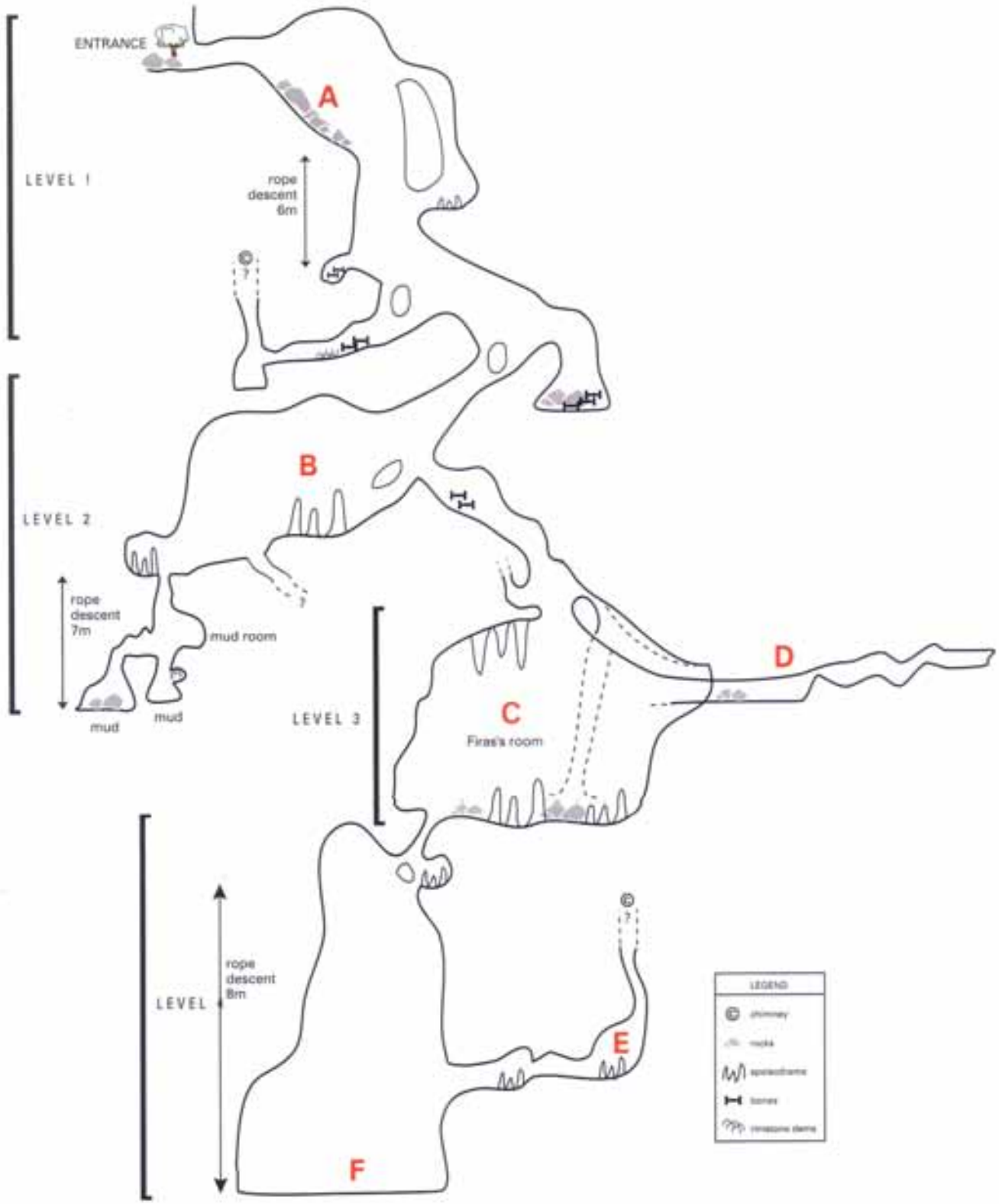


Figure 4
> The survey of Houet Mechane 4 (section view)
Surveyed by Rana Karabouh, Hadi Kassarian, Wissam Hamdan, Hiba al Halou, Ezzedean Jradi, Karen Mouarbache, Nabil Shahid
Drawn by Rana Karabouh
Computer application by Rana Karabouh

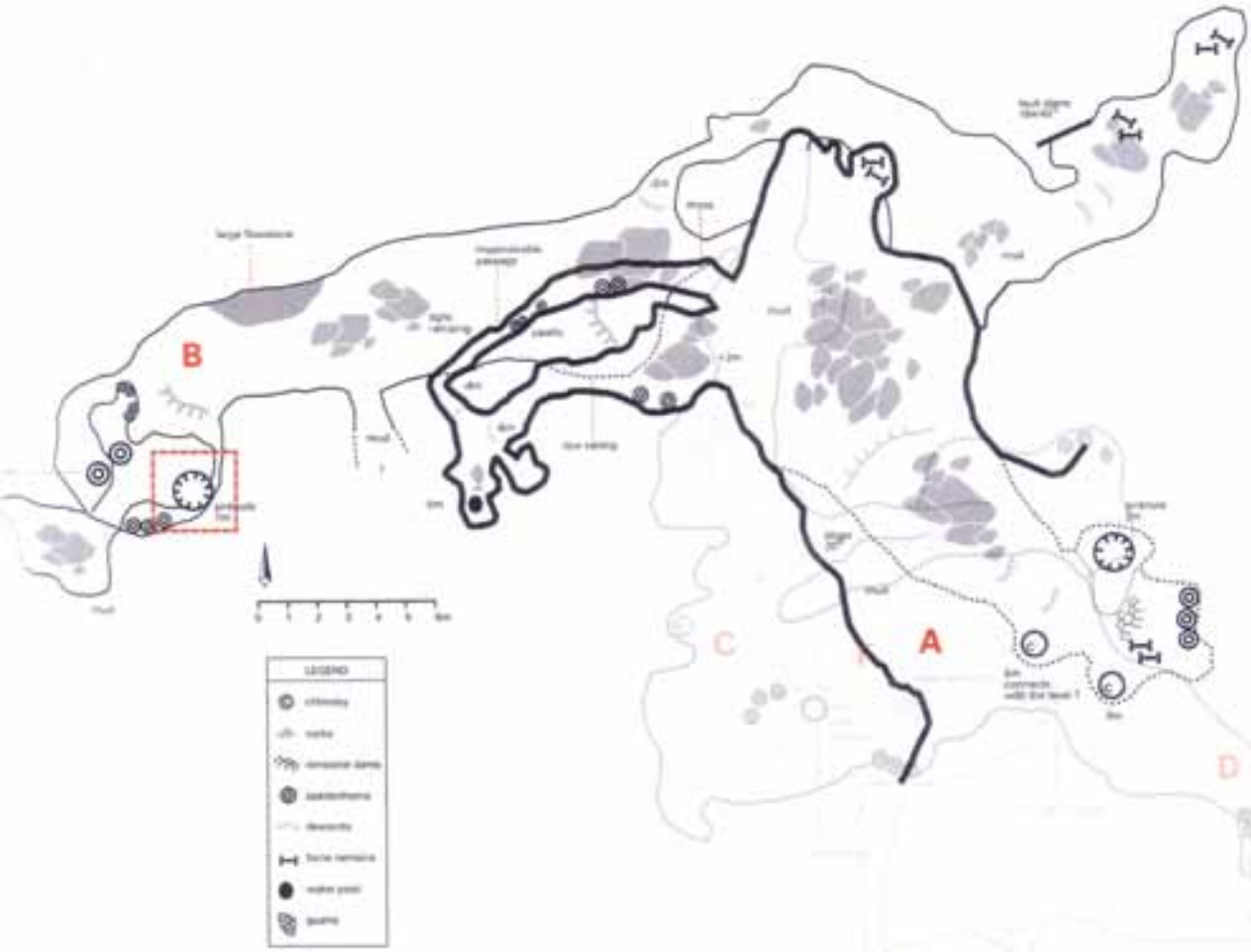


Figure 5
> The survey of Houet **Mechane 4** level 1 and 2 (plan view)
(the dotted square indicates the location of photo 7)

Photo 7
> **The sinkhole located in level 2** (the dotted square in figure 5 indicates the location)
(Photo by Rena Karanouki)

Figure 1
> The location of Mgharet Achou

MGHARET ACHOU

X = 177 790m	Lambert Co-ordinates
Y = 272 980m	Topographic Sheet:
Z = 650m	Sir ed Danniye Sheet 1/20,000

Development: 504m

Location

Sir ed Danniye caza is located at the centre of the North Mouhafaza of Lebanon. Mgharet Achou is located in Sir Ed Dinie on the eastern side of Ouadi Nahr El Bared. The cave is located on a steep flank. The cave trends in a general North-south trend with few exceptions where few passages trend in an east-west direction.

Geology

Sannine Formation, C4.

Discovery

The cave was first discovered in the 1964 by SCL members while work was being done on Nahaa Achou. It was re-explored and mapped in 1991 by SCL members for possible utilization as a tourist site (Al Ouat' Ouate, 1991). The cave was then
re-explored by SCL members in 1999 and a continuation of approximately 120m was discovered extending the development of the cave.

It must be noted that locals call this cave Mgharet el Zahlan. Technically this is wrong as another cave which lies directly below Mgharet Achou (in the valley) is known as Mgharet Zahlan and it is the cave that Nahaa Zahlan emerges from.

Mgharet Achou has been studied by SCL members at the request of the Ministry of Tourism for a potential utilization as a tourist cave. (RB)

References

- Al Ouat' Ouat 6, 1991. *Speleo Club du Liban*.
-Various reports from the SCL archives.

Photo 1
> The large room (Photo by Issam Bou Jawdeh)

Photo 2
> The ascent to the large room (Photo by Issam Bou Jawdeh)

Photo 3
> The large room (Photo by Issam Bou Jawdeh)

Photo 9
> **The archeological remains found in the A section of Mechane cave** (Photo by Johnny Tawk)

MARJABA MINES

X = 152 500m – 152 700m	Lambert Co-ordinates
Y = 220 000 – 220 500	Topographic Sheet:
Z = 1104m (above sea level)	Faraya 1/10,000

Development: 570m

Location and Exploration

The Marjaba souterains or more precisely iron mines are located slightly north from the Marjaba village in central Mount Lebanon (Figure 1). An unpaved road connects the village with the abandoned mines.

Marjaba mines were first explored by SCL in the year 2002. The largest of these mines has two opening connected by a shaft in the center of the cave (Figure 2). The total development of the largest mine is approximately 570m. Most of the sections of the largest mine are walkable except at its end where a natural cave was encountered and ramping is required (Figure 2).

It is a matter of speculations to know when the ore was first mined. It is believed that during the ancient civilizations extractions were limited to picking up iron-rich rocks from visible outcrops. However, 2000 years ago Romans explored and exploited those mines opening pits and adits (Karkhanian, 1974). Since then it has been used by the many different civilizations that have ruled over these lands.

In 1952 the Marjaba Mining Company received a mining concession over an area of 9km^2 near Marjaba village. Mining continued for seven years producing 50,000 tons of iron ore per year. Most of the ore was sold mainly to West Germany and France (Karkhanian, 1974). In the 1970's the Marjaba Mining Company re-assessed the mine and the reserves were found to be inappropriate for exploitation (Karkhanian, 1974).

Today they are abandoned and only some locals, eager for adventure, venture inside.

Geology

The mine was established in the karstic dolomitic limestone of the Kesrouane Formation which belongs to the Jurassic Period. At the end of the main tunnel there is a small natural karstic cavity, which might have developed before and/or during the emplacement of the ore and/or after. Besides this natural cave at the end, small karstic cavities with small speleothems of calcite were observed on the walls of the mine.

The ore body, as speculated by many, might have developed on exposed palaeokarstic terrain of the Kesrouane Formation during the Early Cretaceous Periods before and during the deposition of the Chouf Sandstone Formation.*(IRJ)*

Photo 2
> **One of the galleries in Marjaba mine**
(Photo Issam Bou Jawdah)

Photo 1
> **The opening of the biggest of the iron mines in Marjaba**
(Photo Issam Bou Jawdah)

Photo 3
> **The tools used in the excavation process in Marjaba mines**
(Photo Issam Bou Jawdah)

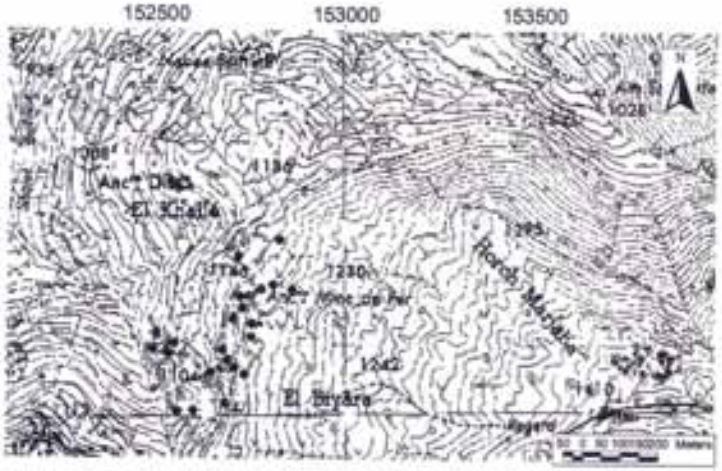


Figure 1
> Map showing the location of Marjaba iron mines with more than ten openings as indicated by the black dots on the map.

Photo 4
> Two passages connecting in Marjaba mine (Photo: Issam Bou Jawdeh)

Figure 2
> Survey of the biggest mine in Marjaba with more than 570m development.

Survey by Rana Karanouh, Issam Bou Jawdeh, Rocco Massad and Hadi Kassarani
Survey drawn by Issam Bou Jawdeh
Computer application by Johnny Tawk

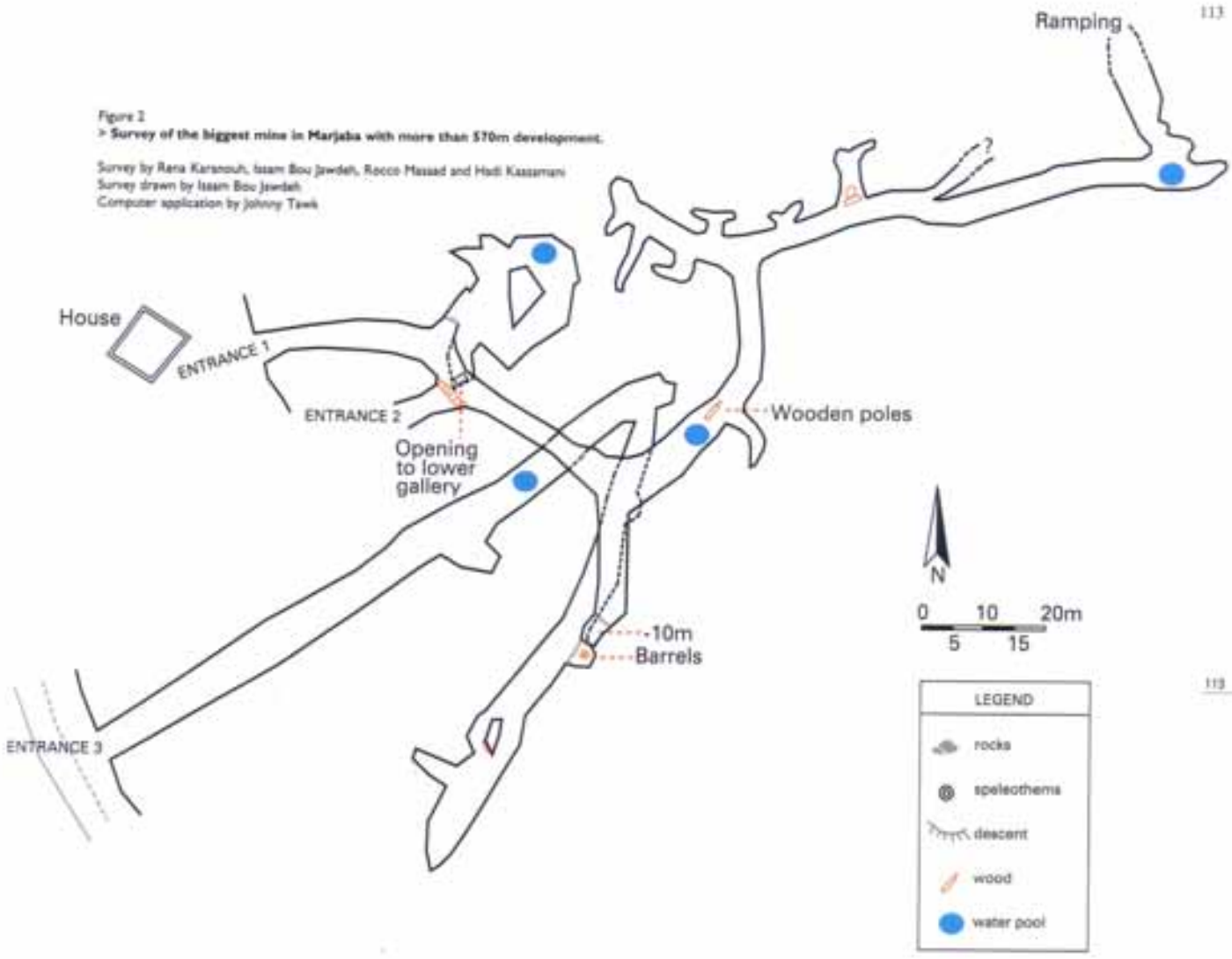


Figure 1
> **The location of Mgharet el Maadan**

Photo 1
> **Hematite and Limonite deposits covered with calcite coating**
(Photo by Rana Karanouh)

MGHARET EL MAADAN

X = 153 462m	Lambert Co-ordinates
Y = 238 502m	Topographic Sheet:
Z = 898m	Faraya 1/10,000

Vertical development: 50m

Location and Exploration

Mgharet el Maadan, as named by locals, is in fact a sinkhole, located at the eastern extremity of Mechane village (Figure 1) on the cliffs facing the valley of Nahr Ibrahim.

The souterrain structure of Mechane village was explored and mapped in 2002 and 2004 by SCL cavers.

This cave is actually a sinkhole (Figure 1) that was mined for its richness in iron deposits. The mine was operational during the middle of the last century. The production was limited to local use.

The sinkhole has several entrances. One of the entrances is walkable and the descent into the sinkhole is quite easy for a path was constructed for the miners to descend and work at the bottom. It has a total depth of approximately 50m. Collapsed rocks and blocks are present in the cave with several excavated pits at the bottom, dug in search of iron.

Geology

The ore body is in the form of veins in the dolomite of the Kesrouane Formation in which the cave is present and iron rich deposits are present on the floor of the cave and are covered with calcite coatings. Iron rich deposits are probably due to diagenesis, karstification and exposure. *(IBJ)*

Photo 2
> **The hematite and limonite deposits on the floor of Mgharet el Maadan covered with a crust of calcite**
(Photo by Rana Karanouh)

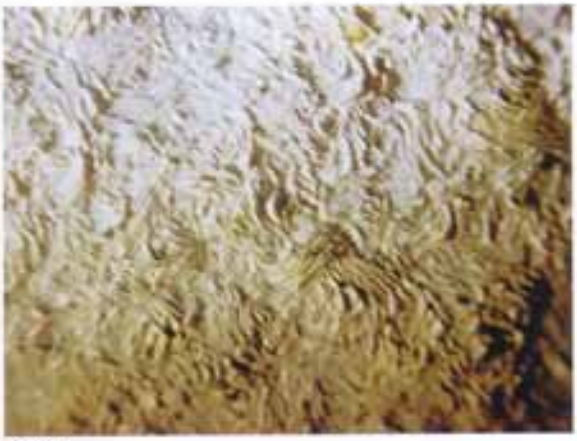
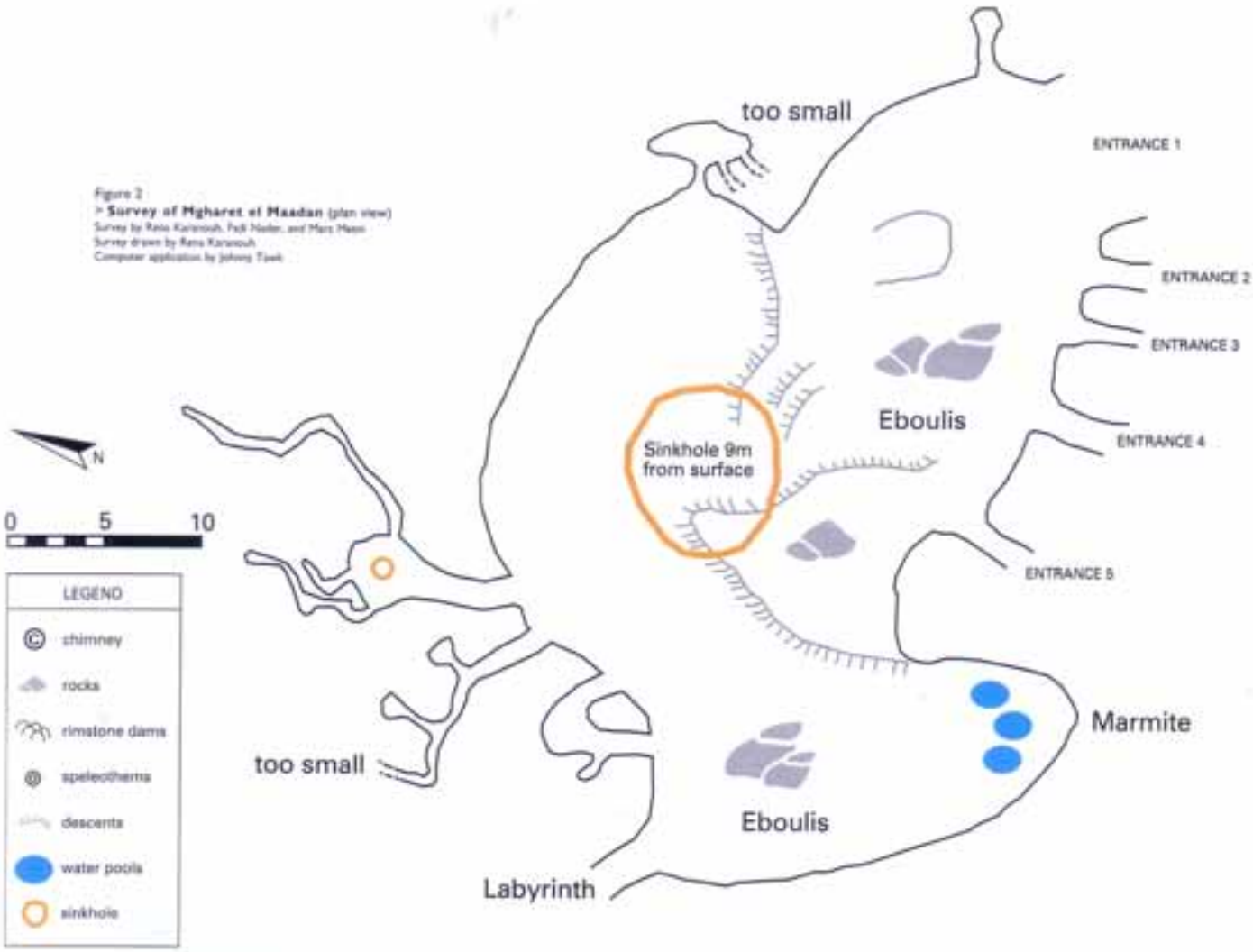


Photo 3
> **Unidentified mineral deposits on the walls of Mgharet el Maadan.**
(Photo by Rana Karanouh)

Figure 2
> **Survey of Mgharet el Maadan** (plan view)
Survey by Reno Karanouh, Fadi Nader, and Marc Maon
Survey drawn by Reno Karanouh
Computer application by Johnny Tawk



TAR MINES OF SOHMOR

X = 145 788m	Lambert Co-ordinates
Y = 174 100m	Topographic Sheet:
Z = 970m (above sea level)	Mashghara 1/20,000

Vertical development: 65m

Location and Exploration

The Sohmor souterrains are located south of the Sohmor village, close to Tairoun valley in Southern Bekaa (Figure 1). An unpaved road connects Sohmor village to these souterrains.

Sohmor mines were first explored by SCL cavers in 2001. Several pits were discovered and were probably drilled for exploration purposes. The deepest of these pits reaches 15m. However, the abandoned tar mine has two interconnected shafts approximately 65m deep and 40m apart (Figure 2). The shafts are connected at the bottom by a main tunnel.

As early as the Phoenicians times, the tar was discovered and used for smearing boats and houses. Exploitation and extraction boomed during World War II and the middle of the last century. The bulk of the production was mostly directed to local use (as was pointed out by one of the locals).

Geology

The mine is present in the karstic limestone of the Eocene Formation. The mine has developed along an E-W fault hosting a seepage of approximately 20cm in thickness.

Several types of tar speleothem-like features were observed in the Sohmor mine. A curtain of tar was observed with a beautiful folded base (Photos 1 & 2). In addition to this curtain, a cluster of stalactites reaching 2m in length were documented (photo 3) in addition to popcorn of different shapes and sizes and flow-like structures on the walls (photo 4). *(IBJ)*

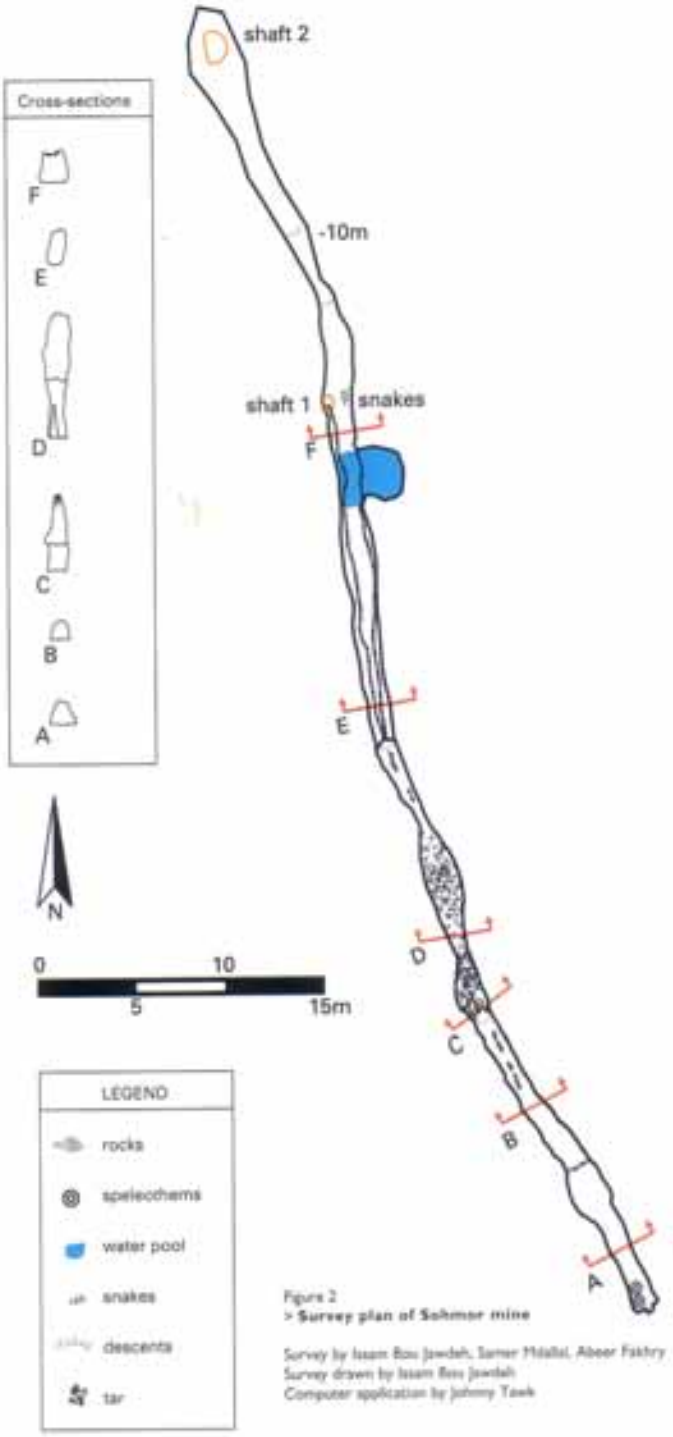


Figure 2
> Survey plan of Sohmor mine

Survey by Issam Bou Jawdeh, Samer Mdallal, Abeer Fakhry
Survey drawn by Issam Bou Jawdeh
Computer application by Johnny Tawk

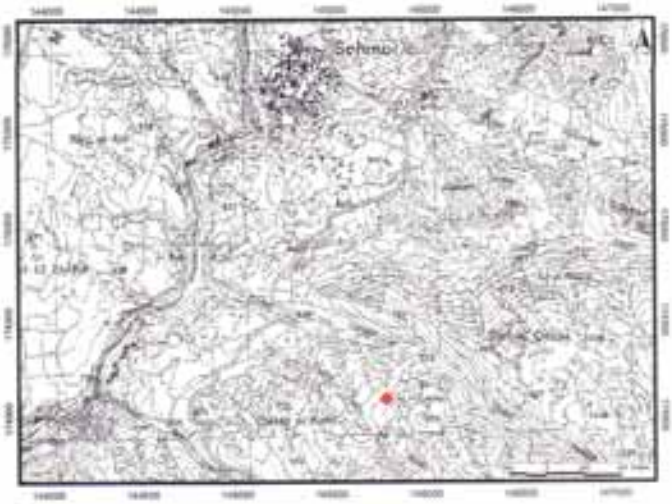


Figure 1
> Location map of Sohmor mine

Photo 1
> The tar curtain discovered in Sohmor mine (Photo by Rana Karanouh)

Photo 2
> **The tar curtain in the Sohmor mine** (Photo by Rana Karanouh)

Photo 3
> **The tar stalactites in the Sohmor mine**
(Photo by Issam Bou Jawdah)

Photo 4
> **The tar popcorn in the Sohmor mine**
(Photo by Issam Bou Jawdah)

Figure 3
> **Survey of Sohmor mine** (elevation view)

Survey by Issam Bou Jawdeh, Samer Mudallal, Abeer Fakhry
Survey drawn by Issam Bou Jawdah
Computer application by Johnny Tawk

MGHARET TANNOURINE

X = 164 949m	Lambert Co-ordinates
Y = 250 283m	Topographic Sheet:
Z = 1370m (above sea level)	Hasroun 1/20,000
Development: 70m	

Figure 1
> Location map of Mgharet Tannourine

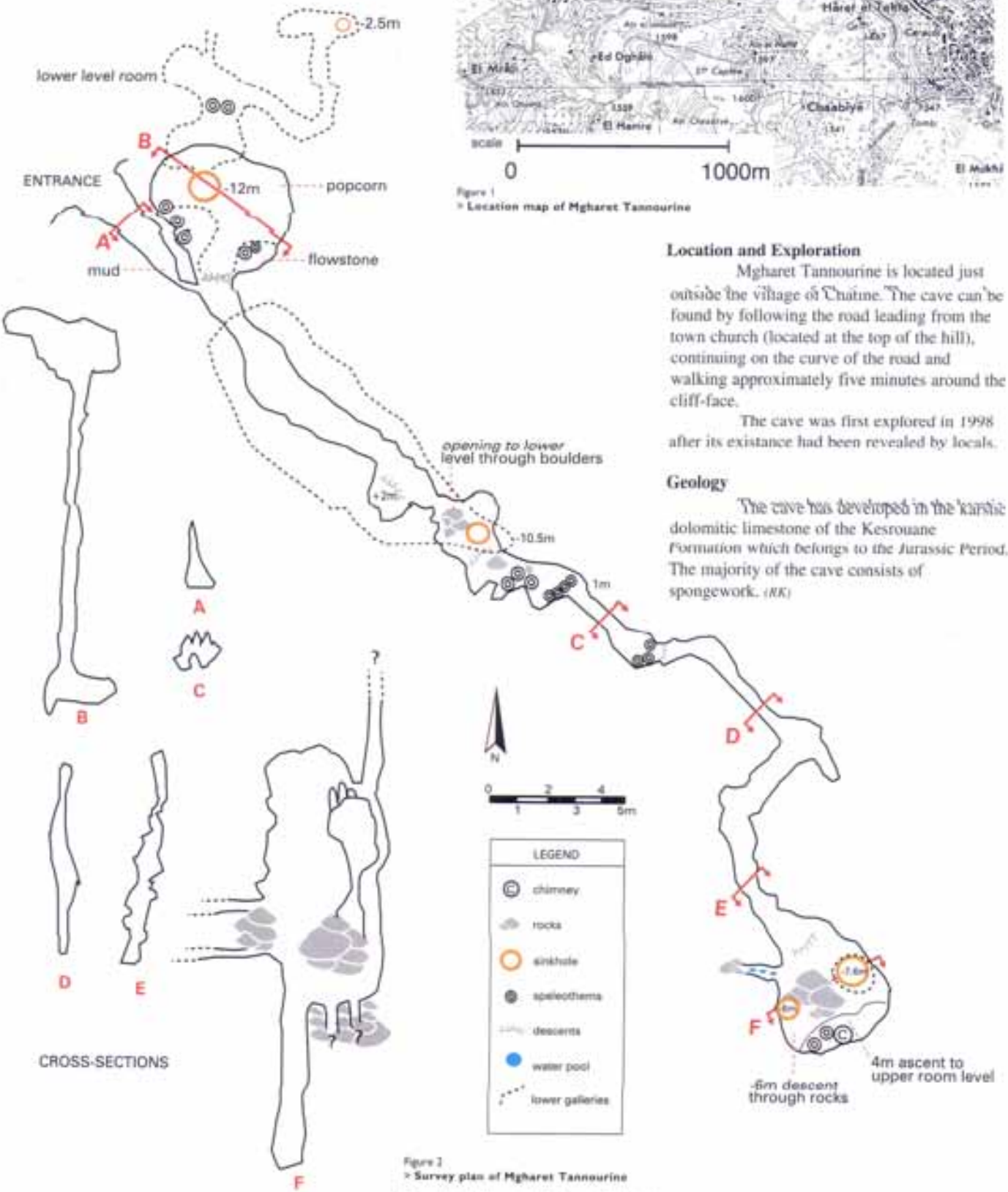


Figure 2
> Survey plan of Mgharet Tannourine

Survey by Bashir Khouri, Hadi Kassarani, Waleed Jad

Location and Exploration

Mgharet Tannourine is located just outside the village of Chatine. The cave can be found by following the road leading from the town church (located at the top of the hill), continuing on the curve of the road and walking approximately five minutes around the cliff-face.

The cave was first explored in 1998 after its existance had been revealed by locals.

Geology

The cave has developed in the karstic dolomitic limestone of the Kesrouane Formation which belongs to the Jurassic Period. The majority of the cave consists of spongework. *(RK)*

Photo 1
> The entrance of Mgharet Tannourine
(Photo by Rana Karanouh)

Photo 2
> The tight passages inside the cave
(Photo by Rana Karanouh)

Photo 3
> Surveying the cave
(Photo by Rana Karanouh)

Photo 4
> The spongework of Tannourine cave
(Photo by Rana Karanouh)