MAPS OF CAVES SURVEYED BY SAUDI GEOLOGICAL SURVEY, KINGDOM OF SAUDI ARABIA

COMPILED BY

SAUDI CAVE UNIT

Abstract

This collection consists of nineteen maps and sketches of caves in Saudi Arabia explored by the Saudi Geological Survey Cave Unit between 2000 and 2004. Twelve are limestone caves located in the Umm er Radhuma or Aruma formations or in the overlying, unnamed Tsm formation. Seven are lava caves, located in Harrats Khaybar, Ithnayn, Kishb and Nawasif-Buqum. Each map or sketch is accompanied by a brief description of the cave itself, its geological setting and its location. A discussion is included of techniques and problems related to surveying caves in the Saudi Arabian environment as well as a brief history of cave exploration and mapping in Saudi Arabia.

خرائط الكهوف
التي تم مسحها بواسطة هيئة المساحة الجيولوجية السعودية
في المملكة العربية السعودية

تجميع
وحدة الكهوف السعودية

الخلاصة

تتألف هذه المجموعة من تسع عشرة خريطة ورسم تخطيطي للكهوف التي استكشفتها وحدة الكهوف بهيئة المساحة الجيولوجية السعودية في المملكة العربية السعودية بين عامي 2000 و 2004 م . وتقع اثنا عشر كهفاً منها وهي كهوف حجر جيري في متكون أم الرضومة أو متكون عرمة أو داخل المتكون الذي يعلوها والتابع للعصر الثلاثي والذي لم تتم تسميته بعد . وسبعة من هذه الكهوف هي كهوف لابية ، تقع في حرة خيبر وحرة اثنين وحرة كشب ونواصف البقوم. وكل خريطة أو رسم تخطيطي للكهف مصحوب بوصف مختصر للكهف وتوضيح لوضعه الجيولوجي وموقعه.وتشمل الدراسة التقنيات والمشكلات المتعلقة بمسح الكهوف في بيئة المملكة العربية السعودية ، بالإضافة إلى ملخص لتاريخ استكشاف وتخريط الكهوف في المملكة العربية السعودية.

INTRODUCTION

Sketches of caves located in Saudi Arabia have probably been made for centuries, but the production of accurate cave maps based on the use of survey compasses, measuring tapes and clinometers is a very recent development. This data file brings together nineteen maps and sketches of caves explored by the Saudi Geological Survey Cave Unit during the years 2000-2004. Their location and geological setting are indicated in Figure 1. One of these caves was found within the city limits of Riyadh, possibly in the Hanifa Formation. Four of the caves are located on the As Sulb Plateau in an unnamed Miocene-Pliocene unit of calcareous sandstone, marl and limestone sometimes referred to as the Tertiary Sandstone and Marl (Tsm) formation or in the underlying Umm-Er-Radhuma Formation of fine-grained and arenitic limestones and chert-bearing dolomites. Seven are found in the northern regions of the Kingdom, in chalky limestone of the Umm-Er-Radhuma Formation interbedded with gypsum and possibly affected by the Aba al Qur dissolution collapse structure. Finally, seven more are lava caves, located in Harrats Khaybar, Ithnayn, Kishb and Nawasif-Buqum.

Fifteen of the above-mentioned caves were considered significant enough to warrant a survey using compass, a laser device for measuring distances, a clinometer (when needed) and the setting of survey stations. Two of the caves (Azizia Collapse and Bushy Cave) were considered too small or insignificant for surveying and were only sketched. Two more (Munbateh Blowhole and Dahl Abu Rijl Maksura were cursorily measured and sketched but not surveyed due to danger of collapse.

Each map or sketch in this collection contains a BCRA Survey Grade indicating its accuracy. Standards for cave surveys have been set by the British Cave Research Association (BCRA) and are accepted by the International Union of Speleology (UIS) and many speleological organizations around the world. BCRA survey grades are given in tables 1 and 2.

The nineteen cave maps and sketches in this collection represent only a few of the many caves located and/or explored by the SGS Cave Unit between 2000 and 2004 (SGS, 2005) and it is expected that more collections of cave maps and sketches, based on these explorations, will be compiled and published in the future.

SURVEY EQUIPMENT FOR USE IN DESERT CAVES

Technically correct cave surveys require—at the very least—the use of a compass and tape to measure the azimuth and distance between stations set up wherever the cave deviates significantly from "straight ahead." The compass should be a surveyor's compass with a sighting system for precise readings, such as those manufactured by Brunton and Suunto. The tape should be of fiberglass or metal so there will be no distortion due to stretching. In most cases, a precise clinometer is required for measuring vertical angles between stations.

The Saudi Geological Survey Cave Unit pioneered the underground use of the Disto laser device as a substitute for survey tape. In all 19 of the caves listed in this collection, the Disto was used successfully for the precise measurement of distances. Manufactured by Leica, the Disto operates on a range of 0.2-200m and is accurate to within 1.5mm. Although many cave walls have extremely irregular surfaces, the Disto usually gave an accurate reading on the first try and its advantages over survey tape are numerous. For example, ceiling height could be measured instead of estimated and the exact depth of deep pits could be determined in an instant. But the main advantage of the Disto is immediately noticed during the routine measurements which must be made at each station: distances up, down, left and right of the station must be measured or estimated along with the distance to the next station. All of these measurements can be performed at a station in less than a minute with the Disto, resulting in surveys which are much faster and much more accurate than those carried out with tape.

The principal drawback to the Disto is its high price (c. $500 US). Cheaper devices using sound waves were found to be inoperable in caves. It is possible that the Disto might not work properly in a foggy environment. This could not be properly tested in Saudi Arabia's caves, many of which have a humidity of 45 to 70% (relatively low for caves). However, it should be mentioned that the Disto performed well in the Steam Room of Gecko Cave where the humidity reached 97 percent.

While clinometers are essential for cave surveys in many parts of the world, a large number of desert caves in Saudi Arabia feature a vertical entrance shaft above flat, horizontal passages. The depth of these shafts could often be measured using the Disto, with no need for a clinometer. In most cases, a Suunto clinometer was used in these caves, but, when numerous vertical angles had to be measured, a Smartlevel digital clinometer was substituted. Like the Disto for distances, the Smartlevel proved easier and faster to use than traditional surveying instruments.

In most cases, flagging tape suspended from the ceiling, sidewalls or breakdown were used as stations. The station number was written near the lower end of the flagging tape using a ballpoint pen. One advantage of this approach over the use of tripods as stations is that the flagging tape—if left in place—is still visible during

CAVE-BEARING GEOLOGIC FORMATIONS OF SAUDI ARABIA

MAJOR LIMESTONE OUTCROPS AND LAVA FLOWS (HARRATS)

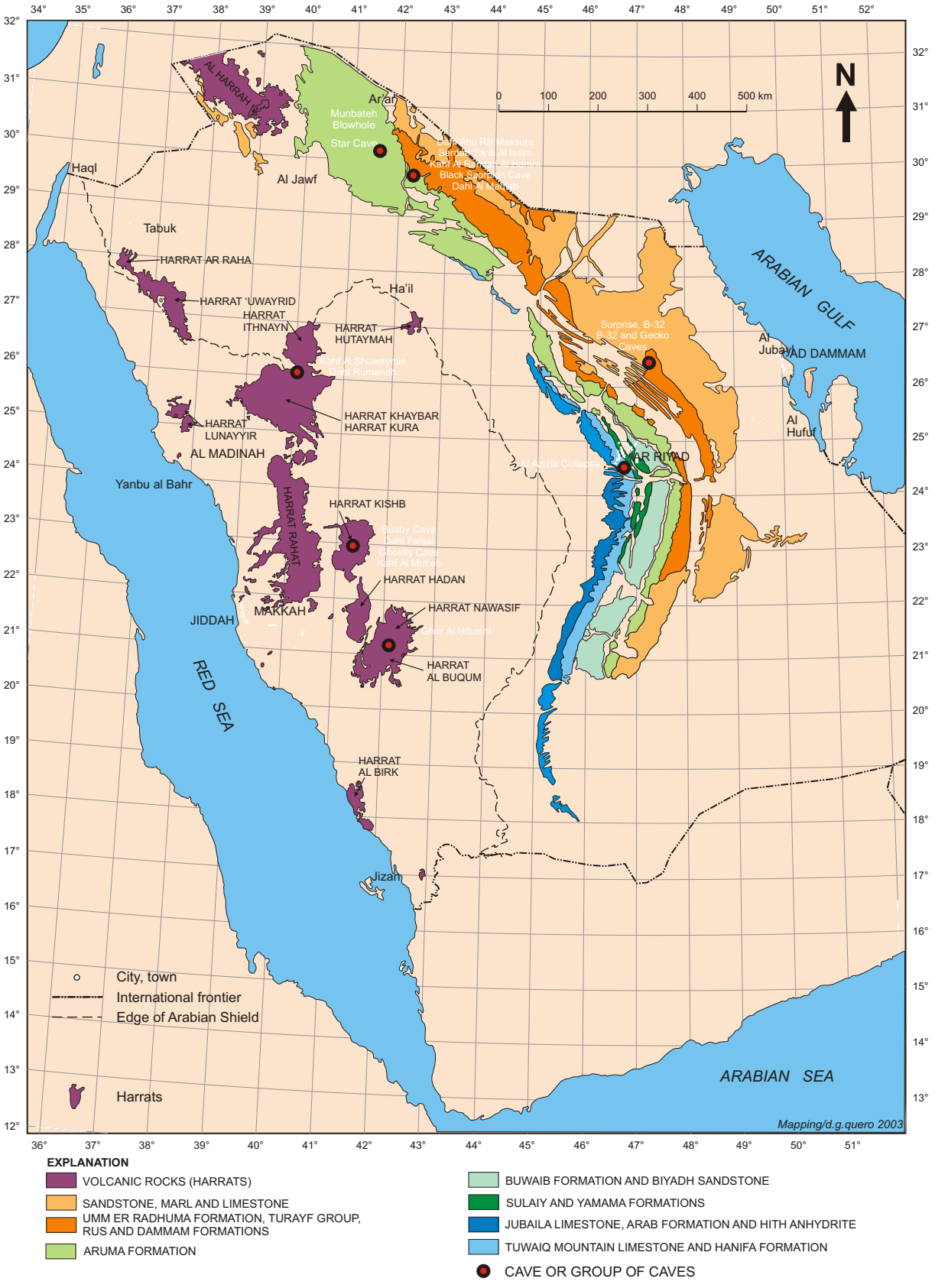

Figure 1. Location and geological setting of caves included in this report.

Table 1: BCRA gradings for a cave line survey

As revised for inclusion in the new edition of Cave Surveying, July 2002

Grade 1

Sketch of low accuracy where no measurements have been made

Grade 2 (use only if necessary, see note 7)

May be used, if necessary, to describe a sketch that is intermediate in accuracy between Grade 1 & 3

Grade 3

A rough magnetic survey. Horizontal & vertical angles measured to ±2.5º; distances measured to ±50 cm; station position error less than 50cm.

Grade 4 (use only if necessary, see note 7)

May be used, if necessary, to describe a survey that fails to attain all the requirements of Grade 5 but is more accurate than a Grade 3 survey.

Grade 5

A Magnetic survey: Horizontal and vertical angles measured to ±1º; distances should be observed and recorded to the nearest centimeter and station positions identified to less than 10cm.

Grade 6

A magnetic survey that is more accurate than grade 5, (see note 5).

Grade X

A survey that is based primarily on the use of a theodolite or total station instead of a compass, (see notes 6 and 10 below).

Notes

1. The above table is a summary and is intended only as an aide memoire; the definitions of the survey grades given above must be read in conjunction with these notes.
2. In all cases it is necessary to follow the spirit of the definition and not just the letter.
3. To attain Grade 3 it is necessary to use a clinometer in passages having appreciable slope.
4. To attain Grade 5 it is essential for instruments to be properly calibrated, and all measurements must be taken from a point within a 10cm diameter sphere centred on the survey station.
5. A Grade 6 survey requires the compass to be used at the limit of possible accuracy, i.e. accurate to ±0.5º; clinometer readings must be to the same accuracy. Station position error must be less than ±2.5 cm, which will require the use of tripods at all stations or other fixed station markers ('roofhooks').
6. A Grade X survey must include on the drawing notes descriptions of the instruments and techniques used, together with an estimate of the probable accuracy of the survey compared with Grade 3, 5 or 6 surveys.
7. Grades 2 and 4 are for use only when, at some stage of the survey, physical conditions have prevented the survey from attaining all the requirements for the next higher grade and it is not practical to re-survey.
8. Caving organisations etc, are encouraged to reproduce Table 1 and Table 2 in their own publications; permission is not required from BCRA to do so, **but the tables must not be reprinted without these notes**.
9. Grade X is only **potentially** more accurate than Grade 6. It should never be forgotten that the theodolite/Total Station is a complex precision instrument that requires considerable training and regular practice if serious errors are not to be made through its use!
10. In drawing up, the survey co-ordinates **must** be calculated and not hand-drawn with scale rule and protractor to obtain Grade 5.

Table 2. BCRA gradings for recording cave passage detail

As revised for inclusion in the new edition of Cave Surveying, July 2002

CLASS A

All passage details based on memory.

Class B

Passage details estimated and recorded in the cave.

Class C

Measurements of detail made at survey stations only.

Class D

Measurements of detail made at survey stations and wherever else needed to show significant changes in passage dimensions.

Notes

1. The accuracy of the detail should be similar to the accuracy of the line.
2. Normally only one of the following combinations of survey grades should be used:

   1A,

   3B or 3C,

   5C or 5D,

   6D,

   XA, XB, XC or XD.

subsequent visits to the cave for the purpose of making a detailed geological description of it. The location of all features of the cave can be pinpointed in relation to the nearest station, replacing a popular expression like "a little farther on" with a more technical "5.5m northeast (40°) of station 20."

Descriptions of cave features are often penciled into the margins of survey books while in use inside the cave or "recalled" outside the cave at some point after the survey. However, the most fruitful approach to a geological description has been the use of a tape recorder. Perhaps as much as 500% more information was recorded on tape during a post-survey walk through the cave than was gleaned from notes hand-written inside the cave or—worst of all—recollections written back at home after the survey.

It was found that a small tape recorder could be protected from sand and dust (the main problems affecting machines in desert caves) by sealing it in a Ziplock bag. Several rubber bands can then be used to hold the bag tightly against the recorder, eliminating the crackling sounds made by a loose bag.

A BRIEF HISTORY OF CAVE MAPPING IN SAUDI ARABIA

In the late 1930s, geologist and later CEO of Aramco, Tom Barger, sketched the interior of some dahls located near Ma'aqala in the karst of the Summan Plateau (Barger, 2003).

In 1968 German divers published a sketch of Ayn Khudud, the largest spring in the Al Hasa Oasis. (Al-Sayari and Zötl, 1978).

In 1976, H. Hötzl and V. Maurin published a map of Ghar an Nashab, a series of 30 m-high, narrow, joint-controlled fissures containing 1.5 kms of passages. Their survey was carried out using tape, compass and clinometer readings and may be the first "professional" cave map ever made in Saudi Arabia. For many years Ghar An Nashab (also called Al Qara Cave), located near Hofuf in Al Hasa, has been Saudi Arabia's best-known (and perhaps only) Show Cave. (Al-Sayari and Zötl, 1978).

In 1983, Bruce Davis of the U.S. National Speleogical Society published sketches of several caves including

Dahl Sabsab (Davis, 1983). Years later, the accuracy of this Sabsab sketch was commended by geologist Greg Gregory after mapping the cave with compass and tape (Gregory, 2001).

Perhaps the first attempt to map a lava tube in Saudi Arabia was made by Mamdoah Al-Rashid who used a 50m-long tape to measure the length of Kahf al Shuwaymis. The date of this event is not recorded, nor is there any reference to the use of a compass, but Mr. Rashid's calculation of the cave's length (500 m) comes very close to the length of 530 m measured in a recent BCRA grade 3C survey (Rashid, 2002). If the length of side passages (30 m) is removed from the total, Mr. Rashid's results are exactly on the mark.

In 1983 mapping of Dahl Sultan was undertaken using compass, clinometer, tape and tripod, perhaps fulfilling the stringent requirements for a BCRA grade 6D survey. Unfortunately, this accuracy was maintained for only the first 18 stations (Peters *and others,* 1990).

In 1986, scientists from King Fahd University of Petroleum and Minerals and the Austrian Academy of Sciences initiated a project to study the role that *dahls* play in replenishing the Umm-Er-Radhuma aquifer, the most important in the Kingdom. Over a period of several years, speleologists from this group explored and surveyed 58 caves located in the vicinity of Ma'aqala, on the Summan Plateau, producing a collection of high-quality cave maps as well as valuable information on the hydrology of this karst area. Of particular interest is their map of UPM Cave which has passages on three different levels and features a large underground room 45 meters wide, 80 meters long and 17 meters high (Benischke *and others,* 1997)

Throughout the 1990's, cave exploration and surveying was carried on by small groups of speleologists and cavers living in Riyadh, Jeddah and Dhahran, mainly centered on the Summan karst. Most notable is the survey of Surprise Cave, which began in 1995 and is still far from finished. To date, 12 individuals from Saudi Arabia and five other countries have participated in the ongoing survey of this labyrinthine cave. (Pint, 2003).

Beginning in the year 2000, the Saudi Geological Survey formed a Cave Unit and began the exploration and mapping of limestone caves on the Summan Plateau and in the northern regions as well as surveys of lava caves in Harrats Kishb, Khaybar, Ithnayn and Buqum-Nawasif. During this period, measurements of temperature, humidity, radon gas content, etc. were carried out in many caves as well as carbon dating of human and animal skulls and bones, uranium-thorium dating of stalagmites and OSL (optically stimulated luminescence) dating of loess on cave floors. Analysis of speleothem samples for hosted cave minerals was also initiated, using a powder diffractometer and/or a Gandolfi camera. Many of the maps in this collection were produced during this period. Meanwhile, geologists in the Eastern Province mapped several caves in that area, most notably Dahl Sabsab and Ain Hit, two well-known caves which have had many visitors but—to the compiler's knowledge—have never been properly surveyed.

Perhaps the most important Saudi cave studied in recent times is Ghar Al Hibashi, a lava tube located in Harrat Nawasif-Buqum and surveyed by the SGS Cave Unit. The map of Hibashi Cave indicates the locations where 19 cave minerals—many very rare—were found, along with the age of a human skull found in the cave and of samples taken from the thick carpet of loess covering the floor. In 2004 Hibashi Cave was named one of the ten most important lava caves in the world, for its mineral content and is presently being used by NASA contractors as a model for the lava tubes of Mars (Pint *and others,* 2005).

THE CHALLENGE OF SURVEYING CAVES IN SAUDI ARABIA

Mapping desert caves exposes the surveyor to certain difficulties and dangers peculiar to the underground environment. Simply entering the cave may require a rappel into a black void of considerable depth or a climb down a swinging cable ladder only centimeters away from a delicately balanced, ten-ton boulder which could shift at any moment. Darkness awaits the surveyor at the bottom, forcing him or her to squint through the sights in his or her instruments at a torch-lit target shrouded in inky blackness. In Saudi caves, a temperature of 25° and humidity as high as 97% might add to the difficulty of taking accurate measurements. Extremely dry caves, on the other hand, may have over a meter of loess or very fine powder covering the floor, producing choking clouds of dust at every step. To make matters worse, a walking passageway may eventually turn into a low crawlway which will require a separate station every time it twists left or right. The surveyor must take notes and measurements while belly-crawling through mud, sand, desiccated hyena scat, water, bat guano, bat urine or a combination of all six. On top of that, in the caves of northern and western Saudi Arabia there is a distinct possibility that he or she will find a hungry wolf waiting at the end of the crawlway.

For all of the above reasons, the compiler of this map collection wishes to thank the dedicated surveyors who toiled in the darkness to make this collection possible and whose names duly appear on each individual map.

MAPS AND SKETCHES OF CAVES

The nineteen caves listed below are arranged according to alphabetical order using one or more key words in the name of each cave. In English, the words *Cave, Pit, Cavern, Blowhole,* etc. are usually appended, while in Arabic, *Dahl, Ghar, Serdab, Kahf, Johr, Ain*, etc. precede the cave's name. Various opinions exist over the exact meaning of each of these Arabic denominations, so it should be noted that in most cases the SGS Cave Unit has not chosen such words arbitrarily, but has tried to preserve the name of the cave exactly as used by local people, whenever any could be found. All cave names in this report should be considered tentative. They are merely *working names* and subject to change upon information provided by historians or other experts. For this reason, numbers have been assigned to all caves in the publication SGS-CDF-2001-1, *List of Caves in the Kingdom of Saudi Arabia*, and are given in the description of each cave listed below. A few cave names were deliberately changed at the request of local people, in order to protect the cave from vandalism. Likewise, the latitude and longitude coordinates given below include degrees and minutes but not seconds in order to discourage destruction or removal of speleothems, pollution caves and the writing of graffiti on cave walls, all of which are becoming more common as roads reach into previously remote areas (Forti, 2003).

Symbols used in these cave maps closely resemble those commonly used by speleologists of all countries. In cases where significantly different symbols exist for the same concept, the standard symbols approved by the International Union of Speleology (UIS) have been adopted.

In addition to the standard cave map symbols, this report makes use of six new symbols representing desiccated animal scat or coprolites. Traditionally, one symbol representing both bat and bird guano has been used in cave maps. However, in Saudi Arabia, the relatively dry climate of desert caves has resulted in the preservation of the scat of various animals, notably bats, rock doves, sheep, goats, foxes, hyenas and wolves. Recent studies (Pint *and others,* 2005) suggest that such scat may contain plant matter, pollen, spores, phytoliths, etc. of possible use to scientists in various fields. In addition, deposits of such scat—like bat guano—are frequently of value to cave explorers as landmarks for navigating complicated labyrinths of passages. The list of cave map symbols used in this report is given in Figure 2.

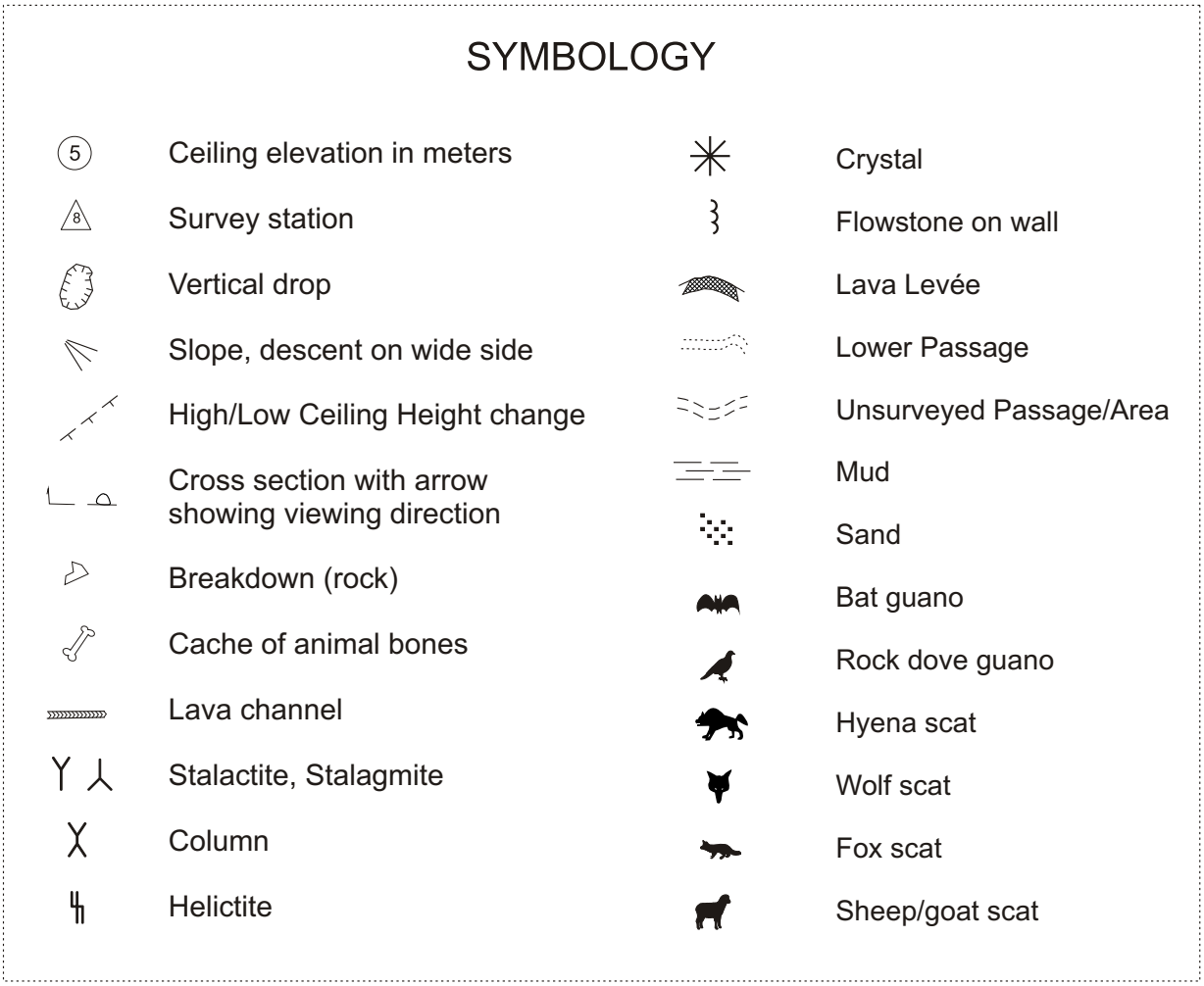

Figure 2: Symbols used in the cave maps of this collection.

AZIZIA

NAMES : Azizia Collapse; Azizia Cave; number 167 in *List of Caves in the Kingdom of Saudi Arabia*.

LOCATION : 24°35′N,46°46″E.

TOTAL LENGTH : 15.22 m

VERTICAL DIFFERENCE : C. 5 m

GEOLOGICAL SETTING : Possibly situated in the Hanifa Formation.

DESCRIPTION : A hole broken into during construction work on a Riyadh street. Entrance: 1.08 m high, 2.65 m wide. Steep slope found below. Width at bottom: 3.67 m and height 2.15 m. Filled with cement after exploration.

RIGGING : Handline used but not needed.

REFERENCES : None

Figure 3 : Map of Azizia Collapse, located under a street in Riyadh. [Editor: I can supply if needed, but Mahmoud Al-Shanti has the original.]

Figure 4 : Entrance to Azizia Collapse in construction channel.

Figure 5 : Entrance to Azizia Collapse broken into by construction workers. View from extreme end of cave.

B-32

NAMES : B-32 Cave; B32 Cave; number 55 in List of Caves in the Kingdom of Saudi Arabia.

LOCATION : 26°27′N., 47°14″E.

TOTAL LENGTH : Over 1 km; only 95 m mapped.

VERTICAL DIFFERENCE : 2 m

GEOLOGICAL SETTING : The cave is situated in the As Sulb Plateau which encompasses the Umm er Radhuma Formation (Paleocene-Early Eocene) and a younger, unnamed Miocene-Pliocene unit of calcareous clastic rocks which consists of calcareous sandstone, marl and limestone (Schyfsma, 1978), sometimes referred to as the Tertiary Sandstone and Marl (Tsm) formation (Peters *and others,* 1990). The Umm er Radhuma Formation is composed of light-colored, fine-grained and arenitic limestones as well as dolomites containing chert. Benischke and others (1997) report that lithologic, sedimentologic and thin-section investigations show a strongly recrystallized texture, dolomitization and partly complete decalcification within the marl-like layers of this formation, favoring the possibilities of karstification or erosion.

DESCRIPTION : The entrance to the cave is a 5 x 8 m, 6 m-deep depression in the Tsm formation, leading to a 5 x 12 m room. A passage heading north leads to three more rooms, all of which are characterized by large, friable slabs of breakdown covering the floor. The northernmost room is well decorated with speleothems. Passages heading east from the first room also lead to notable speleothems. Passage and room heights range from 1 to 5m. A temperature of 21° was recorded in this cave with a relative humidity of 70 percent. It is presumed from references in Hötzl *and others,* 1993 that the east-trending passages continue for at least 1 km.

RIGGING : All areas surveyed are easily climbable. Helmets and caution are absolute requirements in this cave due to fragility of breakdown slabs.

REFERENCES : Hötzl *and others,* 1993; Pint *and others,* 2002 and Pint, 2003.

Figure 6 : Map of B-32 Cave, located on the As Sulb Plateau north of Riyadh.

Figure 7 : Entrance to B-32 Cave. No ropes or ladders are needed for entering it.

Figure 8 : Spelothem display near station 10 of B-32 Cave.

BLACK SCORPION

NAMES : Black Scorpion Cave; Serdab al Aqrab al Aswad; Sirdab al Aqrab al Aswad; South Cave; number 85 in *List of Caves in the Kingdom of Saudi Arabia*.

LOCATION : 29°46′N., 42°18′E.

TOTAL LENGTH : 480 m

VERTICAL DIFFERENCE : 20 m

GEOLOGICAL SETTING : The cave is found in the Umm er Radhuma Formation whose age is Paleocene to lower Eocene and which consists of light gray to white foraminifera-bearing, fine-grained, calcarenitic limestone, dolomitic limestone, and dolomite. In this area, beds of gypsum a few meters thick are interbedded with the limestone. The local terrain may have been affected by the Aba al Qur dissolution-collapse structure, which is characterized by sinkholes, disrupted drainage, and remnants of carbonate dissolution breccia.

DESCRIPTION : The cave is in chalky limestone overlain by a calcarenite unit more than 20 m thick. The entrance is a 10 x 18 m hole in the southwest side of a low hill. The largest room is 17 m high, 30 x 60 m, containing many 3-4 ton blocks of breakdown. Several areas contain thousands of bones and wolf, hyena and fox scat. The biggest bone cache measures 2 x 15m. Gypsum speleothems are found on the walls and ceilings in a great variety of forms, sufficiently attractive for tourism purposes. Calcite crystals are also found. A large bat population and thick guano beds are found at the southern end of the cave. This cave may have been formed by the leaching of a stratum of gypsum.

RIGGING : No rigging needed except for a handline to enter northwest-trending passage between stations 19 and 20.

REFERENCES : Al-Shanti *and others,* 2003; Forti *and others,* 2003; Pint and Pint, 2004

Figure 9 : Map of Black Scorpion Cave, located in the far north of Saudi Arabia.

Figure 10 : Entrance to Black Scorpion Cave seen from inside.

Figure 11 : Large cache of bones between stations 8 and 9 in Black Scorpion Cave.

BUSHY

NAMES : Bushy Cave; number 122 in List of Caves in the Kingdom of Saudi Arabia.

LOCATION : 22°55′N., 41°25′E.

TOTAL LENGTH : 13 m

VERTICAL DIFFERENCE : 0 m

GEOLOGICAL SETTING : The cave is found on the north side of an eroded cone of red agglutinated spatter in the quaternary volcanic deposits of the Hil Basalt (younger than one million years) of Harrat Kishb, a basaltic lava field with an area of 5,892 km², centered about 270 km northeast of Jeddah. These deposits comprise both scoria cones and lava flows which were probably formed during a moist

climatic period or pluvial interval and which are distinguished from overlying subunits because they are significantly eroded (Roobol *and others,* 2002).

DESCRIPTION : The entrance to Bushy Cave is inside a circular collapse area 6 m in diameter and 2 m deep and measures 2 m wide by 1 meter high. Two large bushes obscure the entrance. The cave consists of one nearly round room 12 13 m and 1.8 m high in the center, with a mud and sand floor. A bat was found on the ceiling and mounds of rock dove guano were found on the floor. There is a thin coating of calcite on the cave ceiling. A gas bubble under a hardening lava crust may have produced this cave.

RIGGING : No rigging is required.

REFERENCE : Roobol *and others,* 2002

Figure 12 : Sketch of Bushy Cave, located in Harrat Kishb.

Figure 13 : Entrance to Bushy Cave inside a collapse area 6 m in diameter.

Figure 14 : View from the inside of Bushy Cave at a distance of 12 m from the entrance.

FAISAL

NAMES : Dahl Faisal; number 162 in List of Caves in the Kingdom of Saudi Arabia.

LOCATION : 23°11′N., 41°27′E.

TOTAL LENGTH : 22 m

VERTICAL DIFFERENCE : 3 m

GEOLOGICAL SETTING : The cave is found in a nearly flat-lying "whale-back" lava flow of the Jabal Zuwayr volcano. This flow consists mainly of basanite and alkali olivine basalt with small volumes of hawaiite, phonotephrite and phonolite and is located in the northern portion of the Hil Basalt (younger than one million years) of Harrat Kishb, a basaltic lava field with an area of 5,892 km², centered about 270 km northeast of Jeddah. These deposits comprise both scoria cones and lava flows which were probably formed during a moist climatic period or pluvial interval and which are distinguished from overlying subunits because they are significantly eroded (Roobol *and others,* 2002).

DESCRIPTION : The cave is entered through a smooth, 3-m-long pipe, 80 cm diameter at its narrowest point, oriented at a 60° angle. This appears to be an implosion vent, formed when the cave was created. Below the entrance tube lie a heap of rocks apparently piled up by people using the cave in the past. Dahl Faisal consists of one room, 17 x 22 m, with a maximum ceiling height of 3 m. Sediment of unknown depth covers the original floor. The cave contains basaltic stalactites, stalagmites and lava levees. Desiccated animal scat apparently from wolves, hyenas and foxes was also found.

RIGGING : No rigging is required.

REFERENCES : Roobol *and others,* 2002; Pint and Pint, 2005.

Figure 15 : Map of Dahl Faisal, a lava tube located in Harrat Kishb.

Figure 16 : Smooth-walled entrance to Dahl Faisal produced by air sucked into cave as lava flowed away underneath.

Figure 17 : Surveying inside Dahl Faisal. Note lava stalactites on ceiling.

FRIENDLY

NAMES : Friendly Cave; Deep Throat; number 4 in *List of Caves in the Kingdom of Saudi Arabia*.

LOCATION : 26°26′N., 47°13′E.

TOTAL LENGTH : At least 300 m; only 75 m mapped.

VERTICAL DIFFERENCE : C. 13 m

GEOLOGICAL SETTING : The cave is situated in the As Sulb Plateau which encompasses the Umm er Radhuma Formation (Paleocene-Early Eocene) and a younger, unnamed Miocene-Pliocene unit of calcareous clastic rocks which consists of calcareous sandstone, marl and limestone (Schyfsma, 1978), sometimes referred to as the Tertiary Sandstone and Marl (Tsm) formation (Peters *and others,* 1990). The Umm-Er-Radhuma Formation is composed of light-colored, fine-grained and arenitic limestones as well as dolomites containing chert. Benischke and others (1997) report that lithologic, sedimentologic and thin-section investigations show a strongly recrystallized texture, dolomitization and partly complete decalcification within the marl-like layers of this formation, favoring the possibilities of karstification or erosion.

DESCRIPTION : The entrance is a nearly circular vertical shaft 2.5 m wide, narrowing to c. 1 m in diameter near the bottom. Strong airflow has been noted in this opening. Less than 40 m from the entrance shaft, there is an area richly decorated with calcite stalactites, stalagmites, draperies and helictites as well as small gypsum formations. The floor is covered with sand, the level of which seems to be gradually rising. Northeast of this area lie hundreds of meters of passages, some well decorated. Openings to many more passages were noted, suggesting that Friendly Cave is a vast labyrinth.

RIGGING : A rope or cable ladder is needed for the entrance shaft. If a ladder is used, rigging on the side where there are two small ledges is recommended.

REFERENCES : Pint 2000a and b; Forti *and others,* 2003; Pint, 2003

Figure 18 : Map of Friendly Cave. Hundreds of meters of other passages remain to be surveyed.

Figure 19 : The entrance to Friendly Cave, located on the As Sulb Plateau north of Riyadh. A Rope or ladder is needed for this cave.

Figure 20 : Display of stalactites, helictites and stalagmites. Friendly Cave has potential for cave tourism.

GECKO

NAMES : Gecko Cave; Kahf Al Rutuwbah; number 81 in *List of Caves in the Kingdom of Saudi Arabia*.

LOCATION : 26°26′N., 47°15′E.

TOTAL LENGTH : 200 m

VERTICAL DIFFERENCE: 2 m

GEOLOGICAL SETTING : The cave is situated in the As Sulb Plateau which encompasses the Umm er Radhuma Formation (Paleocene-Early Eocene) and a younger, unnamed Miocene-Pliocene unit of calcareous clastic rocks which consists of calcareous sandstone, marl and limestone (Schyfsma, 1978), sometimes referred to as the Tertiary Sandstone and Marl (Tsm) formation (Peters *and others,* 1990). The Umm er Radhuma Formation is composed of light-colored, fine-grained and arenitic limestones as well as dolomites containing chert. Benischke and others (1997) report that lithologic, sedimentologic and thin-section investigations show a strongly recrystallized texture, dolomitization and

partly complete decalcification within the marl-like layers of this formation, favoring the possibilities of karstification or erosion.

DESCRIPTION : The entrance is at the base of an 11m-diameter, 4.75 m-deep depression in the Tsm formation. An opening 60cm high and 2m wide leads to a series of rooms and passages of varying sizes but mostly less than 1 m high. However, a sandy floor makes crawling easy in most parts of this cave, which takes its names from geckos (Ptyodactylus hasselquistii) found near station 1. Umm er Radhuma limestone can be observed at some points of the cave floor. Many speleothems, including stalactites, stalagmites, banded draperies, helictites, and cauliflower formations are found throughout the cave. The first few rooms of the cave have a temperature of 23-25° with 66 percent humidity while the large room at the southwest end of the cave is 21° with 97 percent humidity.

RIGGING : No rigging is needed.

REFERENCES : Pint *and others,* 2002; Forti *and others,* 2003; Pint, 2003

Figure 21 : Map of Gecko Cave or Kahf Al Rutuwbah (which means "Steamy Cave").

Figure 22 : Sandy floor and speleothems in the Coral Room of Gecko Cave.

Figure 23 : Stalactites and helictites in Gecko Cave. Such displays are common throughout the cave.

GHOSTLY

NAMES : Ghostly Cave; Kahf Al Ashbaah; number 123 in *List of Caves in the Kingdom of Saudi Arabia*.

LOCATION : 22°55′N., 41°25′E.

TOTAL LENGTH : 320 m

VERTICAL DIFFERENCE : 1.5 m

GEOLOGICAL SETTING : The cave is found in a flat area of basaltic pahoehoe lava in the volcanic deposits of the Hil Basalt (younger than one million years) of Harrat Kishb, a basaltic lava field with an area of 5,892 km², centered about 270 km northeast of Jeddah. These deposits comprise both scoria cones and lava flows which were probably formed during a moist climatic period or pluvial interval and which are distinguished from overlying subunits because they are significantly eroded (Roobol *and others,* 2002).

DESCRIPTION : The entrance is a collapse ten meters in diameter with a 7 m drop to a flat floor below. Two passages lead off east and west. Up to 50 stalagmite-like mounds of rock-dove guano are found just inside the entrance to the western passage along with the remains of a stonewall partly buried beneath bird guano. The cave passages have a maximum width of 30 m and vary in height from 1 to 3 m. Both passages have white, calcarious patches on the ceiling and a thick layer of powdery dust on the floor. This consists mainly of calcium, potassium and phosphate. Bats are found at both extremes of the cave. Two flat, L-shaped wooden throwing sticks were found in dark areas of the two passages, resembling similar instruments depicted in Neolithic rock art found in Saudi Arabia.

RIGGING : A man-made heap of rocks lie c. 3 m beneath the eastern lip of the entrance hole. This was reached via cable ladder.

REFERENCES : Roobol *and others,* 2002; Pint and Pint, 2005.

Figure 24 : Map of Ghostly Cave, a lava tube located in Harrat Kishb.

Figure 25 : Entrance to Ghostly Cave. A rope or ladder is needed to reach the floor seven meters below.

Figure 26 : A surveyor at work at the entrance to the eastern wing of the cave. Two throwing sticks, possibly Neolithic, were found in this cave.

HIBASHI

NAMES : Ghar Al Hibashi; Ghar Al Hebashi; Hibashi Cave; Hebashi Cave; number 180 in *List of Caves in the Kingdom of Saudi Arabia*.

LOCATION : 21°08′N., 42°08′E.

TOTAL LENGTH : 689.54 m

VERTICAL DIFFERENCE : 26 m

GEOLOGICAL SETTING : Ghar Al Hibashi lies near the center of Harrat Nawasif/Al Buqum, a group of lava flows located east of Makkah. These titaniferous, olivine basalts are described as gray to dark gray, vesicular, medium-grained and prophyritic (Ziab and Ramsay, 1986). Pint *and others,* 2005, speculate that Ghar Al Hibashi may lie in basalt dated at c. 1.1 million years by Hötzl *and others,* 1978.

DESCRIPTION : The cave entrance is a collapse 14 m in diameter located in a slightly elevated area of a major basaltic flow emanating from a large crater to the southeast. A steep downslope leads to a gallery, which intersects the east-west-oriented main passage of the cave. This passage is typically 12 m wide, increasing to 33 m at its eastern end. The height ranges from <1m to >9m. The floor is mostly covered with as much as 1.5 m of loess (having lain up to c. 5800 years inside the cave), underlying beds of burnt bat guano at the extreme ends of the main passage. Volcanic levees, stalactites and stalagmites are common. At least 19 hosted minerals were found in the cave, three of them being extremely rare organic compounds related to the guano combustion. Bones, desiccated animal scat and a human skull c. 425 years old were also found in the cave.

RIGGING : No rigging is needed.

REFERENCE : Forti, 2005; Pint *and others,* 2005; Pint, 2005

Figure 27 : Map of Ghar Al Hibashi, a lava tube in Harrat Nawasif-Buqum.

Figure 28 : The entrance to Hibashi Cave, a collapse 14 meters in diameter.

Figure 29 : Lava stalagmites lining the wall of the western passage of Hibashi Cave.

MAQLAB

NAMES : Dahl al Maqlab; Practical Joke Cave; Six-Dove Cave; number 174 in *List of Caves in the Kingdom of Saudi Arabia*.

LOCATION : 29°50′N., 42°13′E.

TOTAL LENGTH : 29 m

VERTICAL DIFFERENCE : 22 m

GEOLOGICAL SETTING : The cave is found in the Umm er Radhuma Formation whose age is Paleocene to lower Eocene and which consists of light gray to white foraminifera-bearing, fine-grained, calcarenitic limestone, dolomitic limestone, and dolomite. In this area, beds of gypsum a few meters thick are interbedded

with the limestone. The local terrain may have been affected by the Aba al Qur dissolution-collapse structure, which is characterized by sinkholes, disrupted drainage, and remnants of carbonate dissolution breccia.

DESCRIPTION : The entrance to this cave is located on a small hill and measures 7 x 8 m wide with a wide ledge 10 m below the surface and a further 12 m drop to the floor. No speleothems were found.

RIGGING : A cable ladder was used to reach the floor of the cave.

REFERENCE : Al-Shanti *and others,* 2003

Figure 30 : Map of Dahl al Maqlab, a limestone cave in the Habakah area of northern Saudi Arabia.

Figure 31 : The impressive entrance to Dahl al Maqlab, which leads to a small cave of little consequence ("Maqlab" means "Practical Joke.")

MUNBATEH BLOWHOLE

NAMES : Munbateh Blowhole; Munbateh Blowhole Cave; Dahl Munbateh; number 94 in *List of Caves in the Kingdom of Saudi Arabia*.

LOCATION : 30°07′N., 41°36′E.

TOTAL LENGTH : 33 m

VERTICAL DIFFERENCE : 18 m

GEOLOGICAL SETTING : The cave is found in the Aruma Formation, which is comprised of white, crystalline and nodular limestone typical of an open-platform domain. The thickness of the sequence is 125 m and its age is Late Cretaceous. At the top, the formation becomes clayey and then dolomitic (Laurent, 1992).

DESCRIPTION : The blowhole, 65 cm in diameter, is located in the floor of a 14-m-long shelter cave found at the bottom of a circular depression 6 m in diameter. A smooth-walled, narrow, downsloping passage leads to a free drop of 5 m to the top of a breakdown heap in an 8 x 14 m room 10 m deep. Thick, white powder, possibly gypsum, covers all surfaces. The ceiling of this room and the passage leading into it are decorated with flowstone and stalactites. At least three passage lead from this room, all of them considered too unstable and fragile to be entered. One room is located under the breakdown pile. Air flows both ways through the blowhole at different times. An 18.6-kph maximum outflow was measured, but much higher wind velocity was observed at other times.

RIGGING : The blowhole is easily reached on foot. The 5-m drop requires a rope or cable ladder.

REFERENCES : Pint and Pint, 2004

Figure 32 : Map of Munbateh Blowhole Cave, a limestone cave located relatively near 'Ar 'ar in northern Saudi Arabia.

Figure 33 : Full box of tissues suspended in the strong air flow above Munbateh Blowhole.

Figure 34 : Flowstone covers the walls around the drop to the room located below the Munbateh Blowhole.

MUT'EB

NAMES : Kahf Al Mut'eb; number 124 in List of Caves in the Kingdom of Saudi Arabia.

LOCATION : 22°55′N., 41°24′E.

TOTAL LENGTH : 150 m

VERTICAL DIFFERENCE : 1.5 m

GEOLOGICAL SETTING : The cave is found in a sinuous ridge of smooth, hard lava curving around an older, obstructing scoria cone in the volcanic deposits of the Hil Basalt (younger than one million years) of Harrat Kishb, a basaltic lava field with an area of 5,892 km ², centered about 270 km northeast of Jeddah. These deposits comprise both scoria cones and lava flows which were probably formed during a moist climatic period or pluvial interval and which are distinguished from overlying subunits because they are significantly eroded (Roobol *and others,* 2002).

DESCRIPTION : The entrance to the cave measures 3 x 7 m and is found on the east side of a collapse 20 m in diameter. Remains of an ancient, man-made wall cross the front of the cave. A single passage trends east, sometimes reaching 20 m width. The passage height varies from 3 to 5 meters. Sand or clay-rich sediment cover the floor to an undetermined depth. The cave contains abandoned wasps' nests, mounds of rock-dove guano, animal bones, bat urine on the walls and ceiling, and a 40-cm-long cord composed of long plant fibers. The cord, with one knot in it, was hidden beneath a flat rock at the eastern end of the cave.

RIGGING : No rigging is required.

REFERENCES : Roobol *and others,* 2002; Pint and Pint, 2005.

Figure 35 : Map of Kahf Al Mut'eb, a lava tube in Harrat Kishb.

Figure 36 : Geologists examine an ancient wall crossing the entrance to Kahf Al Mut'eb.

Figure 37 : Stalagmites of rock-dove guano inside Kahf Al Mut'eb. The cave entrance is visible in the distance.

RIJL MAKSURA

NAMES : Dahl Abu Rijl Maksura; Dahl Rajul Maksura; Broken-Leg-Man Cave; Broken-Leg Cave; number 86 in *List of Caves in the Kingdom of Saudi Arabia*.

LOCATION : 29°45′N.,42°18′E.

TOTAL LENGTH : 50 m minimum (only partially explored)

VERTICAL DIFFERENCE : 11 m

GEOLOGICAL SETTING : The cave is found in the Umm er Radhuma Formation whose age is Paleocene to lower Eocene and which consists of light gray to white foraminifera-bearing, fine-grained, calcarenitic limestone, dolomitic limestone, and dolomite. In this area, beds of gypsum a few meters thick are interbedded with the limestone. The local terrain may have been affected by the Aba al Qur dissolution-collapse structure, which is characterized by sinkholes, disrupted drainage, and remnants of carbonate dissolution breccia.

DESCRIPTION : The nearly round, vertical entrance hole measures 5.85 x 4.5 m. There is a drop of 6.98 m to the top of a steep-sided mound. The floor lies 11 m below the surface. Calcite stalactites, stalagmites and helictites were observed in great numbers at the base of the mound. Samples proved to be older than 400,000 years and not datable by U/Th. The ceiling of the cave was found to be quite unstable.

RIGGING : A cable ladder or rope is needed for the 6.98 m drop. The steep slope is climbable.

REFERENCES : Al-Shanti *and others,* 2003; Pint and Pint, 2004; Fleitmann *and others,* 2004;

Figure 38 : Sketch of Dahl Abu Rijl Maksura, located in the Habakah region of northern Saudi Arabia.

Figure 39 : Entrance to Dahl Abu Rijl Maksura. A rope or ladder is needed to gain access to the cave.

Figure 40 : "Rajil Maksura" means man with a broken leg, named after the person who tried to climb into the cave using the bedsprings shown here.

RAMLAH AL HAMRA

NAMES : Kahf Al Ramlah Al Hamra; Red Sand Cave; number 175 in *List of Caves in the Kingdom of Saudi Arabia*.

LOCATION : 29°50′N., 42°14′E.

TOTAL LENGTH : 70 m

VERTICAL DIFFERENCE : 35 m

GEOLOGICAL SETTING : The cave is found in the Umm er Radhuma Formation whose age is Paleocene to lower Eocene and which consists of light gray to white foraminifera-bearing, fine-grained, calcarenitic limestone, dolomitic limestone, and dolomite. In this area, beds of gypsum a few meters thick are interbedded with the limestone. The local terrain may have been affected by the Aba al Qur dissolution-collapse structure, which is characterized by sinkholes, disrupted drainage, and remnants of carbonate dissolution breccia.

DESCRIPTION : The cave has a vertical entrance measuring 15 by 22 m, located in a channel surrounded by small hills of limestone. The walls are of fine-grained limestone and blocks of rock weighing one to three tons cover a steep slope leading to a horizontal room at the bottom, where secondary gypsum can be seen on the ceiling and iron oxide, interbedded with the fine-grained limestone, is visible on the walls. No speleothems were noted. Local people hold meetings of small groups in the room at the bottom.

RIGGING : All points of the cave can easily be reached without special equipment.

REFERENCES : Al-Shanti *and others,* 2003; Pint and Pint, 2004

Figure 41 : Map of Kahf Al Ramlah Al Hamra, located in the Habakah area of Saudi Arabia.

Figure 42 : Twenty-two-meter-long entrance to Kahf Al Ramlah Al Hamra. No ropes or ladders are needed for entering this cave.

Figure 43 : Iron oxide, interbedded with the fine-grained limestone, can be seen in the room at the bottom of Kahf Al Ramlah Al Hamra.

RUMAHAH

NAMES : Dahl Rumahah; Dahl Romahah; number 176 in *List of Caves in the Kingdom of Saudi Arabia*.

LOCATION : 25°56′N., 39°54′E.

TOTAL LENGTH : 208 m

VERTICAL DIFFERENCE : 2 m

GEOLOGICAL SETTING : This cave is located 169 kms NNE of Medina in the northern part of Harrat

Khaybar, part of an area comprising 20,560km² of lava flows. The lavas and volcanoes in Harrat Khaybar are mildly alkaline with small Na and K contents and include alkali olivine basalt (AOB); hawaiite; mugearite; benmoreite; trachyte and comendite. The age of the Khaybar lavas ranges from ~5 million years old (orangish flow field) to post-Neolithic (reddish-orange lava flows), to historic (black lava flows). Rumahah Cave is found in a black flow.

DESCRIPTION : The cave has a horizontal entrance 1 m high by 1.5 m wide, set in a small depression. A long, low wall outside the entrance channels rainwater into the cave, which local people say was used as a reservoir. Most of the cave is a single, nearly flat, northwest-trending passage from 1.5 to 7 m wide and 2.5 m high. Rooms N of station 7 and S of station 11 terminate in very low crawls that may be connected. In September of 2003, dry sediment covered the floor of the SE part of the cave while mud in the NW portion and along part of the eastern wall. Water droplets and cave slime cover the ceiling at the far NW end of the cave. A natural bridge 1.5 m thick crosses the passage near its W end. Calcite has leaked through ceiling cracks, producing white stalactites, curtains and flowstone. There is a large cache of bones, hedgehog and porcupine quills, mixed with desiccated hyena, wolf and fox scat. The highest radon level noted in Saudi caves was found in Rumahah: 119 Pci/L.

RIGGING : No rigging is needed.

REFERENCE : Pint, 2004

Figure 44 : Map of Dahl Rumahah, located in Harrat Khaybar.

Figure 45 : Entrance to Dahl Rumahah. A nearby low rock wall channels water into the cave during rain storms.

Figure 46 : Calcite flowstone which has leaked into Dahl Rumahah through ceiling and wall cracks.

SHUWAYMIS

NAMES : Kahf Al Shuwaymis; Kahf Al Shuwamis; Shuwaymis Cave; Shisma Cave; number 177 in *List of Caves in the Kingdom of Saudi Arabia*.

LOCATION : 26°14′N., 40°07′E.

TOTAL LENGTH : 530 m

VERTICAL DIFFERENCE : 7 m

GEOLOGICAL SETTING : This cave is located at the foot of Hazim Al Khadra Volcano in Harrat Ithnayn, which is a lava field centered 240 km north-northeast of Medina. This lava is mildly alkaline with small Na and K contents and its age ranges from ~3 million years to present. The cave is one of at least seven collapses located in a rough straight line 2.5 km long 164° from the center of the volcano.

Thermal activity, manifested in fumaroles emanating from shelter caves, was noted along this line, at a distance of 560 m from the lip of the volcano and 2.1 km from Kahf Al Shuwaymis.

DESCRIPTION : The entrance is a collapse hole 15 m in diameter overlooking the floor of a horizontal passage 5 m below. A steep breakdown slope leads to a mostly south-trending passage varying in width from 4 to 15 m. with a typical height of c. 10 m. Speleothems are limited to lava stalactites under 5 cm in

length. There are at least four caches of animal bones, presumably carried into the cave by hyenas. A narrow channel of sand runs almost the entire length of the cave, indicating water flow in the past. Air currents entering the cave were noted from the east wall near station 12 and from the floor near station 17. There is a small, parallel upper passage between stations 8 and 9. Evidence of present-day, small-animal activity was noted in this passage.

RIGGING : No rigging is needed for this cave.

REFERENCE : Pint, 2004

Figure 47 : Map of Kahf Al Shuwaymis, a lava tube located at the foot of Hazim Al Khadra Volcano in Harrat Ithnayn.

Figure 48 : Entrance to Kahf Al Shuwaymis, 15 m in diameter, seen from the foot of a slope covered with breakdown.

Figure 49 : SGS Cave Unit speleologists place a radon-gas detector in Kahf Al Shuwaymis.

STAR

NAMES : Star Cave; Kahf Al Najmah; Kahf Al Najimah; number 96 in *List of Caves in the Kingdom of Saudi Arabia*.

LOCATION : 30°07′N., 41°38′E.

TOTAL LENGTH : 43 m

VERTICAL DIFFERENCE : C. 13 m

GEOLOGICAL SETTING : The cave is found in the Aruma Formation, which is comprised of white, crystalline and nodular limestone typical of an open-platform domain. The thickness of the sequence is 125 m and its age is Late Cretaceous. At the top, the formation becomes clayey and then dolomitic (Laurent, 1992).

DESCRIPTION : Two entrances to this cave are found in a 6.22 m diameter depression. One is 2.8 m wide by 0.8 m height and the other is 3.8 m wide by 2.6 m high. The first room is 32.5 m long and 11 m wide with an average height of one meter. At the south end of the cave there is a 1m wide, flowstone-coated passage through which airflow up to 15 kph was measured. A stronger velocity was noted on other occasions. This passage drops 10 meters to a lower room with apparently unstable walls and ceiling. The cave contains a variety of speleothems. Stalagmites collected from this cave featured a 0.5-1.0 cm thick rind of dense and milky-white calcite and were found to be too old for U/Th dating. Their age is estimated at one million years.

RIGGING : No rigging is needed except for the south-end passage which requires a rope or cable ladder and, perhaps, bolting.

REFERENCES : Fleitmann *and others,* 2004; Pint and Pint, 2004

Figure 50 : Map of Star Cave, located near ʻArʻar in Northern Saudi Arabia.

Figure 51 : Entrance to Star Cave. A strong current of air blows in and out of this cave at most times.

Figure 52 : Flowstone, columns and other speleothems are found in Star Cave. They have been age-dated at over 400,000 years before present and are thought to be one million years old.

SURPRISE

NAMES : Surprise Cave; Dahl Almofaja'ah; Kahf Almofaja'ah; numbers 5 and 6 in *List of Caves in the Kingdom of Saudi Arabia*.

LOCATION : 26°28′N., 47°14′E.

TOTAL LENGTH : 652 m

VERTICAL DIFFERENCE : 14 m

GEOLOGICAL SETTING : The cave is situated in the As Sulb Plateau which encompasses the Umm er Radhuma Formation (Paleocene-Early Eocene) and a younger, unnamed Miocene-Pliocene unit of calcareous clastic rocks which consists of calcareous sandstone, marl and limestone (Schyfsma, 1978), sometimes referred to as the Tertiary Sandstone and Marl (Tsm) formation (Peters *and others,* 1990). The Umm-Er-Radhuma Formation is composed of light-colored, fine-grained and arenitic limestones as well as dolomites containing chert. Benischke and others (1997) report that lithologic, sedimentologic and thin-section investigations show a strongly recrystallized texture, dolomitization and partly complete decalcification within the marl-like layers of this formation, favoring the possibilities of karstification or erosion.

DESCRIPTION : Two entrances are known, but others probably exist. Entrance 1 is a 14-m vertical shaft below a 90 cm diameter round hole. Entrance 2 is a horizontal opening in the wall of a gully southwest of entrance 1, leading to a 3 meter drop to the cave floor. The explored parts of the cave mainly consist of labyrinthine horizontal passages from 6 to 0.5 m high and up to 15 m wide whose floors are mostly covered with breakdown but occasionally with loess, sand or mud. Many parts of the cave are richly decorated with calcite speleothems such as stalactites (some living), fossil stalactites coated with a translucent layer of calcite, stalagmites, draperies and flowstone. A great variety of gypsum speleothems are found throughout the cave. The temperature is 25° and the humidity 85 percent.

RIGGING : Entrance 1 is climbable with a handline, but a rope or ladder are safer. The 2-m drop at entrance 2 requires a rope or ladder connected to an outside vehicle, due to fragility of possible anchor points.

REFERENCES : Pint, 2000a and b; Forti *and others,* 2003; Pint, 2003; Fleitmann *and others,* 2004;

Figure 53 : Map of Surprise Cave, located on the As Sulb Plateau, north of Riyadh.

Figure 54 : Typical of many caves in the Ma'aqala karst, the 90-cm-diameter entrance to Surprise Cave leads to a labyrinth of hundreds of meters of passages below.

Figure 55 : A geologist collects water samples in Surprise Cave. Many of the beautiful stalactites of this cave have been broken or removed by vandals.

TAYIB AL ISSIM

NAMES : Serdab Tayib Al Issim;That's-A-Nice-Name Cave;North Cave;number 84 in *List of Caves in the Kingdom of Saudi Arabia*.

LOCATION : 29°51′N.,42°16′E.

TOTAL LENGTH : 130 m

VERTICAL DIFFERENCE : 2 m

GEOLOGICAL SETTING : The cave is found in the Umm-Er-Radhuma Formation whose age is Paleocene

to lower Eocene and which consists of light gray to white foraminifera-bearing, fine-grained, calcarenitic limestone, dolomitic limestone, and dolomite. In this area, beds of gypsum a few meters thick are interbedded with the limestone. The local terrain may have been affected by the Aba al Qur dissolution-collapse structure, which is characterized by sinkholes, disrupted drainage, and remnants of carbonate dissolution breccia.

DESCRIPTION : The entrance measures 2 x 6 m and is found at the bottom of a low depression 8 m in diameter at the foot of a hill. One passage has natural bridges and sausage-shaped speleothems that appear to have been formed underwater. Stalagmites with soft, powdery centers are found near station 10. *Asellia tridens* bats inhabit the cave.

RIGGING : No rigging needed.

REFERENCES : Al-Shanti *and others,* 2003; Forti *and others,* 2003; Pint and Pint, 2004

Figure 56 : Map of Serdab Tayib Al Issim, located in the Habakah region of northern Saudi Arabia.

Figure 57 : Six-meter-long entrance to Serdab Tayib Al Issim, which contains caches of animal bones and many impressive speleothems.

Figure 58 : Graffiti on one of the formations in Serdab Tayib Al Issim. A system to protect caves from damage is badly needed in Saudi Arabia.

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AZIZIA COLLAPSE CAVITY

RIYADH, Saudi Arabia

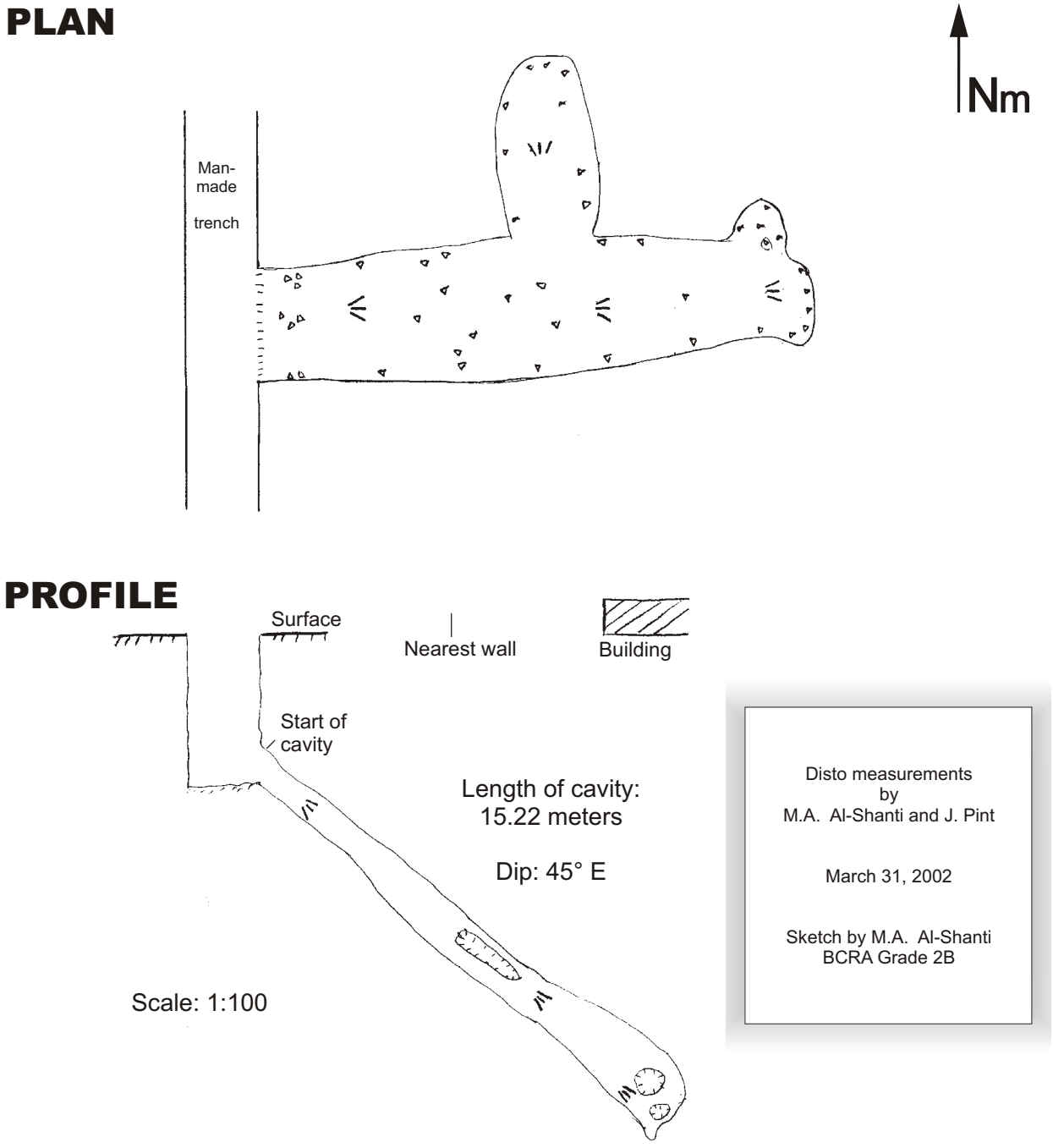


Figure 3: Map of Azizia Collapse, located under a street in Riyadh.

Figure 4: Entrance to Azizia Collapse in construction channel.

Figure 5: Entrance to Azizia Collapse broken into by construction workers. View from extreme end of cave.

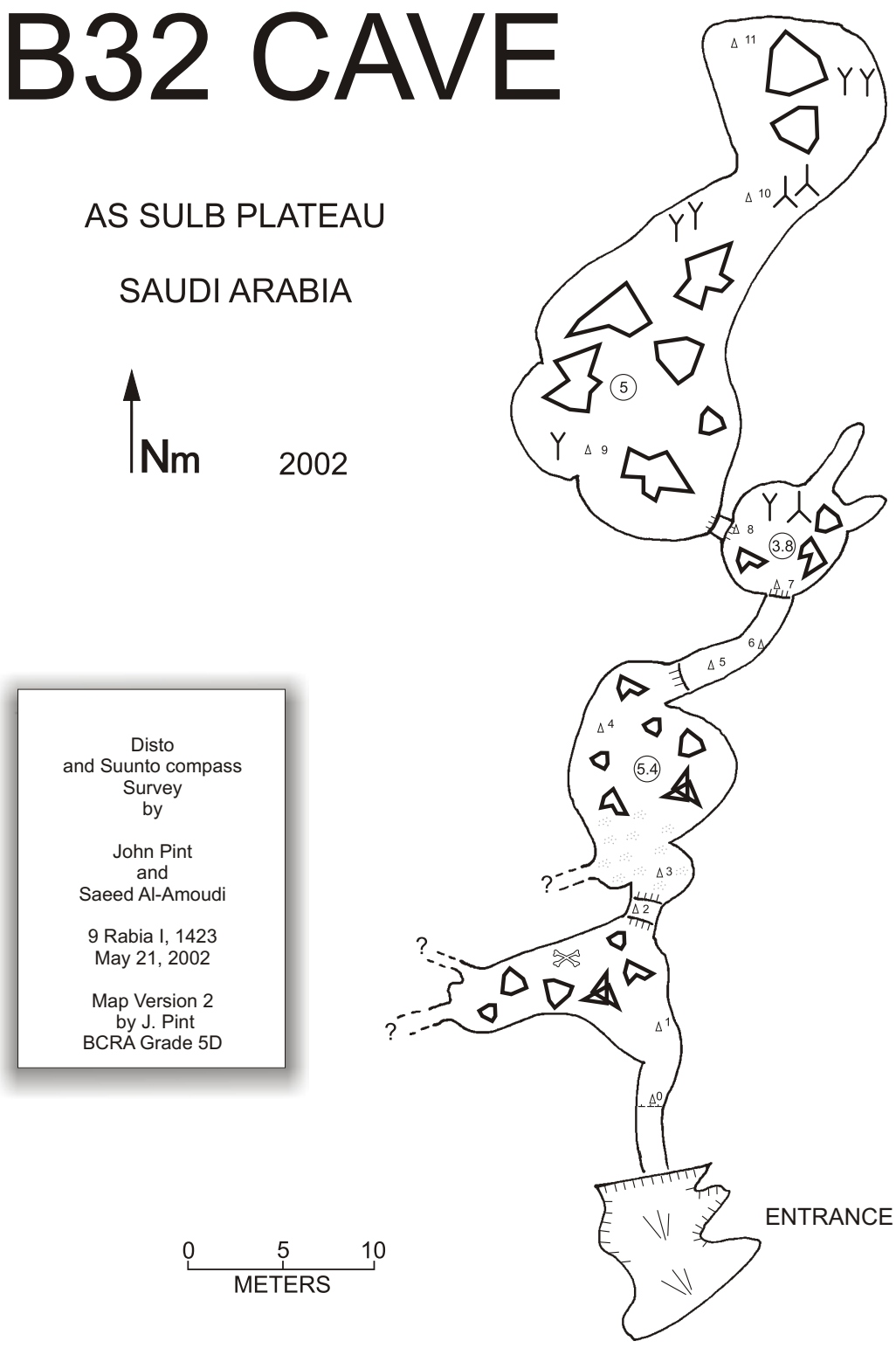


Figure 6: Map of B-32 Cave, located on the As Sulb Plateau north of Riyadh.

Figure 7: Entrance to B-32 Cave. No ropes or ladders are needed for entering it.

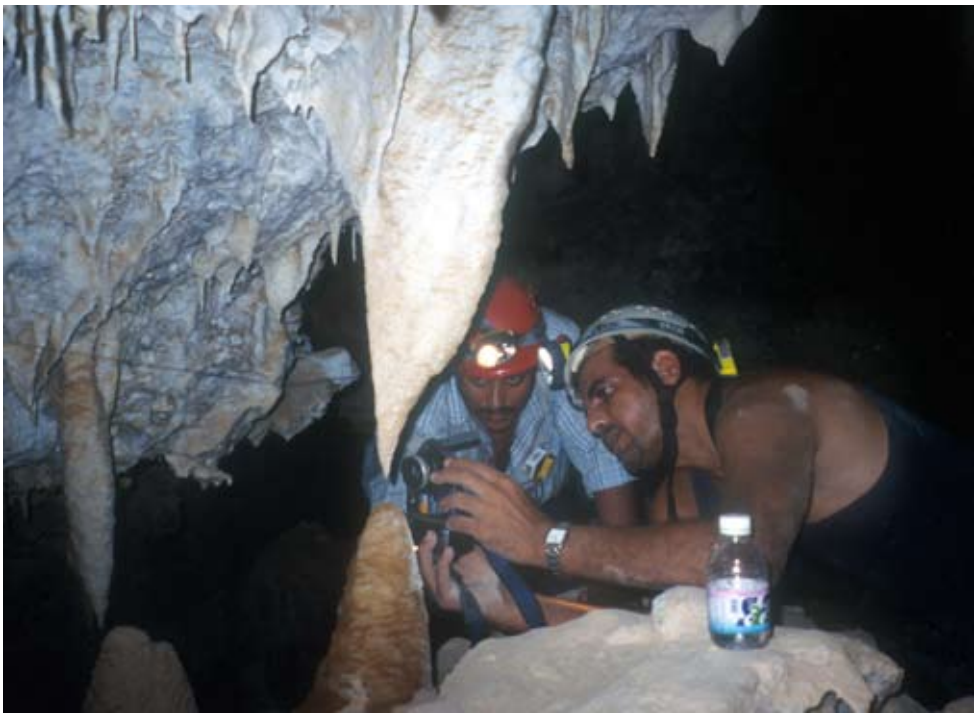


Figure 8: Spelothem display near station 10 of B-32 Cave.

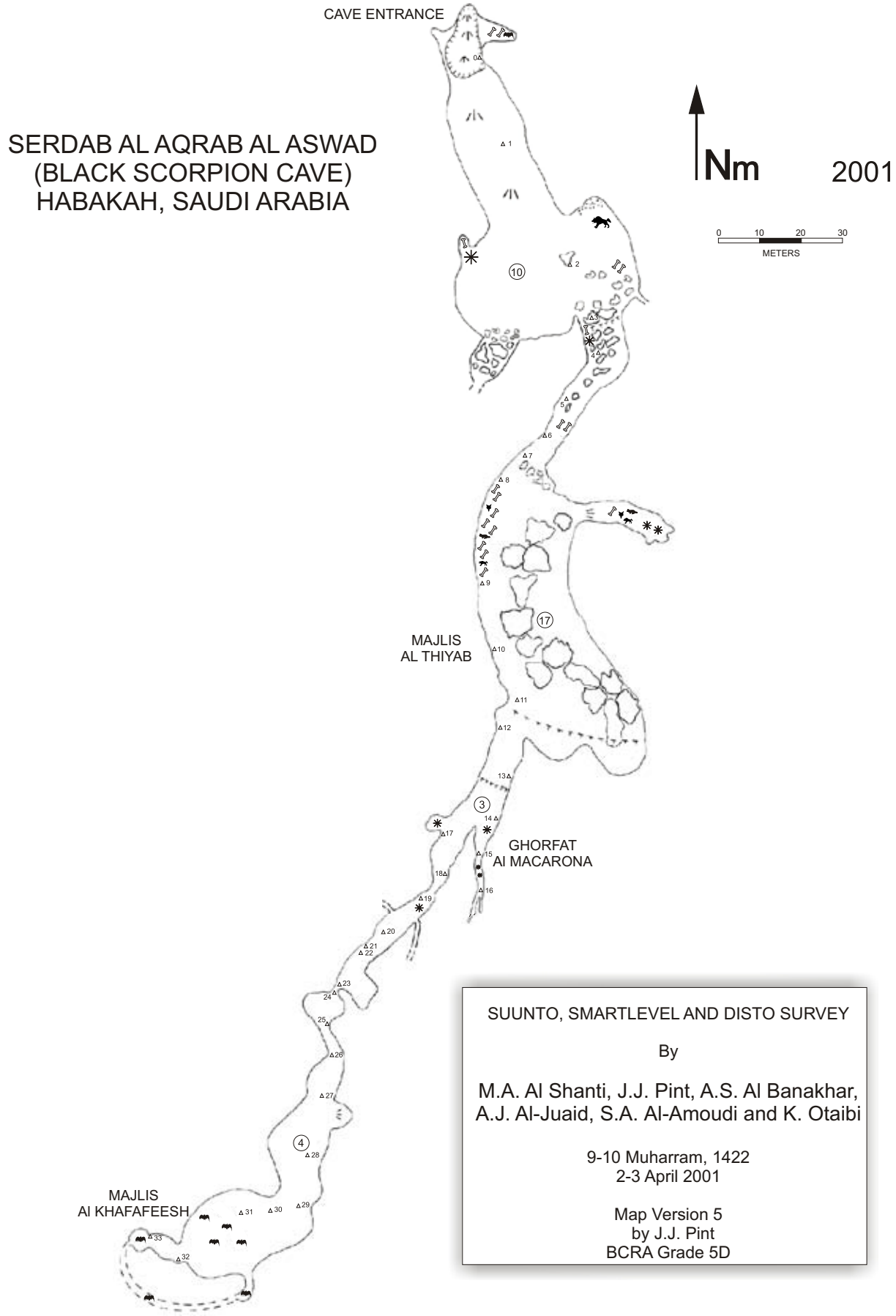


Figure 9: Map of Black Scorpion Cave, located in the far north of Saudi Arabia.

Figure 10: Entrance to Black Scorpion Cave seen from inside.

Figure 11: Large cache of bones between stations 8 and 9 in Black Scorpion Cave.

BUSHY CAVE
Harrat Kishb, Saudi Arabia

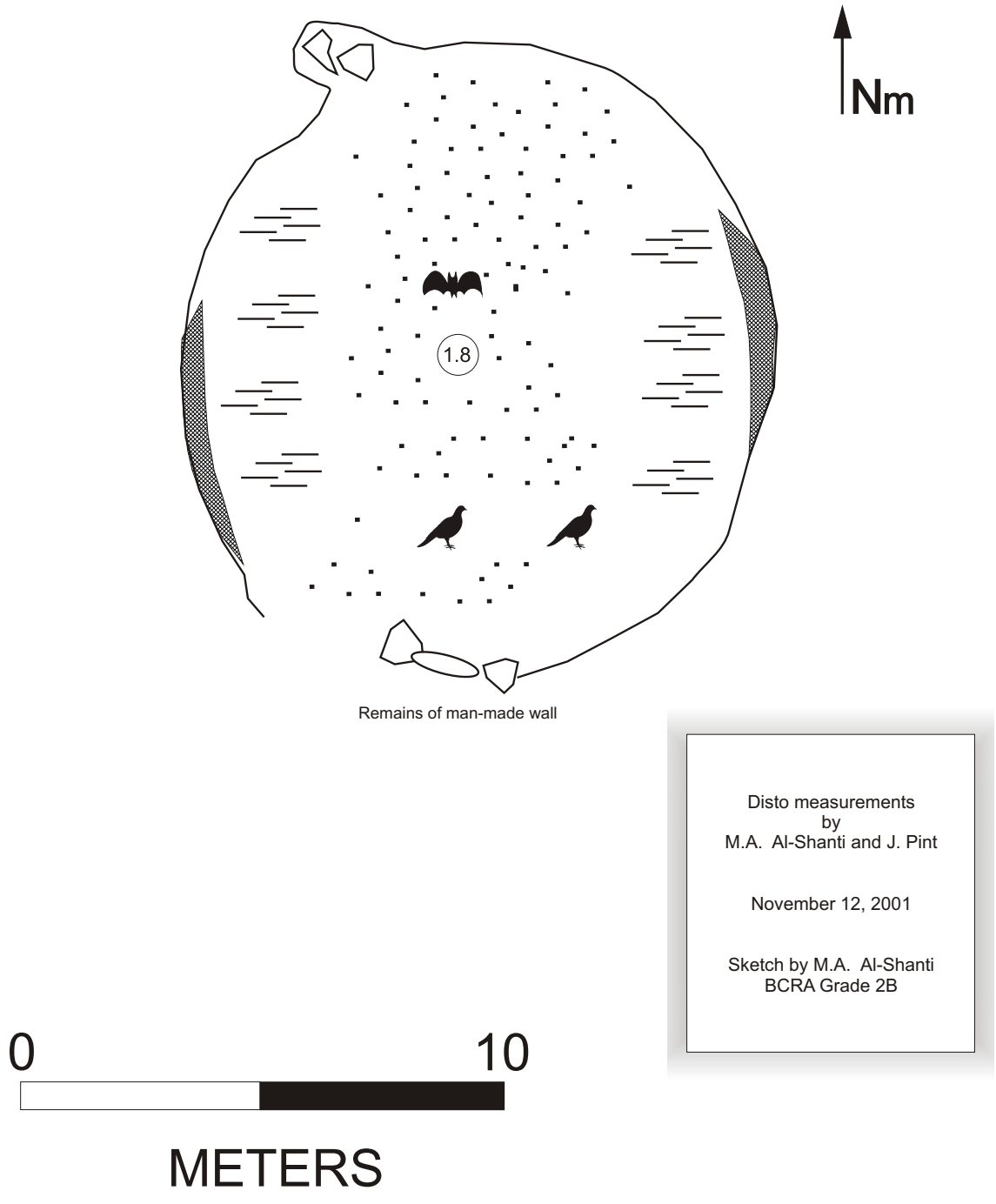


Figure 12: Sketch of Bushy Cave, located in Harrat Kishb.

Figure 13: Entrance to Bushy Cave inside a collapse area 6 meters in diameter.

Figure 14: View from the inside of Bushy Cave at a distance of 12 meters from the entrance.

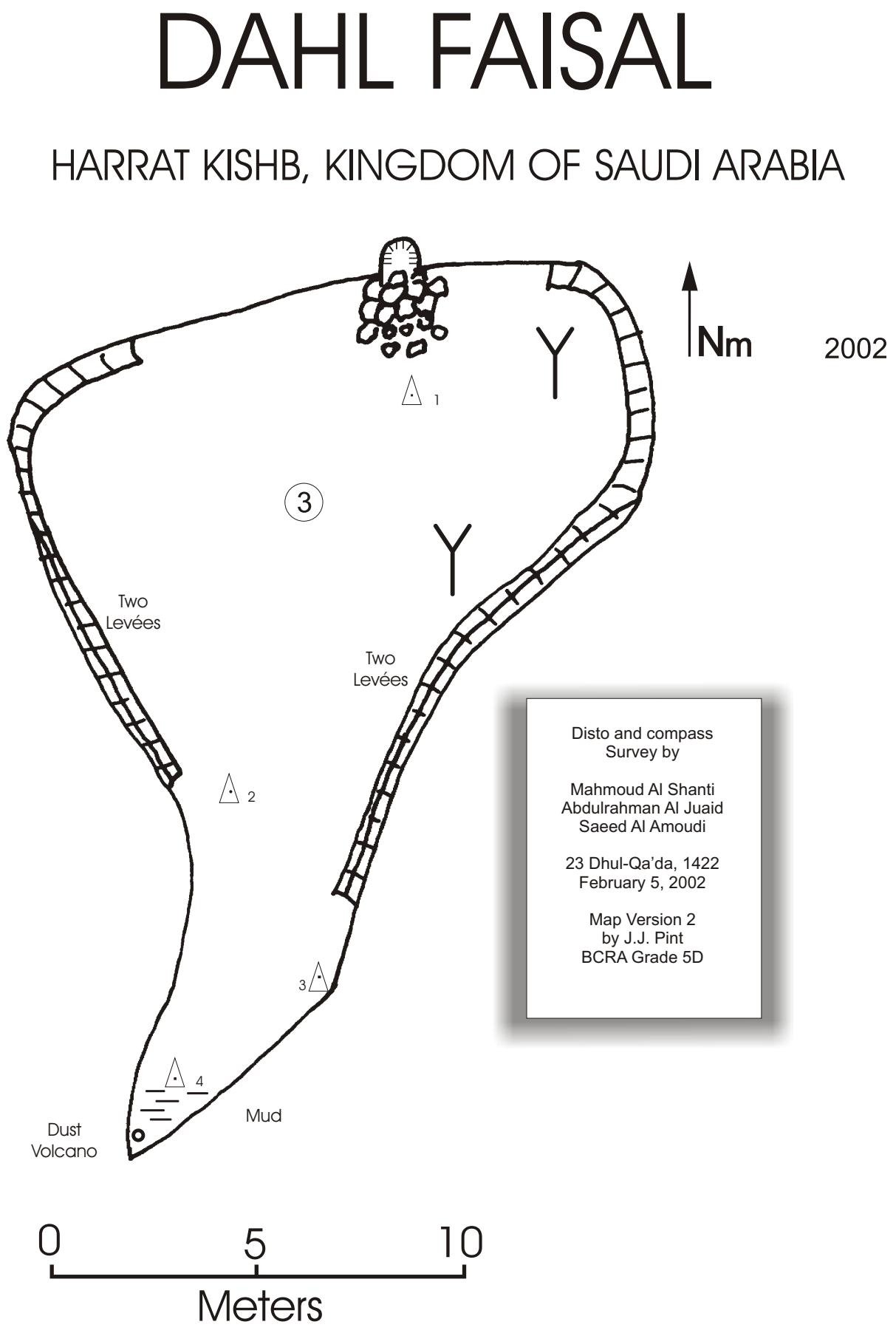


Figure 15: Map of Dahl Faisal, a lava tube located in Harrat Kishb.

Figure 16: Smooth-walled entrance to Dahl Faisal produced by air sucked into cave as lava flowed away

Figure 17: Surveying inside Dahl Faisal. Note lava stalactites on ceiling.

FRIENDLY CAVE

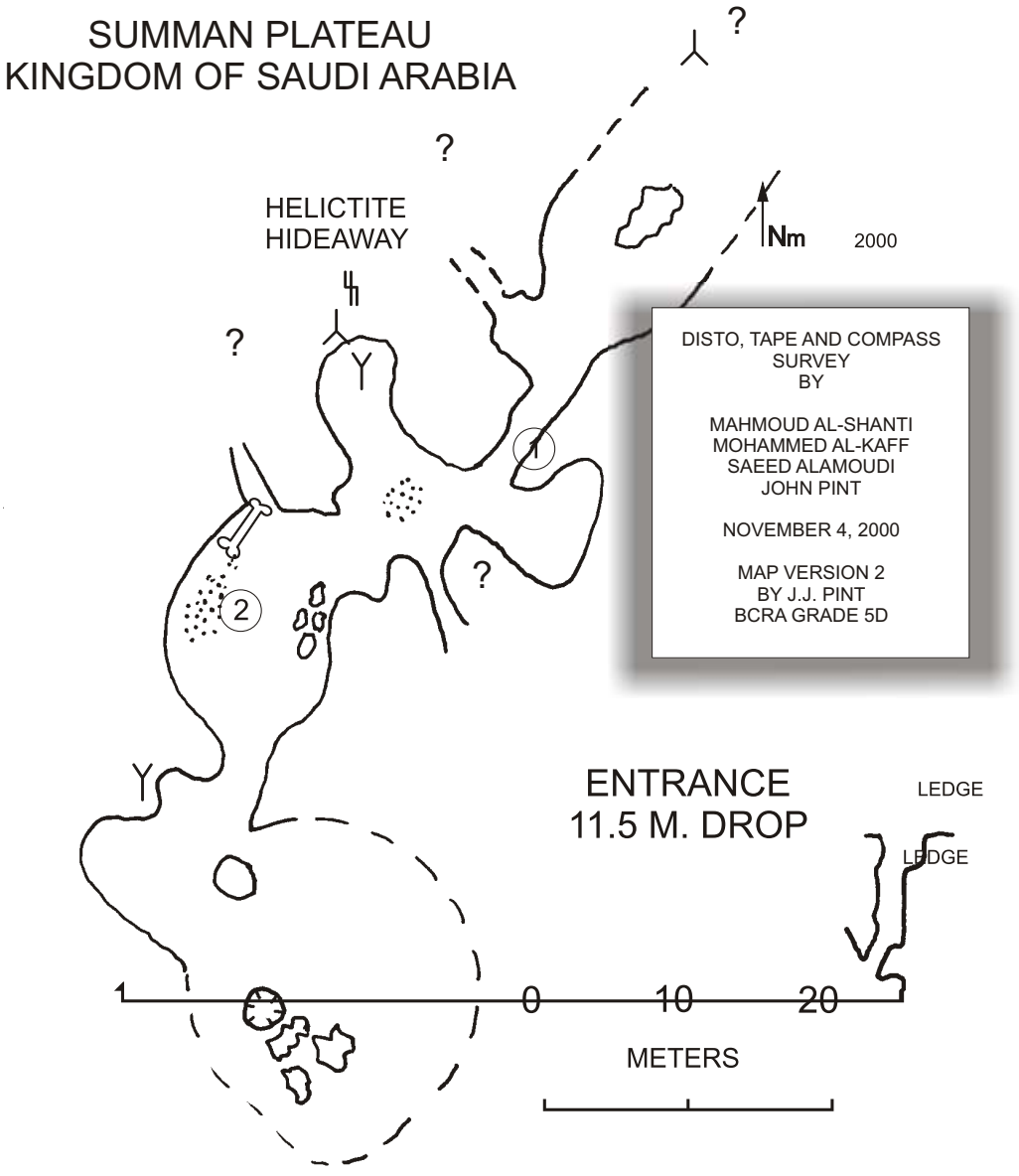


Figure 18: Map of Friendly Cave. Hundreds of meters of other passages remain to be surveyed.

Figure 19: The entrance to Friendly Cave, located on the As Sulb Plateau north of Riyadh. A Rope or ladder is needed for this cave.

Figure 20: Display of stalactites, helictites and stalagmites. Friendly Cave has potential for cave tourism.

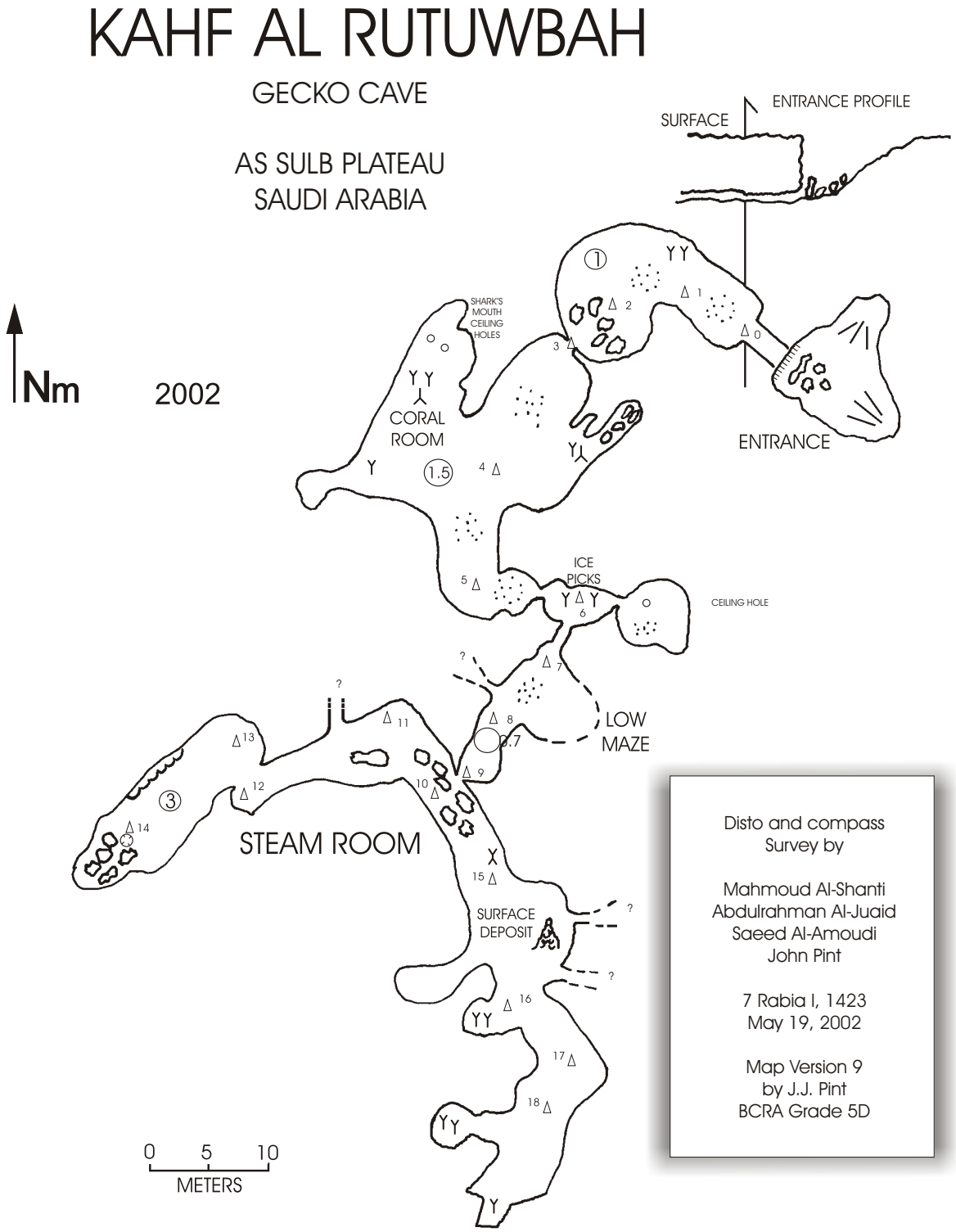


Figure 21: Map of Gecko Cave or Kahf Al Rutuwbah (which means "Steamy Cave").

Figure 22: Sandy floor and speleothems in the Coral Room of Gecko Cave.

Figure 23: Stalactites and helictites in Gecko Cave. Such displays are common throughout the cave.

KAHF AL ASHBAAH

(GHOSTLY CAVE)

HARRAT KISHB, KINGDOM OF SAUDI ARABIA

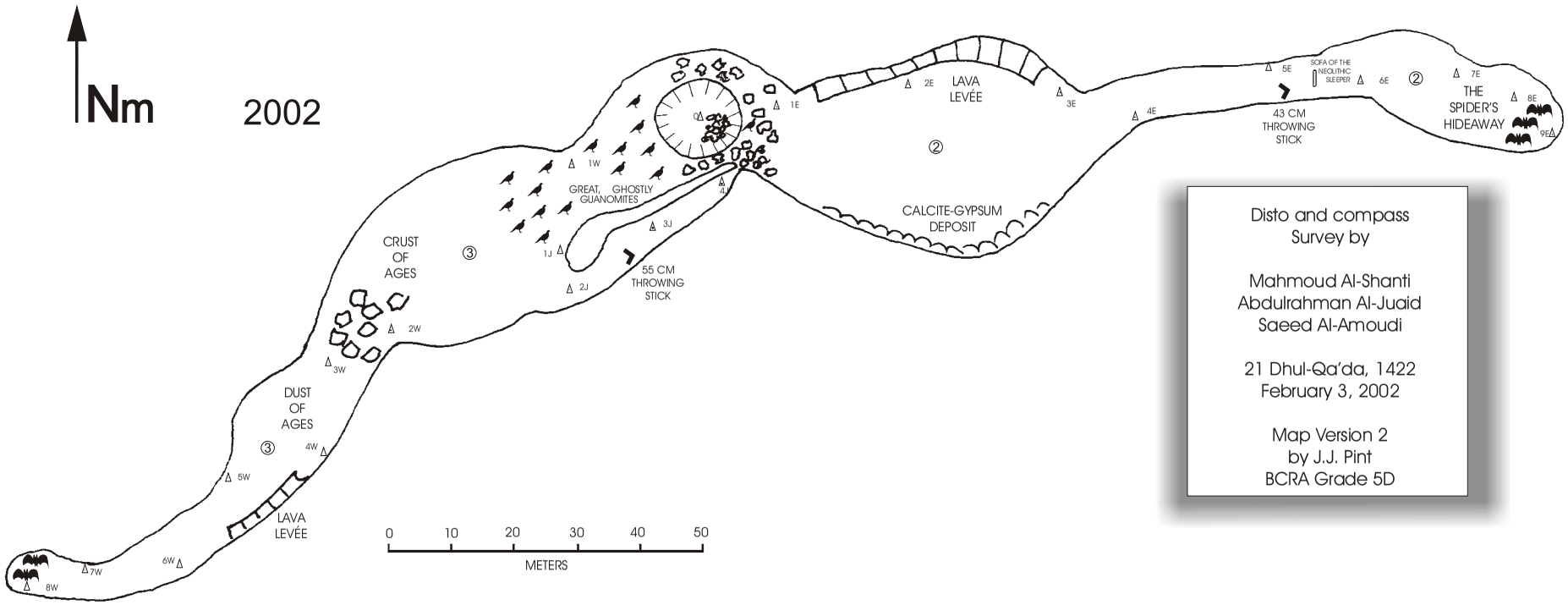


Figure 24: Map of Ghostly Cave, a lava tube located in Harrat Kishb.

Figure 25: Entrance to Ghostly Cave. A rope or ladder is needed to reach the floor seven meters below.

Figure 26: A surveyor at work at the entrance to the eastern wing of the cave. Two throwing sticks—possibly Neolithic—were found in this cave.

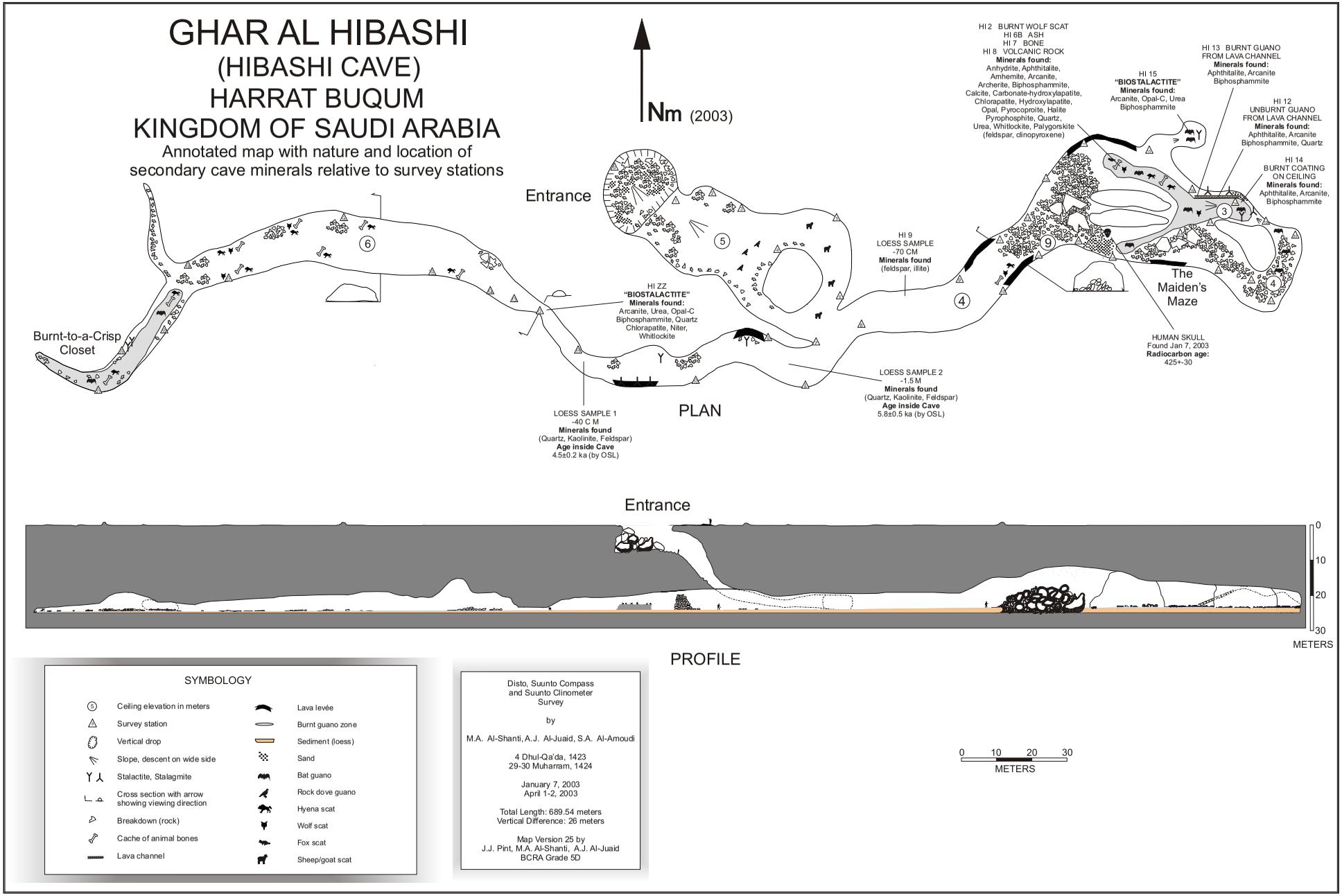


Figure 27: Map of Ghar Al Hibashi, a lava tube in Harrat Nawasif-Buqum.

Figure 28: The entrance to Hibashi Cave, a collapse 14 meters in diameter.

Figure 29: Lava stalagmites lining the wall of the western passage of Hibashi Cave.

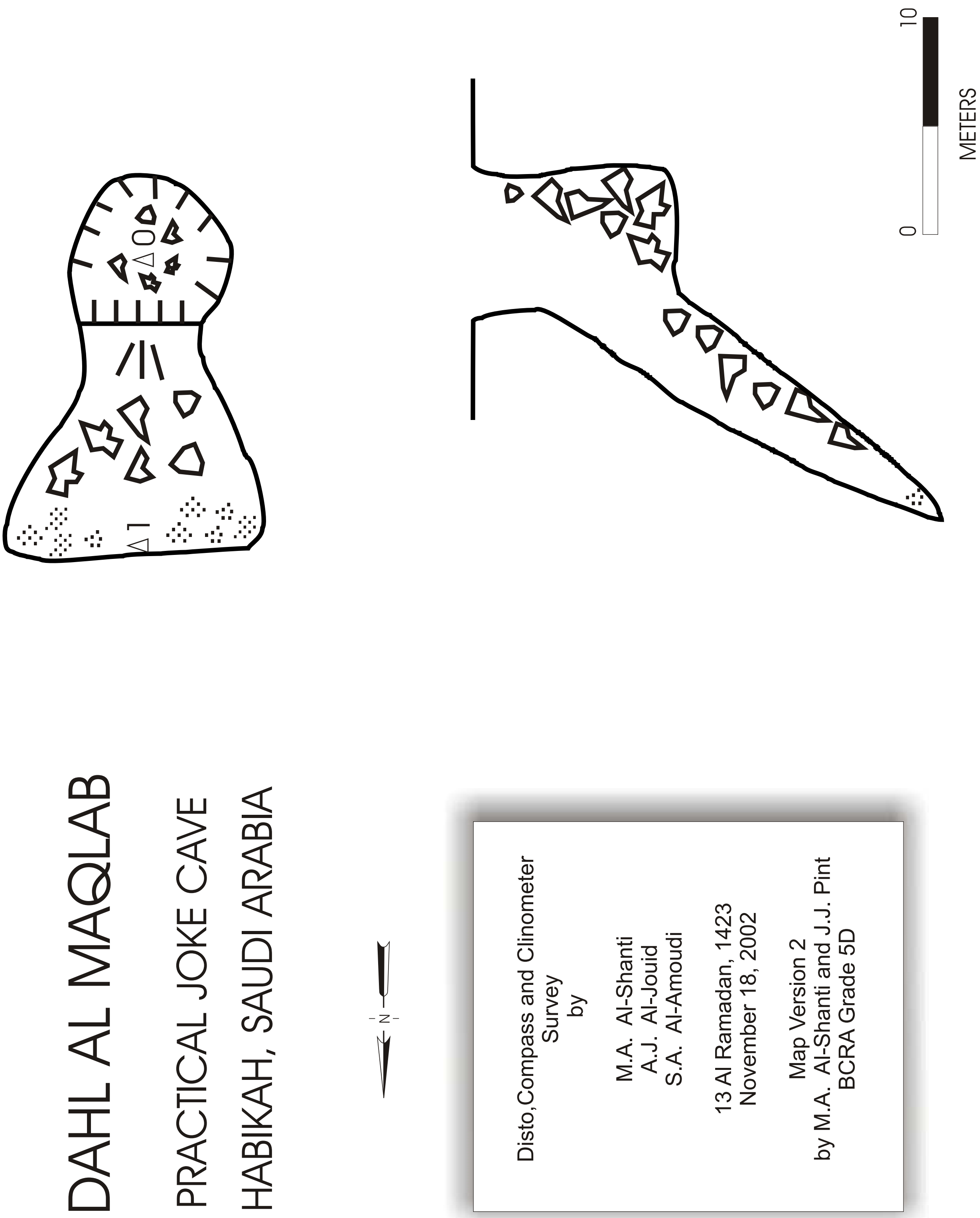


Figure 30: Map of Dahl al Maqlab, a limestone cave in the Habakah area of northern Saudi Arabia.

Figure 31: The impressive entrance to Dahl al Maqlab, which leads to a small cave of little consequence ("Maqlab" means "Practical Joke.")

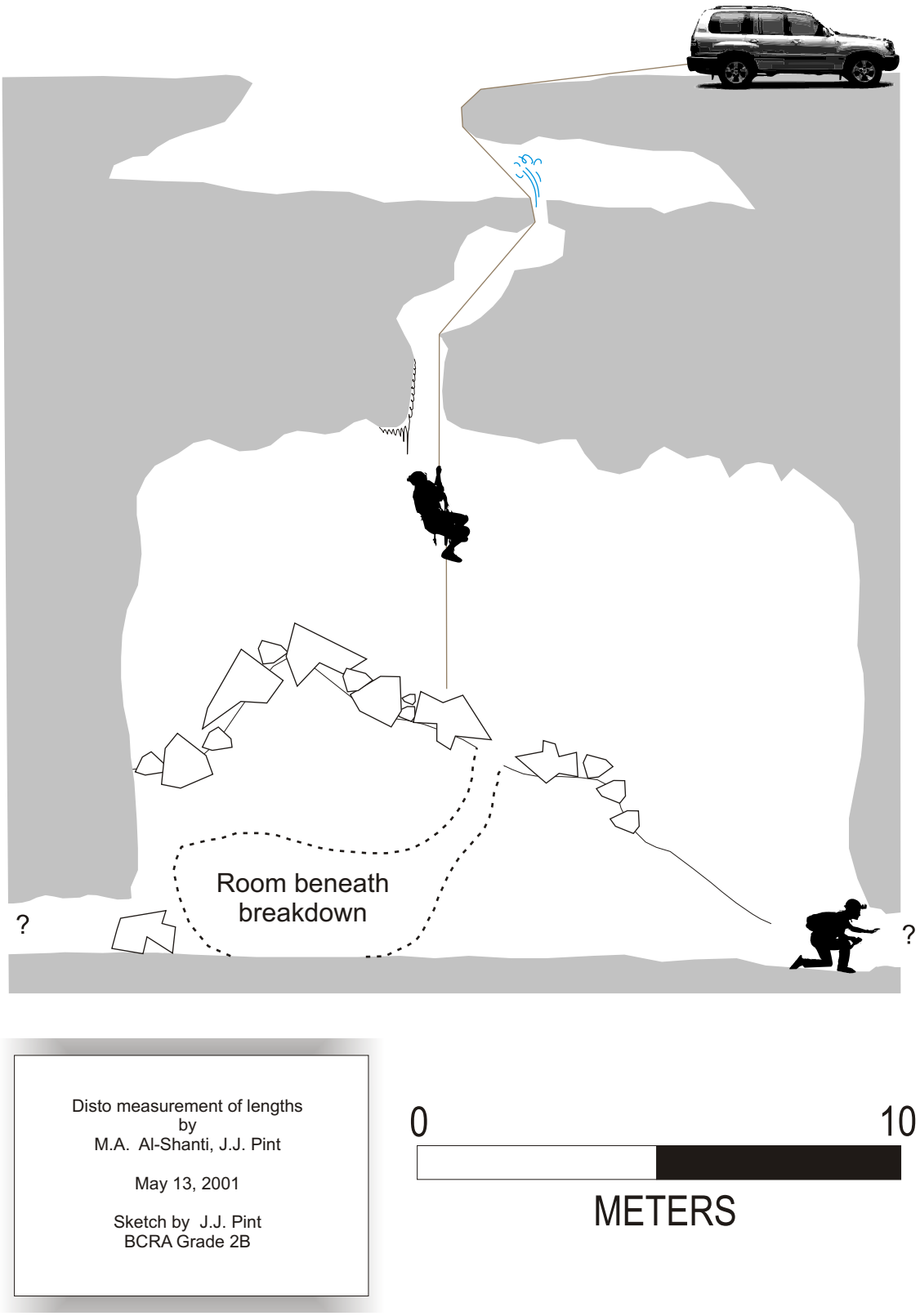


Figure 32: Map of Munbateh Blowhole Cave, a limestone cave located relatively near ‘Ar ‘ar in northern Saudi Arabia.

Figure 33: Full box of tissues suspended in the strong air flow above Munbateh Blowhole.

Figure 34: Flowstone covers the walls around the drop to the room located below the Munbateh Blowhole.

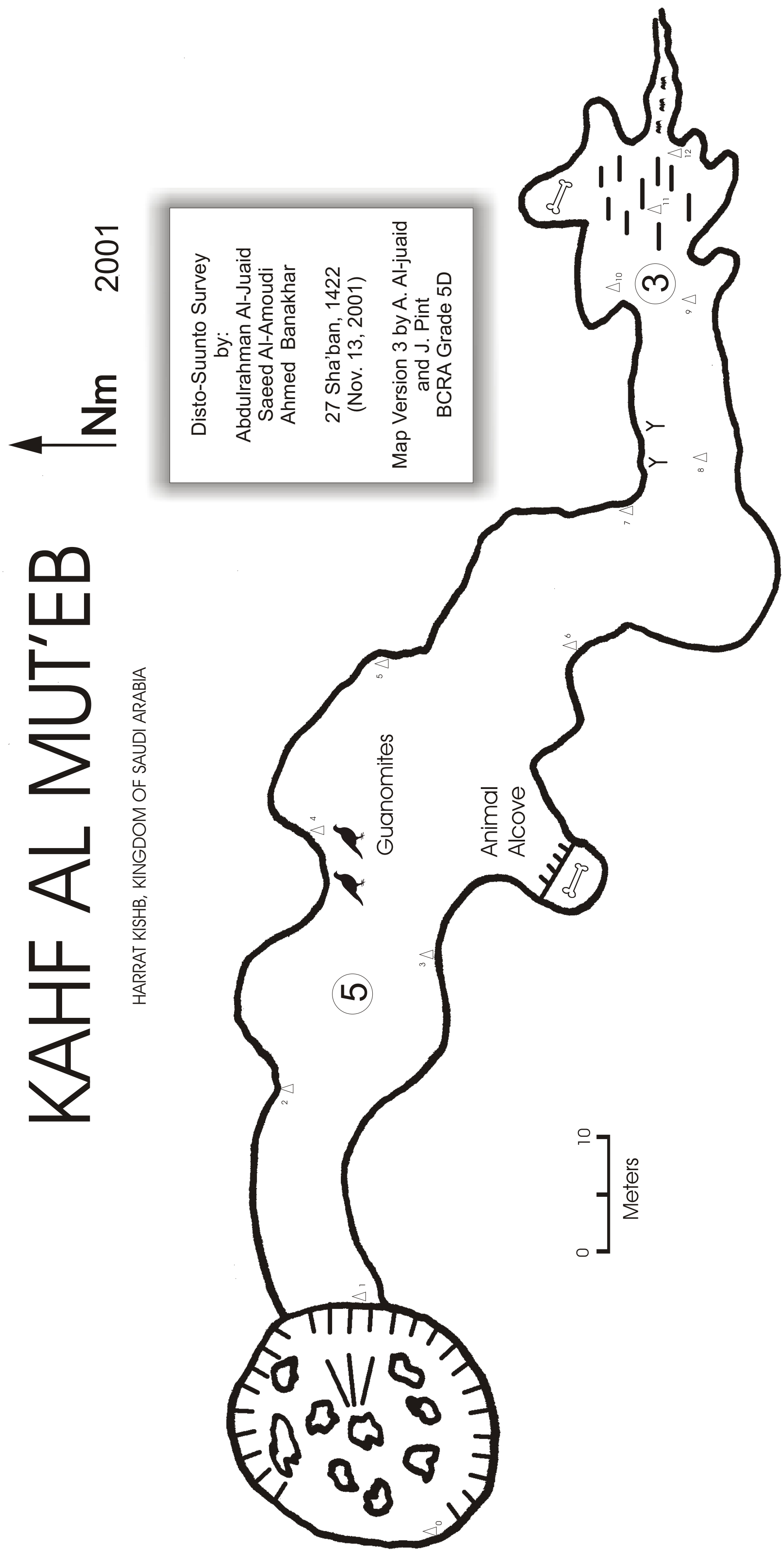


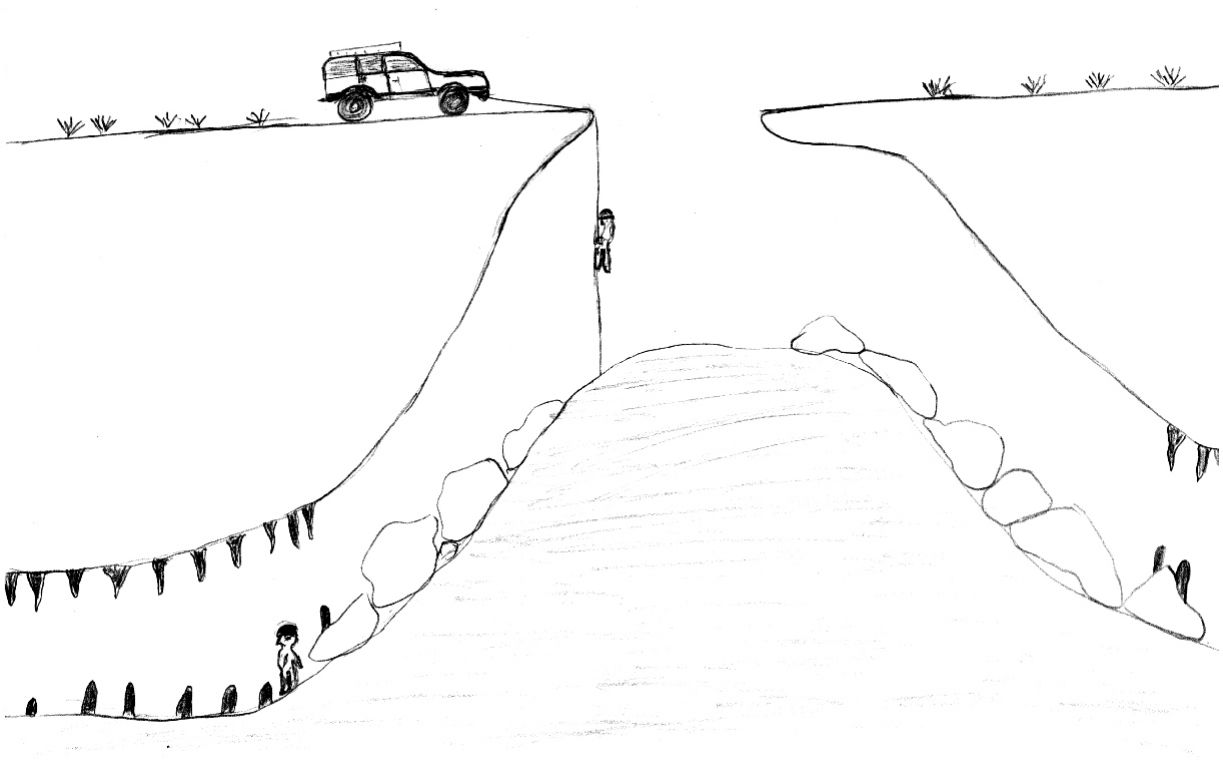
Figure 35: Map of Kahf Al Mut'eb, a lava tube in Harrat Kishb.

Figure 36: Geologists examine an ancient wall crossing the entrance to Kahf Al Mut'eb.

Figure 37: Stalagmites of rock-dove guano inside Kahf Al Mut'eb. The cave entrance is visible in the distance.

DAHL ABU RIJL MAKSURA

Habakah, Saudi Arabia



Disto measurements
by
M.A. Al-Shanti

October 29, 2001

Sketch by M.A. Al-Shanti
BCRA Grade 2B

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Figure 38: Sketch of Dahl Abu Rijl Maksura, located in the Habakah region of northern Saudi Arabia.

Figure 39: Entrance to Dahl Abu Rijl Maksura. A rope or ladder is needed to gain access to the cave.

Figure 40: "Rajil Maksura" means man with a broken leg, named after the person who tried to climb into the cave using the bedsprings shown here.

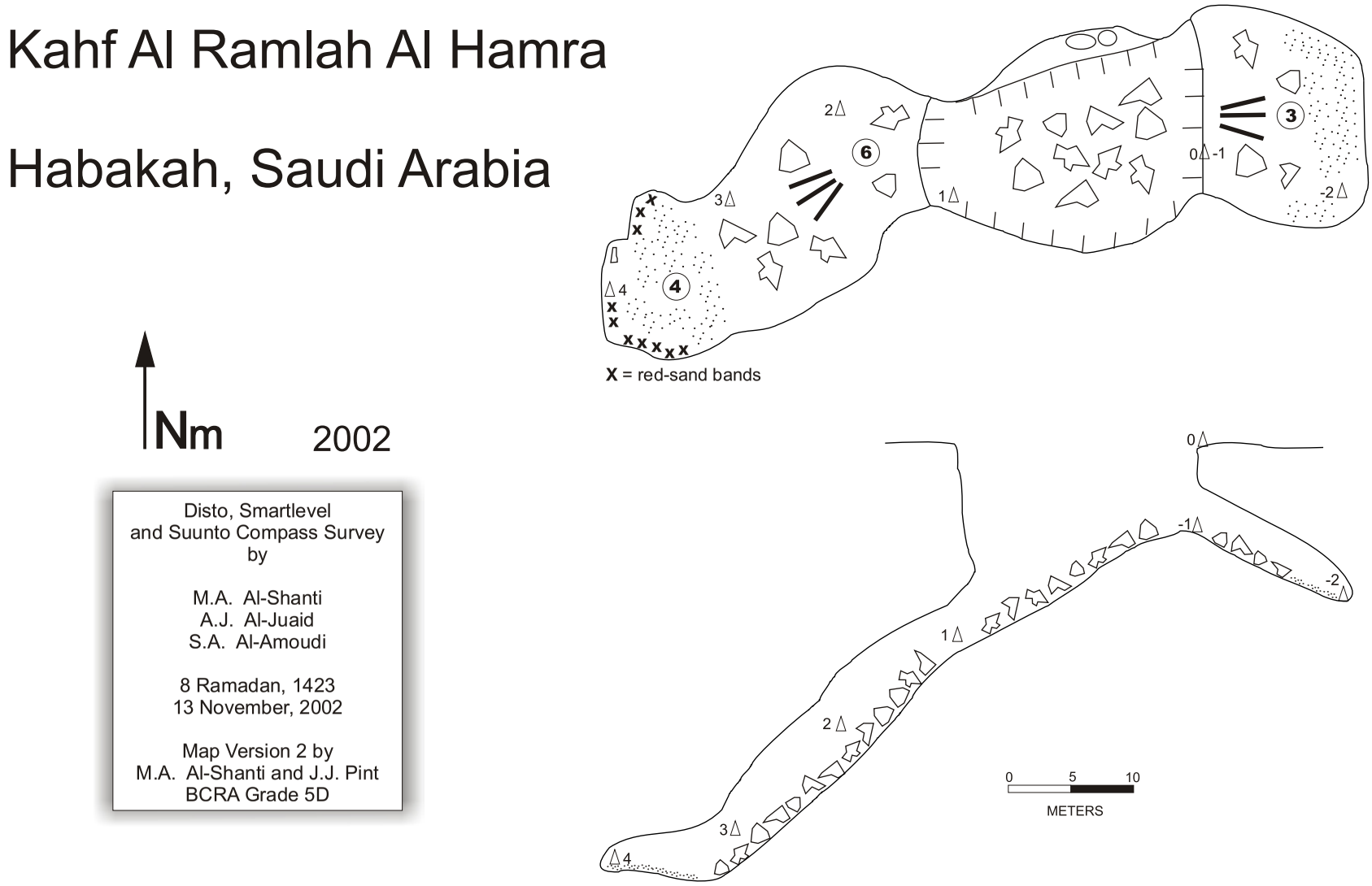

Figure 41: Map of Kahf Al Ramlah Al Hamra, located in the Habakah area of Saudi Arabia.

Figure 42: Twenty-two-meter-long entrance to Kahf Al Ramlah Al Hamra. No ropes or ladders are needed for entering this cave.

Figure 43: Iron oxide, interbedded with the fine-grained limestone, can be seen in the room at the bottom of Kahf Al Ramlah Al Hamra.

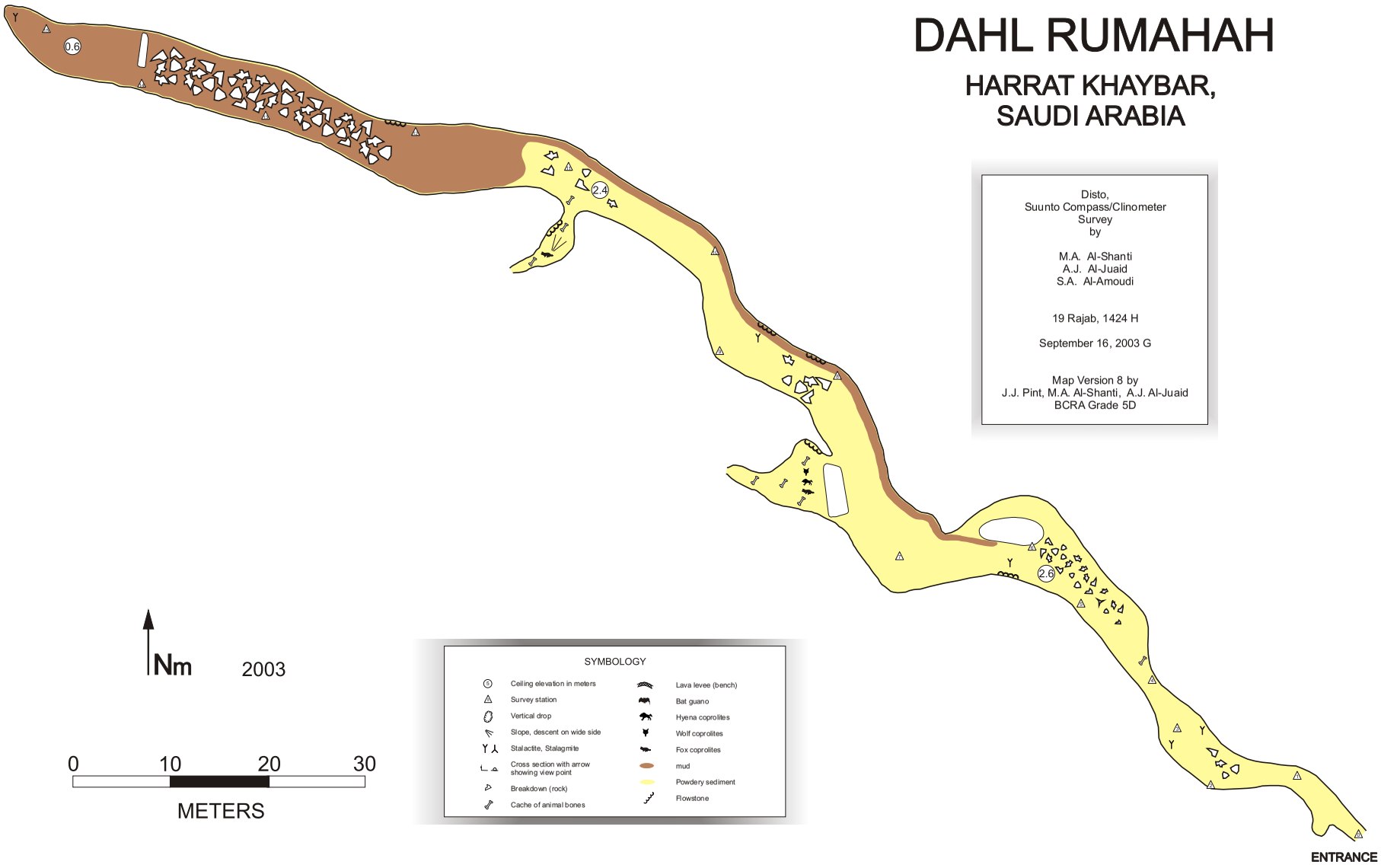

Figure 44: Map of Dahl Rumahah, located in Harrat Khaybar.

Figure 45: Entrance to Dahl Rumahah. A nearby low rock wall channels water into the cave during rain storms.

Figure 46: Calcite flowstone which has leaked into Dahl Rumahah through ceiling and wall cracks.

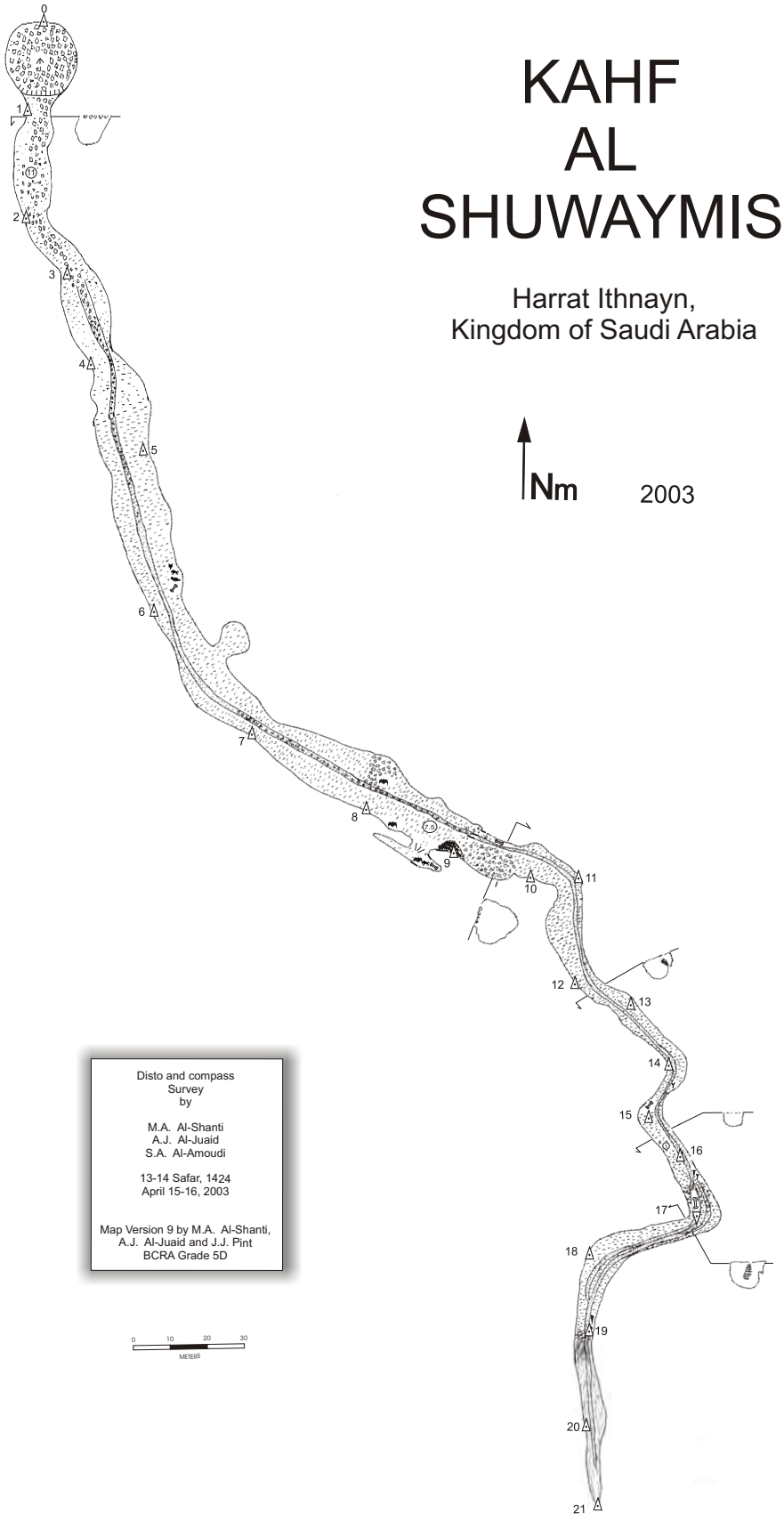

Figure 47: Map of Kahf Al Shuwaymis, a lava tube located at the foot of Hazim Al Khadra Volcano in Harrat Ithnayn.

Figure 48: Entrance to Kahf Al Shuwaymis, 15 m in diameter, seen from the foot of a slope covered with breakdown.

Figure 49: SGS Cave Unit speleologists place a radon-gas detector in Kahf Al Shuwaymis.

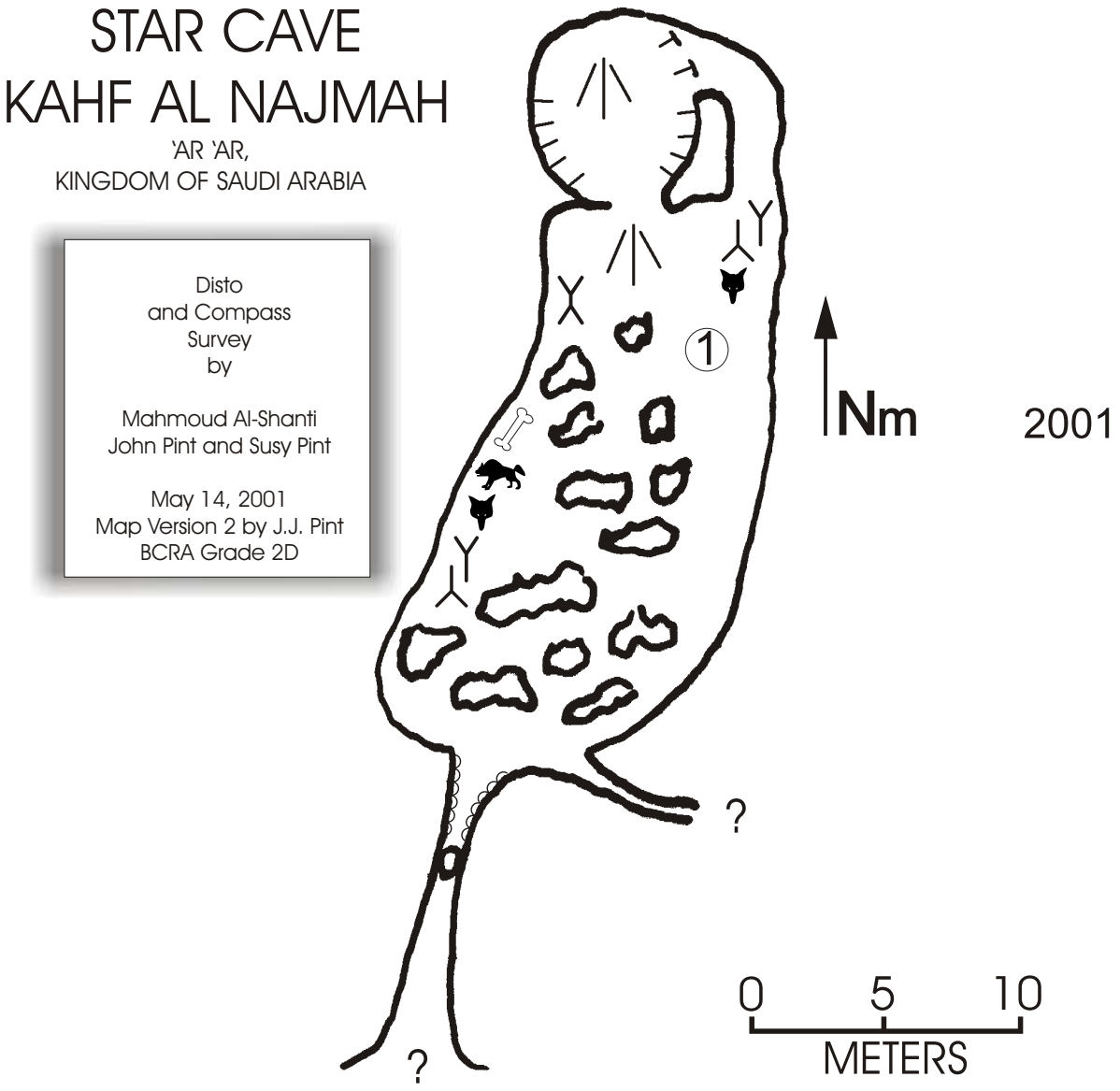

Figure 50: Map of Star Cave, located near 'Ar 'ar in Northern Saudi Arabia.

Figure 51: Entrance to Star Cave. A strong current of air blows in and out of this cave at most times.

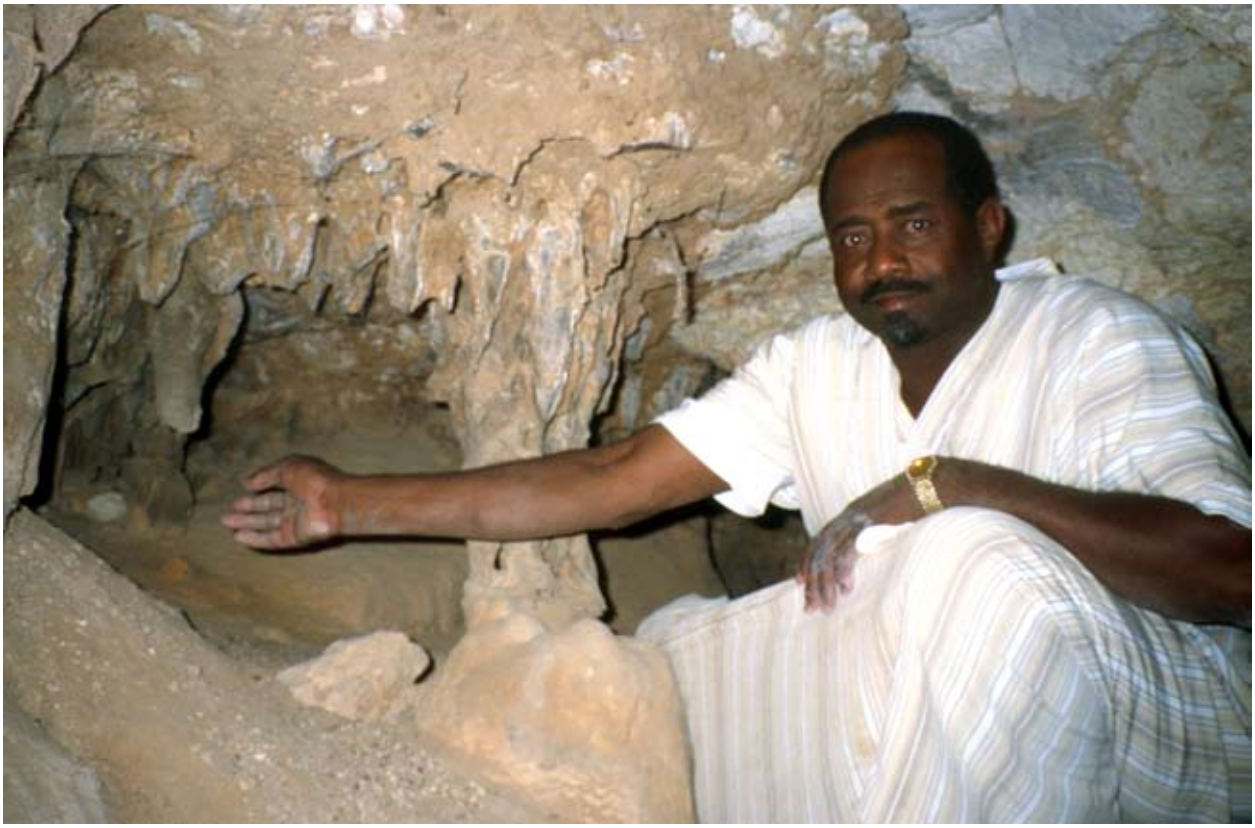

Figure 52: Flowstone, columns and other speleothems are found in Star Cave. They have been age-dated at over 400,000 years before present and are thought to be one million years old.

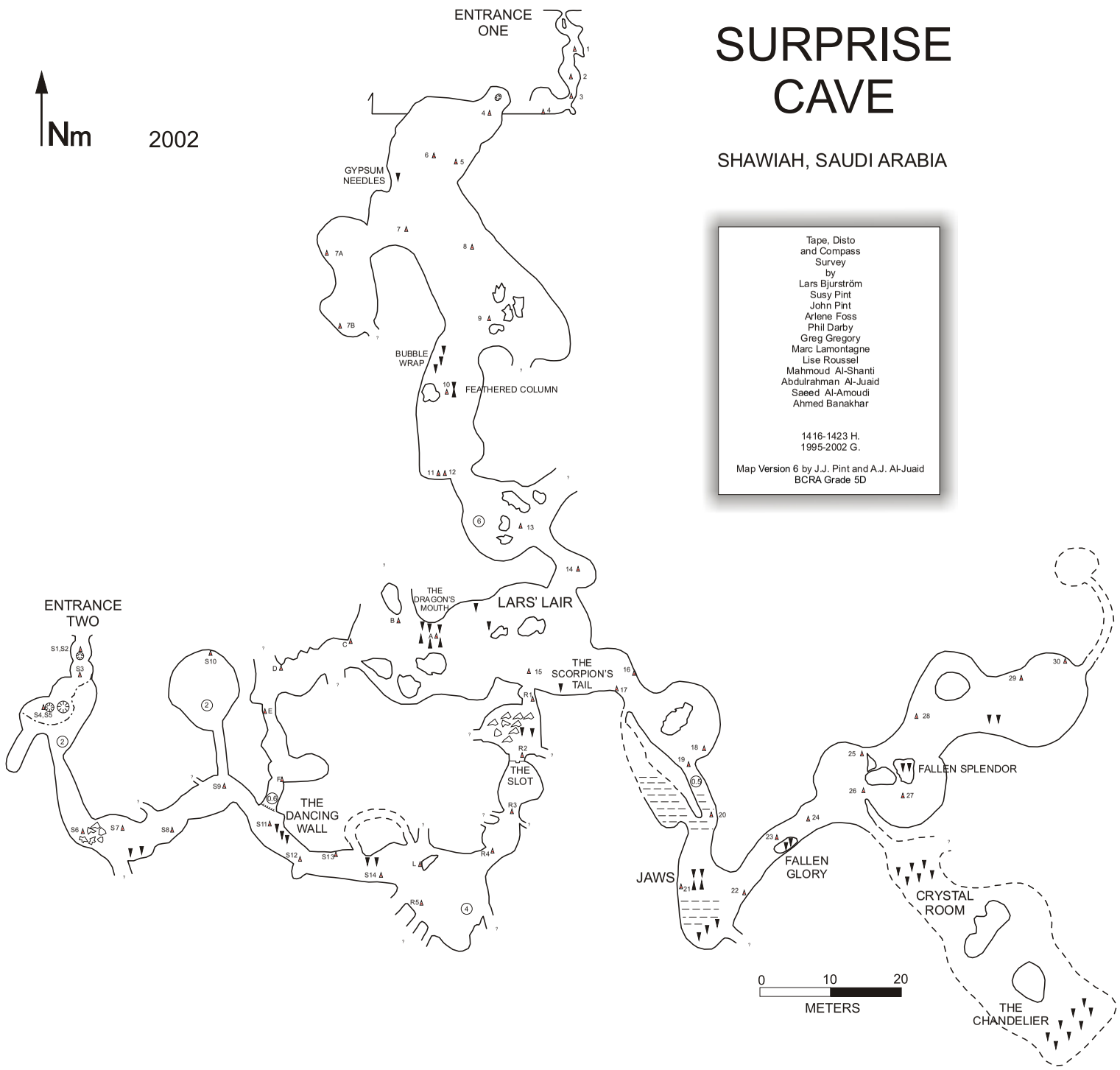

Figure 53: Map of Surprise Cave, located on the As Sulb Plateau, north of Riyadh.

Figure 54: Typical of many caves in the Ma'aqala karst, the 90-cm-diameter entrance to Surprise Cave leads to a labyrinth of hundreds of meters of passages below.

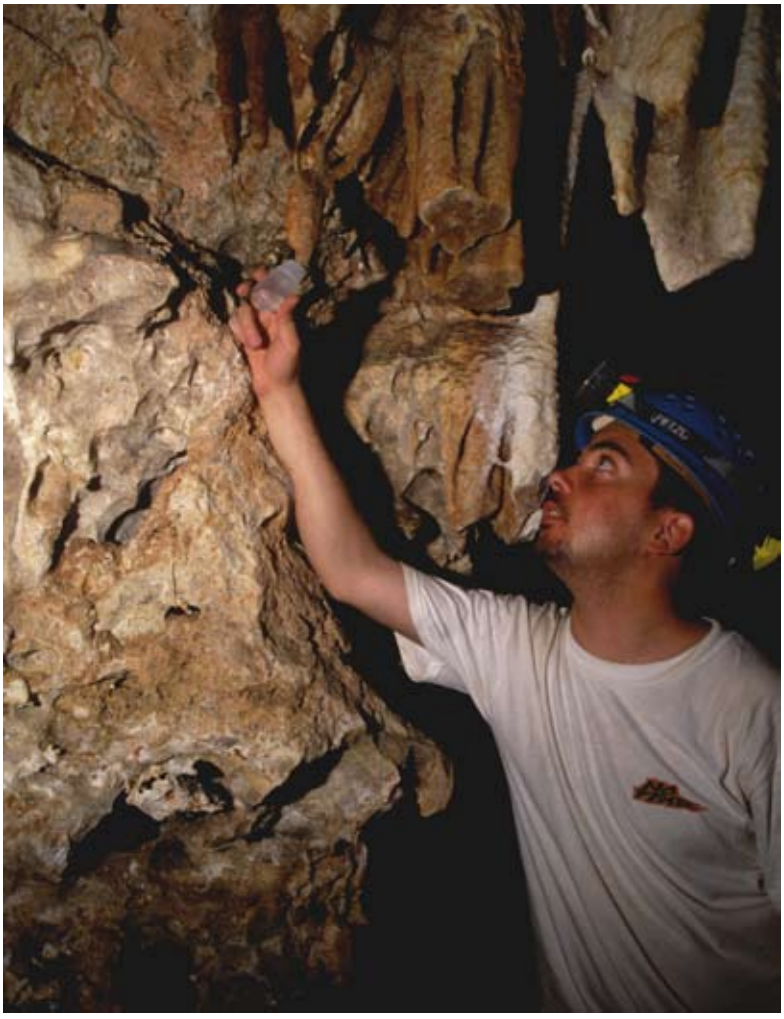

Figure 55: A geologist collects water samples in Surprise Cave. Many of the beautiful stalactites of this cave have been broken or removed by vandals.

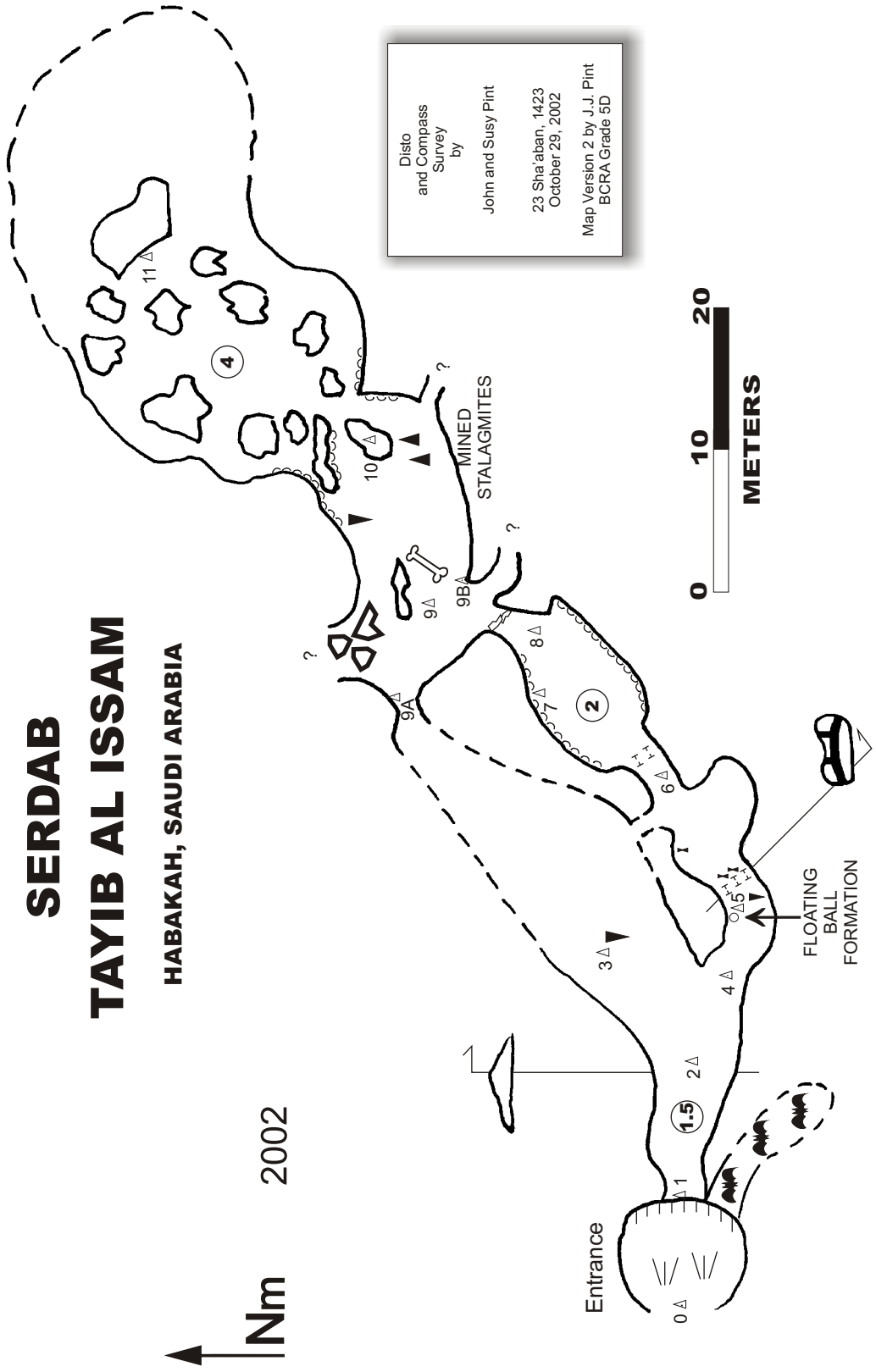

Figure 56: Map of Serdab Tayib Al Issim, located in the Habakah region of northern Saudi Arabia.

Figure 57: Six-meter-long entrance to Serdab Tayib Al Issim, which contains caches of animal bones and many impressive speleothems.

Figure 58: Graffiti on one of the formations in Serdab Tayib Al Issim. A system to protect caves from damage is badly needed in Saudi Arabia.