A study of Fountain National Park and Fountain Cavern

Anguilla, British West Indies

JEANNE GURNEE, EDITOR

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INTRODUCTION

by Russell H. Gurnee

During the past decade, the Anguillian government has been working with the Island Resources Foundation (a not-for profit organization in the U.S. Virgin Islands) in search of an appropriate resource management plan for the island. At the invitation of the government, the Island Research Foundation fielded a professional team to make an archaeological survey of the island. This preliminary study in 1979 revealed a series of surface aboriginal sites throughout Anguilla and one major underground discovery in Fountain Cavern that indicated the cave was visited more than 1,000 years ago.

Encouraged by this discovery, Dr. Edward Towle, President of the Foundation, recommended that the Anguillian government contact the National Speleological Foundation in the U.S.A.

The National Speleological Foundation had just completed a study of Harrison's Cave for the Barbados government and the cave was now open to the public. Representatives of the Anguillian government visited Barbados to see the project, and then requested the National Speleological Foundation make a similar study for Fountain Cavern.

Fountain National Park was created by the government of Anguilla, and in 1987 a Fountain National Park Development Committee was formed to manage the funds for the development of the cave and park facilities and for the promotion and initial management plan for the Park's operation. Members of the committee are listed above.

The purpose of this report is to record scientific investigations of the site followed by a plan to modify the cave and park in order to preserve, protect, and exhibit the underground environment and petroglyph area in Fountain Cavern. The project would present a safe, educational, and entertaining visit for the public as well as provide preservation techniques for the fine archaeological evidences in the cave. In the Caribbean it has been demonstrated at Harrison's Cave, Barbados, and Parque de las Cavernas del Rio Camuy, Puerto Rico, that show caves can provide outstanding attractions for visitors, protect the natural environment, and provide a fine economic return.

The Fountain Cavern study is a cooperative effort by many individuals and several organizations to provide a working plan for the preservation and protection of an unusual archaeological site so that visitors may experience the outstanding culture and natural history of Anguilla.

PART ONE

Fountain Cavern Reports

SUMMARY REPORT ON THE ARCHAEOLOGY OF FOUNTAIN CAVERN

by David R. Watters, Ph.D.

INTRODUCTION

This is a summary report of archaeological investigations undertaken at Fountain Cavern during a research trip to Anguilla, British West Indies, between 5 and 17 January, 1986. The research was conducted at the request of the Anguilla Archaeological and Historical Society (AA&HS) and the Government of Anguilla. At the request of the AA&HS, a preliminary report (Watters, 1986) and final report (Watters, 1987) were provided. This summary report is extracted from the final report.

METHODOLOGY

The strategy used in assessing the prehistoric archaeology of Fountain Cavern involved a general survey of the floor of the cavern, excavation of test pits in selected parts of the cavern, examination of the known petroglyphs, and analysis of recovered artifacts and faunal remains. At the request of the AA&HS, the majority of the time spent in Fountain Cavern was devoted to excavation of test pits.

General Survey

A general survey of the cavern floor took place during the first two days of the project. From an archaeological standpoint the cavern can be segregated into two chambers. Chamber 1 includes the area under the vertical entrance and the domed ceiling in the front of the cavern (Fig. 1). Chamber 2 begins at a raised platform occupying the middle part of the cavern and continues west into its deepest recesses. Chamber 1 contains almost all of the observed archaeological remains.

Entry into Fountain Cavern is by way of a vertical steel ladder. Under the entrance is a relatively level area from which the floor of Chamber 1 slopes sharply downward to the southeast, south, and southwest. Pool 1, a freshwater pool, is found along the south wall of Chamber 1. The floor of Chamber 2 is flat compared to the sloping floor of Chamber 1, The raised platform in the middle of the cavern marks the boundary between chambers and raises the floor of Chamber 2 to a higher elevation.

Extensive spalling from the ceiling and walls has occurred in Fountain Cavern and soil depths vary. Within Chamber 1, the major soil deposits occur beneath the entrance, on the slope, and against the southeast and south walls. They often have greater quantities of spall than soil. Sediment deposition on Chamber 2 is negligible.

Archaeological Survey

Examination of the cavern's floor confirmed that cultural materials were largely confined to Chamber 1, as were all known petroglyphs (Douglas, 1985, 1986), and most artifacts previously surface collected by the AA&HS. Chamber 2 revealed very few artifacts on the surface and, given the very shallow depth of sediments, it is unlikely that any major cultural deposit occurs in that sector of the cavern.

Two areas of Chamber 1 contained abundant cultural materials on the surface. The first, termed "Surface Area A," was located near Pool 1 at the base of a major stalagmite, atop of which is a carving listed by the AA&HS as petroglyph No. 12 and labeled "Jocahu" or "The Creator" by Douglas (1986). The second area, "Surface Area B," was located along the south wall of the cavern including where that wall meets Pool 1.

Based on the results of the archaeological survey as well as the previous work undertaken by the AA&HS, it was decided to focus the testing effort initially in Chamber 1, followed by a check of the shallow sediments in Chamber 2.

Test Pits

Three test pits were excavated in Fountain Cavern, two of which were in Chamber 1 and one on the raised platform in Chamber 2 (Fig. 1). All test pits were 1 by 1 meter. They

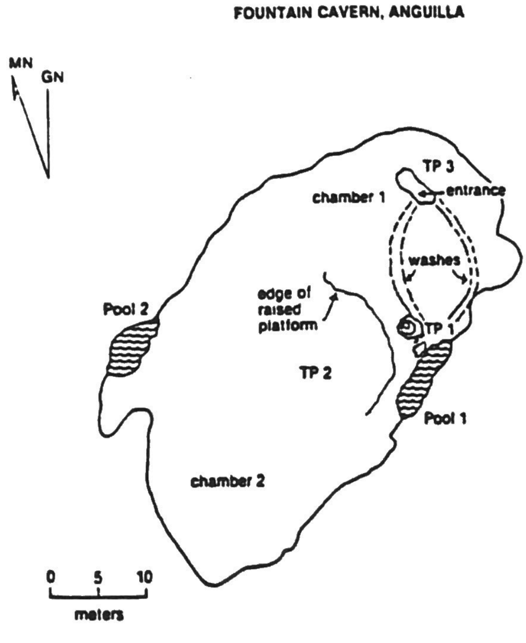

Fig. 1. Map of Fountain Cavern showing locations of test pits.

were dug to bedrock and all natural and cultural materials were removed. Deposits were screened through 1/8-inch wire mesh and materials were segregated by units.

Test pit 1, located in the southwest section of Chamber 1, was positioned between the base of the large stalagmite with petroglyph No. 12 and the base of a nearby flat-topped stalagmite (with petroglyph No. 11). Although four soils were identified in test pit 1, Soil 4 was the principal deposit and it occurred to a depth of about 155 cm. (Fig. 2). It has been characterized as a soil, but that designation is somewhat misleading because a large amount of the volume of the deposit consisted of spall. In fact, it is really more accurate to think of the matrix as consisting primarily of fragmented rocks and broken speleothems with many cavities containing patchy accumulations of soil. Excavation of test pit 1 was further complicated by intrusion of the stalagmite base into the pit. The stalagmite occupied almost 50% of the area at the bottom of the test pit 1 (Fig. 2).

Artifacts were found throughout test pit 1. However, it was clear that many of these artifacts had been transported downward through the crevices and holes found among the rocks in Soil 4. Cultural materials clearly were mixed at different depths and were not in good stratigraphic context. Artifacts from test pit 1 cannot be regarded as being in primary context when excavated.

The second test pit was excavated in Chamber 2 on the raised platform in the middle of the cavern (Fig. 1). The reasons for excavating test pit 2 were to verify the shallow depth of deposit and confirm the paucity of artifacts. The sediment was composed of bat excrement and decomposing limestone. Across most of the test pit the depth did not exceed 5 cm. above bedrock. Two pieces of partially buried prehistoric pottery were recovered from the surface.

Test pit 3 was dug on the east side of the relatively level area beneath the entrance to Fountain Cavern (Fig. 1). This location was chosen because of its position by the only known entrance to the cavern, its proximity to a number of petroglyphs, and its expected depth of deposit. Two soils were identified in test pit 3. Soil 1 overlays bedrock to a depth of about 30 cm. A number of crevices and holes penetrated into the bedrock and a fissure near the northwest corner reached a depth of about 75 cm. below ground level. Soil 2 occupied these crevices and holes.

Artifacts were recovered only from Soil 1, which yielded both prehistoric and historic objects throughout the test pit. Once again, the artifacts cannot be regarded as being in primary context because of the obvious mixing of cultural remains.

CONSIDERATIONS AND RECOMMENDATIONS

If Fountain Cavern is to be developed, the development can and should fulfill two purposes simultaneously. It can serve an economic role by being developed as a facility to enhance tourism on the island. At the same time, it can serve an educational role for the people of Anguilla. Such economic and educational roles do not have to be mutually exclusive; instead they can be complementary ones if each is planned carefully.

In the preliminary and final reports (Watters, 1986,1987), a number of general recommendations for appropriate themes were made. Only the Amerindian occupation theme, knowledge of which is derived from archaeological research, will be discussed in this summary report.

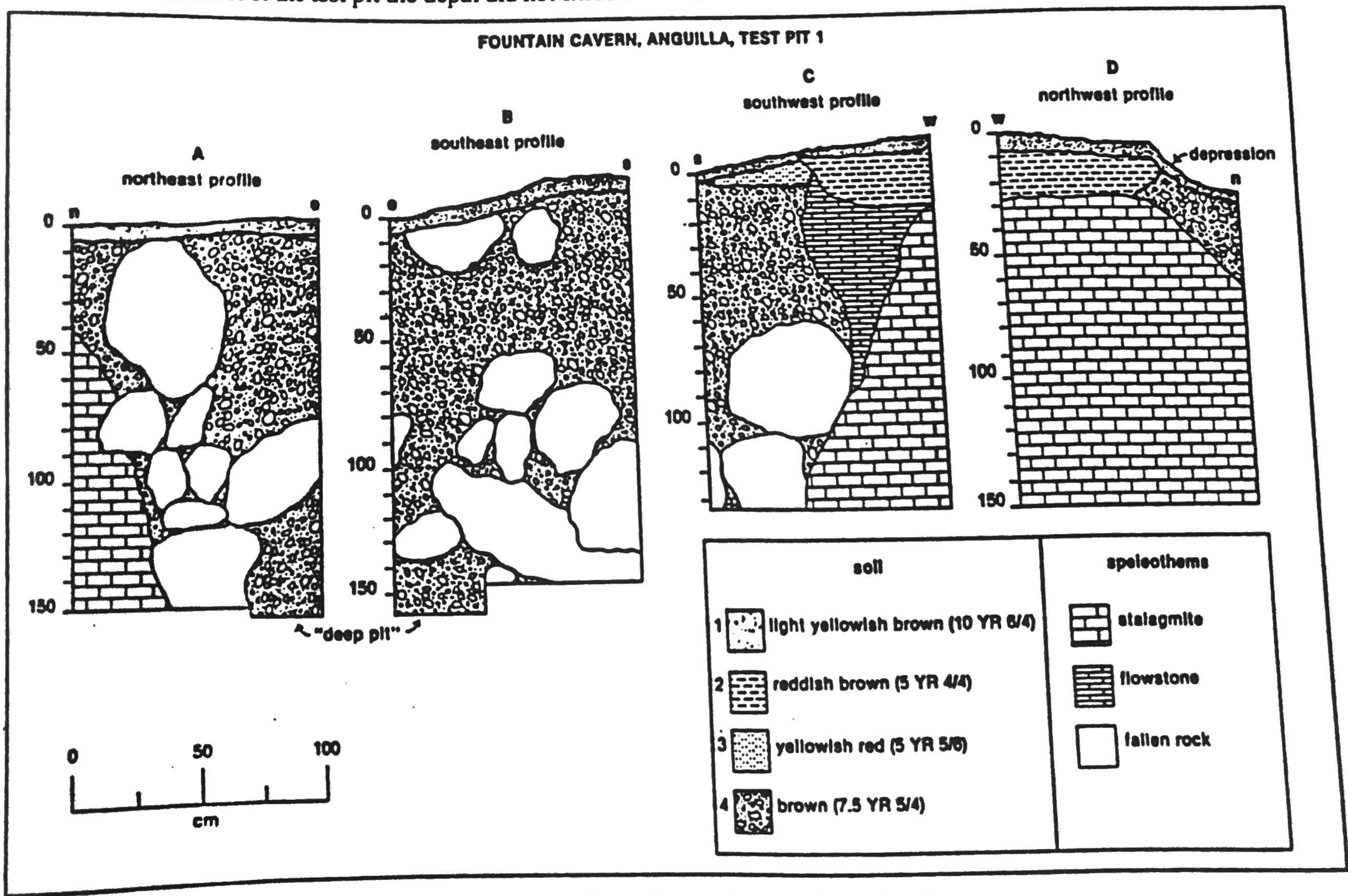

Fig. 2 - Four profiles of test pit 1 at Fountain Cavern.

Fountain Cavern has the potential to become a very important facility for interpreting the culture of the Amerindian peoples of the Caribbean. The major focus within the cavern would be the petroglyphs themselves. Nowhere in the Lesser Antilles is there a site with so many well preserved petroglyphs, so Anguilla really has an opportunity to present something unique to the public. Activities related to the archaeology of Fountain Cavern should be centered in Chamber 1, where all of the petroglyphs occur. Fountain Cavern appears to have been a ceremonial site for the Amerindian population of Anguilla. In considering how to develop Fountain Cavern, serious thought should be given to ways of enhancing the ceremonial aspects as related to the petroglyphs.

Fountain Cavern can be developed into a spectacular site by drawing on three strengths: (1) the well preserved petroglyphs, (2) the ceremonial center theme, and (3) making use of known Amerindian myths and legends about caves, associated fauna (e.g., bats), and deities. These are appropriate themes to develop and present to visitors within the cavern itself. Here the visitor should experience the dramatic, the enlightening, and the entertaining.

The museum/interpretation center at the entrance of the cave would be the main educational component of the complex, where the visitor (whether a tourist or an Anguillian) should have opportunity to learn, to contemplate, and to wonder. When he leaves the center, he should be more knowledgeable about the cavern, its fauna and flora, and the Amerindian occupation.

SUMMARY

The Government of Anguilla has the opportunity to develop Fountain Cavern in an enlightened manner that serves to enhance both the economic and educational roles that the cavern can play. No other Lesser Antilles island has a resource that combines the natural and cultural aspects to the extent that Fountain Cavern does. In this sense, the cave provides an unique opportunity for Anguilla to showcase its farsighted, long-term development plan.

From the archaeological standpoint, the petroglyphs provide the ideal motif or focus around which the ceremonial function of the cavern should be dramatically developed for the visitor. At the same time, the above ground museum/interpretation center provides the ideal facility for carrying out the educational role for tourists and Anguillians. Artifacts recovered from Fountain Cavern can be used to enhance the visitor's experience in the museum.

The Government of Anguilla and the Anguilla Archaeological and Historical Society should actively pursue plans to adequately develop Fountain Cavern as a major tourist attraction and an educational facility. It has the capability to enlighten, inspire, educate, and entertain the visitor. With proper planning and attention to detail, Fountain Cavern would become a centerpiece for appropriate development strategies in the eastern Caribbean.

ACKNOWLEDGMENTS

The archaeological fieldwork would not have been possible without the cooperation of the Government of Anguilla and the assistance of the Anguilla Archaeological and Historical Society. Support for the archaeological survey of Fountain Cavern included a Canadian International Development Agency (CIDA) grant to the Government of Anguilla and funds from the M. Graham Netting Research Fund of The Carnegie Museum of Natural History, Pittsburgh, Pennsylvania.

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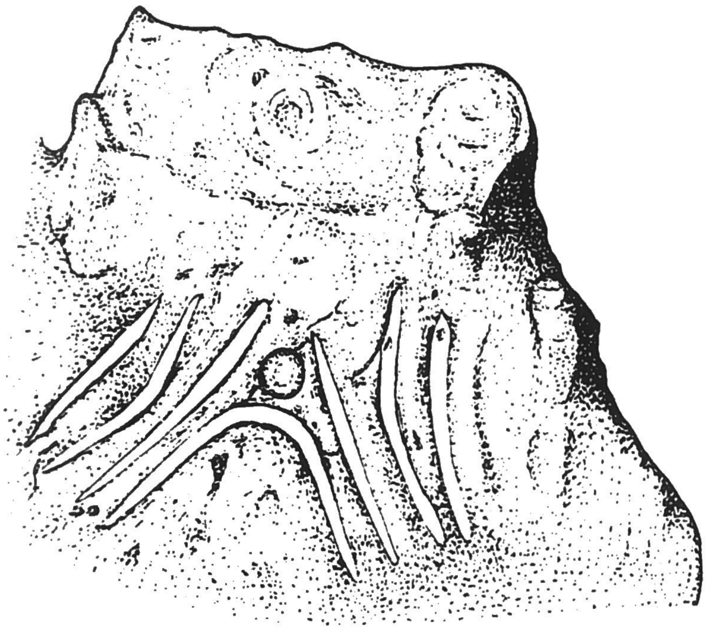
THE PETROGLYPHS OF FOUNTAIN CAVERN

by Nik Douglas/Illustrations by Penny Slinger



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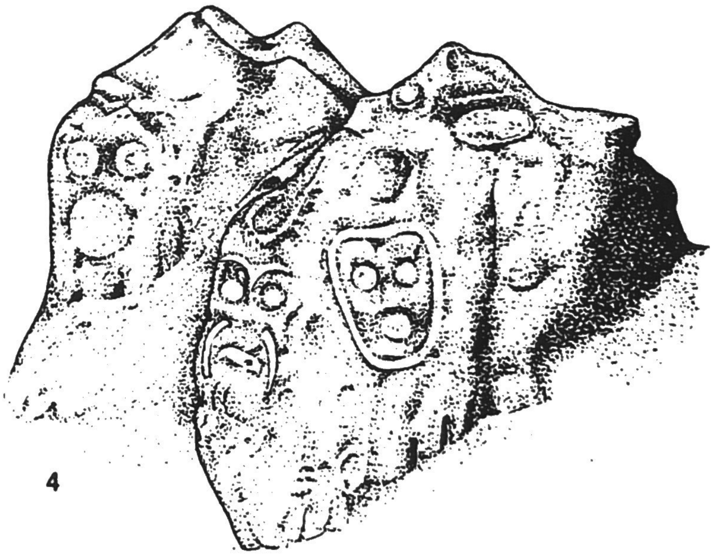


4

3 2

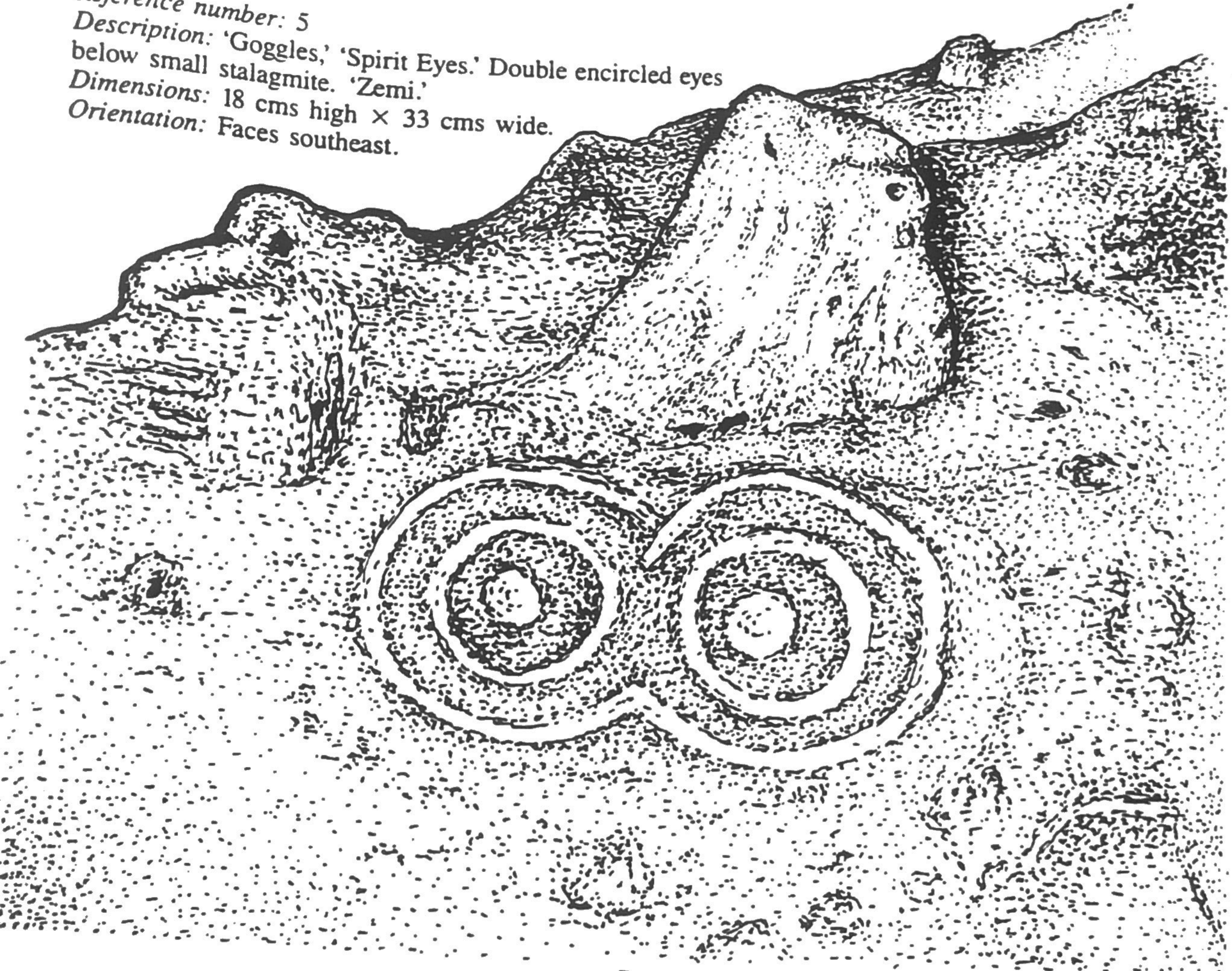
Reference number: 1
Description: Arc with chevrons and solar orb, possibly with eyes above. 'Juluca' rainbow deity.
Dimensions: 20 cms high × 30 cms wide.
Orientation: Faces east.

Reference number: 2
Description: Encircled face. 'Ancestor.'
Dimensions: 14 cms high × 12 cms wide.
Orientation: Faces east.

Reference number: 3
Description: Plain face with cheek markings. 'Ancestor.'
Dimensions: 14 cms high × 10 cms wide.
Orientation: Faces east.

Reference number: 4
Description: Face with wide eyes and mouth. 'Ancestor.'
Dimensions: 16 cms high × 12 cms wide.
Orientation: Faces east.

Reference number: 5
Description: 'Goggles,' 'Spirit Eyes.' Double encircled eyes below small stalagmite. 'Zemi.'
Dimensions: 18 cms high × 33 cms wide.
Orientation: Faces southeast.



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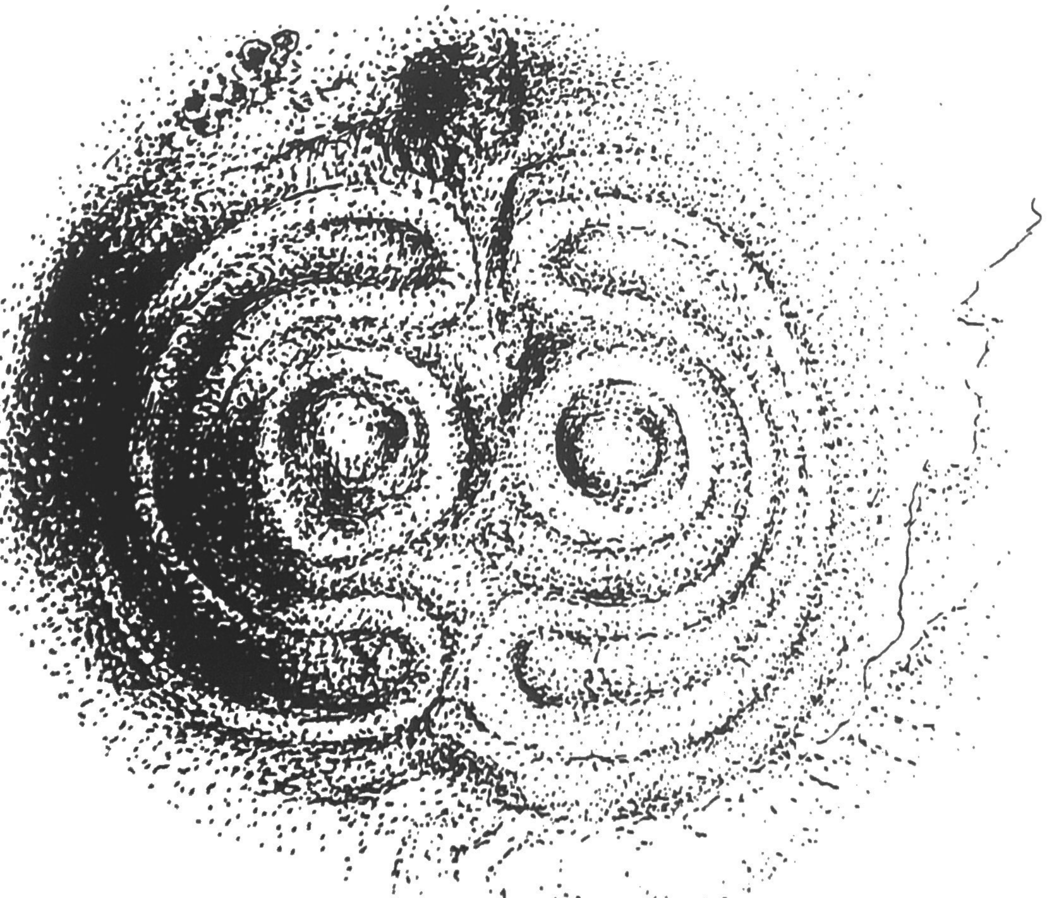
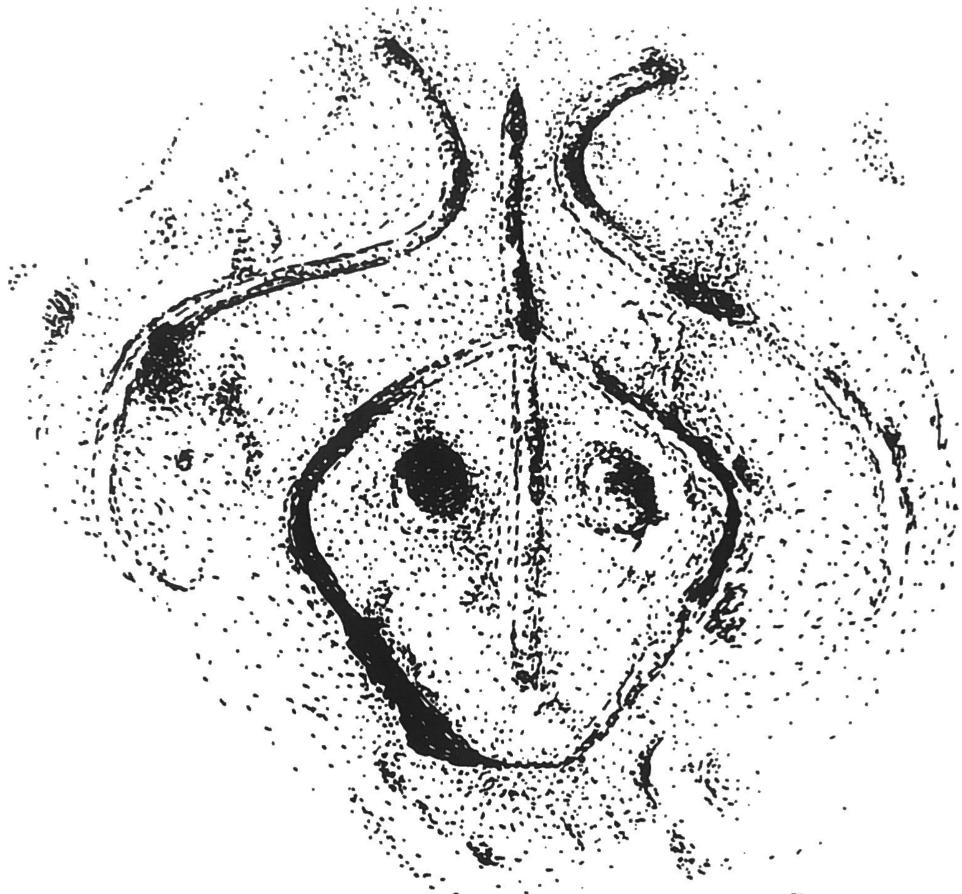


6

Reference number: 6
Description: Looped encircled eyes below small stalagmite. 'Spirit Eyes.' 'Zemi.'



7

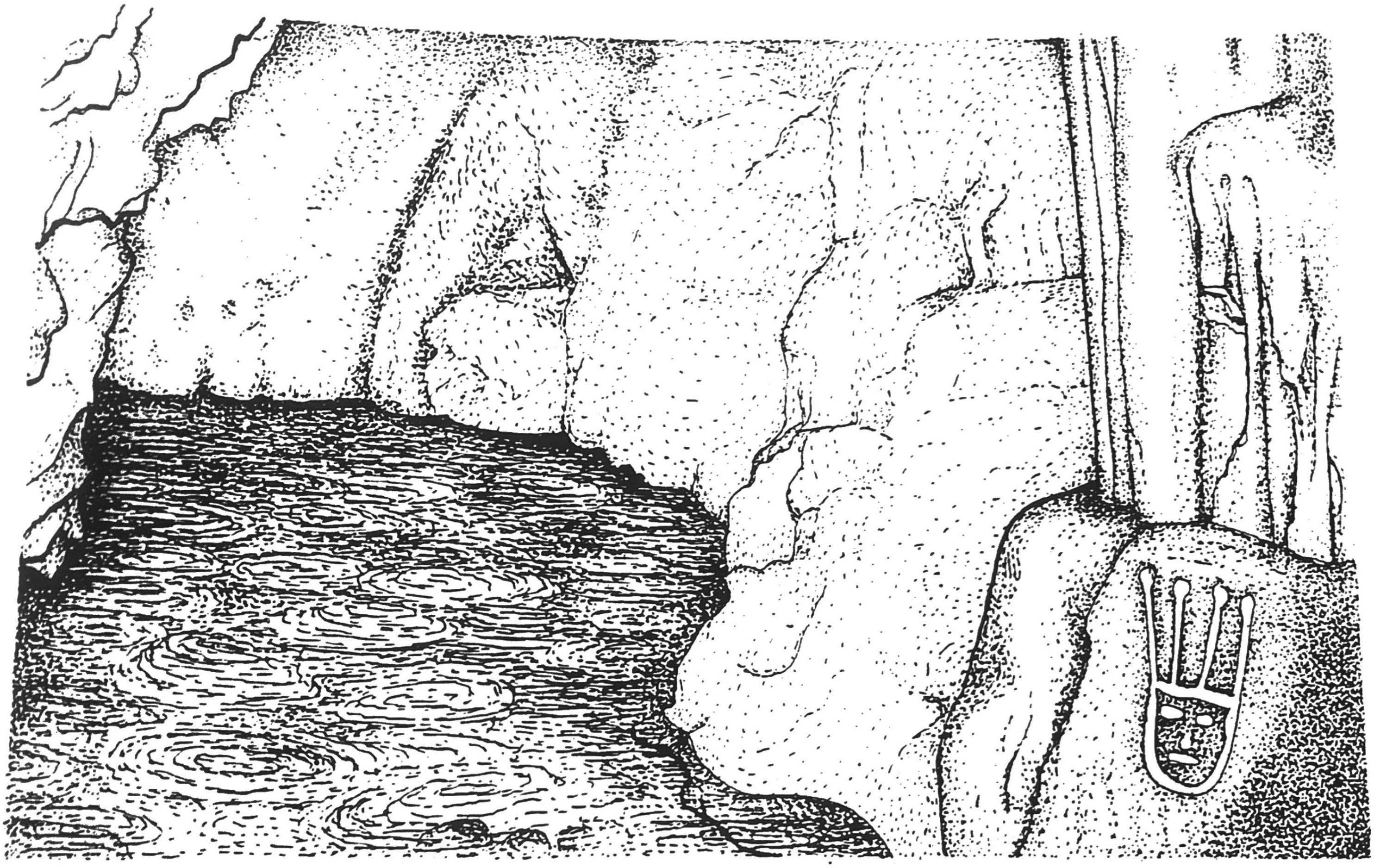
Reference number: 7
Description: 'Lizard with front legs extended.' 'Snake or Skull in a Water Pot.' Fertility symbol (?)
Dimensions: 35 cms high × 35 cms wide.
Orientation: 10 degrees south of east.

10

Reference number: 8 (not illustrated)
Description: Simple face on stalagmite. 'Ancestor.'
Dimensions: 16 cms high × 12 cms wide.
Orientation: Faces east.

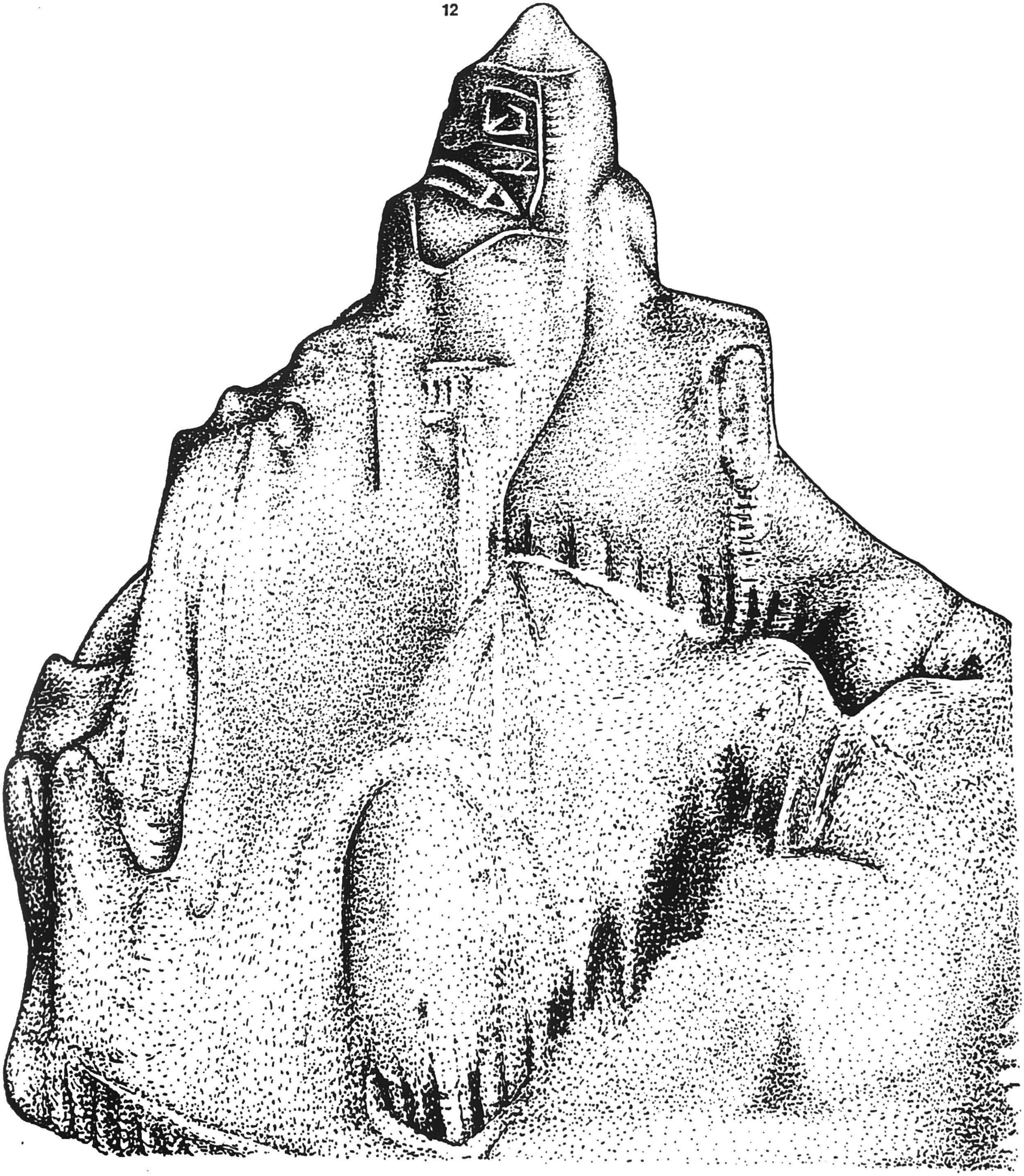
Reference number: 9 (not illustrated)
Description: Simple face on stalagmite. 'Ancestor.'
Dimensions: 14 cms high × 7.5 cms wide.
Orientation: Faces southeast.

Reference number: 10 (left)
Description: Large face on stalagmite column. Appears bearded. 'Ancestor.'
Dimensions: 15 cms high × 10 cms wide.
Stalagmite height: 40 cms.
Orientation: Faces southeast.

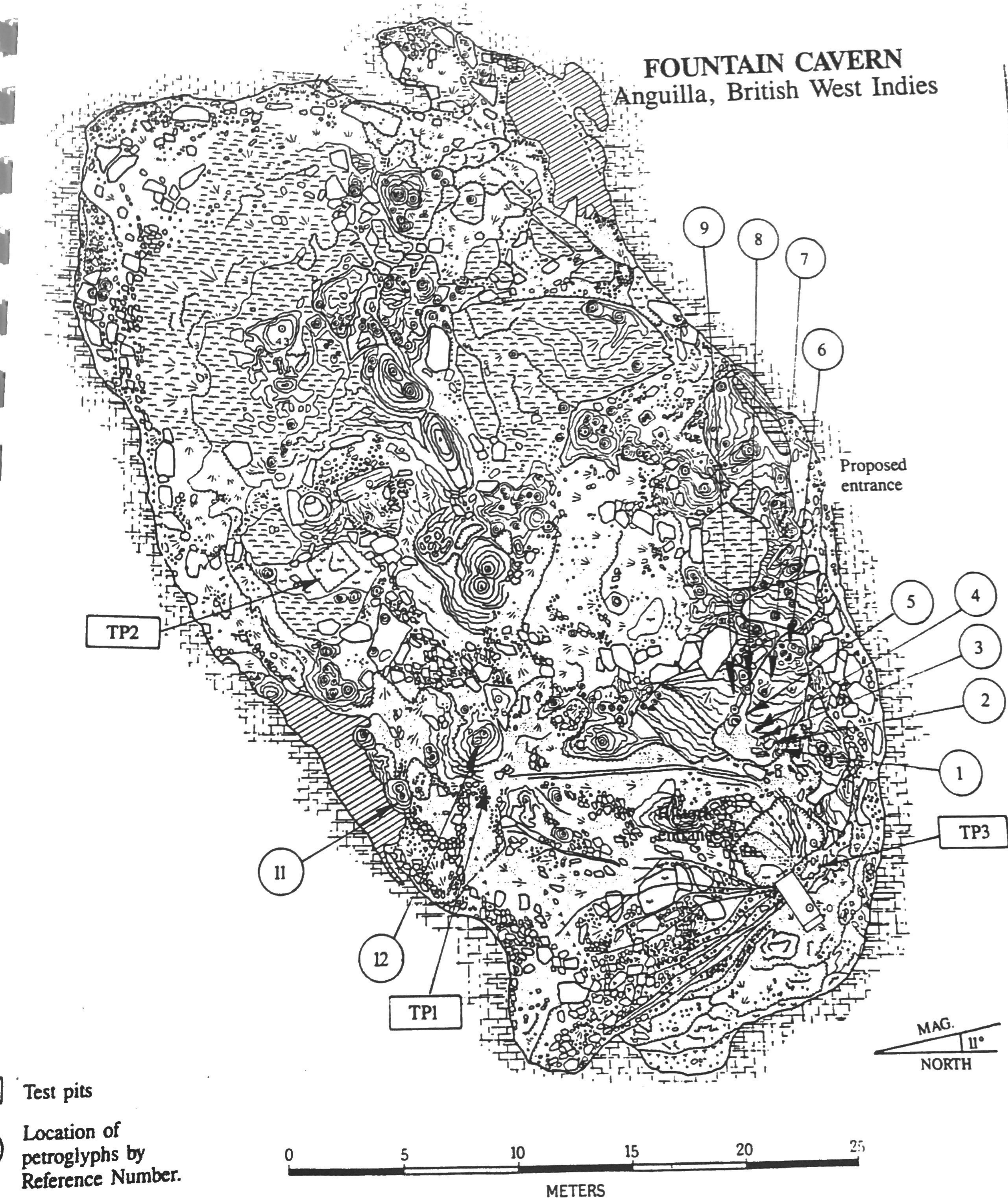


11

Reference number: 11
Description: Long face with four 'feathers' forming crown. 'Chief,' 'Solar Chieftain.' On the stalagmite surface next to water source.
Dimensions: 25 cms high × 12 cms wide.
Orientation: Faces east.



Reference number: 12
Description: Face with markings, carved on upper part of six-metre-high stalagmite. Looks like head. 'Jocahu' the Creator.
Dimensions: Carved parts 50 cms high × 38 cms wide.
Orientation: Faces east.


FOUNTAIN CAVERN
Anguilla, British West Indies
9
8
7
6
Proposed entrance
5
4
3
2
1
TP2
TP3
11
12
TP1
MAG.
11°
NORTH
Test pits
Location of petroglyphs by Reference Number.
0
5
10
15
20
25
METERS

THE PETROGLYPHS OF FOUNTAIN CAVERN: OF WHAT INTEREST?

by Henri Petitjean Roget

In Anguilla, on a plateau not far from the sea, opens a chasm which gives access by a vertical iron ladder, half held by the roots of a fig-tree, to a cave named the Fountain Cavern because of the presence of small permanent pools where, since time immemorial, people came to get water.

Just above the water a rock has an impressive engraved face that gives the impression of quiet power. Nearby, engraved eyes in the stone stare out at you, and a kind of "tadpole" looks like it wants to leave the stone which it inhabits.

This cavern inspires fear and respect, creating a deep feeling of protection. Is this a Magic Cavern, a ritual place, or simply a source of water? Certainly, all this together, (because we know by the presence of these stone faces—petroglyphs—found in other places in the West Indies) represents an expression of the religious beliefs of those who were on these lands before us. But do we know who were the perpetrators of these art works?

It is believed that the populating of the West Indies started from South America as early as the fifth millennium before our era. A small dry island like Anguilla was probably occupied around 1600 B.C., by people at the stage of technological development called "hunter-collectors." These small groups did not know about pottery or cassava agriculture. Their survival depended on hunting the animals of the earth, on fishing and shellfish, and on collecting wild edible plants.

Another moment in West Indian prehistory starts a little before the Christian era, with the arrival of certain tribes, carriers of ceramic traditions. They introduced the manioc (cassava) to the islands. This migration came from west Venezuela.

Next there appeared tribes which we refer to as "Saladoids," who came from the Saladero region in the Orinoco delta. They embarked for the islands, passed by Trinidad, and continued up the archipelago, leaving tools, cooking remains and broken pottery on the sites of their villages.

From about 120 A.D., the Saladoids settled in Puerto Rico; around 200 A.D. they reached the Dominican Republic. At the end of a Saladoid cultural evolution, which adapted itself to the constraints and resources of the new insular context where it got implanted, the Taino civilization began. It was these descendants who Columbus met in the Greater Antilles in 1492.

The Tainos spoke a language of the Arawak family, originally from mainland South America. One is used to speak of the Arawaks, by an extension of language, to refer to the Saladoid culture which was between 0 and 700 A.D. in the Lesser Antilles. Finally, around the year 600 A.D. for the southern end of the Lesser Antilles, or around 800 to 900 A.D. for Anguilla, a new migration from the Guyana plateau unfurled over the islands. After a series of violent fights with the newcomers, the Saladoids were, little by little, chased out of the Lesser Antilles.

These warriors, who chased out the Saladoids, went slowly up to Puerto Rico. Columbus had heard about the Kalinas or Caribes upon his arrival in Hispaniola in 1492. By various transformations this name became "Cannibal," for these people practiced a ritual and selective cannibalism, eating only male captives.

The succession of cultures in the islands does not make for easy dating or cultural attribution of the curious petroglyph faces in Fountain Cavern. Fortunately the pottery found in the cave can be dated by the thermoluminescence process and by comparison with other dated typological units. The aesthetic style of the carvings is a supplementary indication. Placed in the context of other Amerindian artistic manifestations found in both the Lesser and Greater Antilles, we can advance a hypothesis as to cultural attributions.

The engraved faces of Fountain Cavern are of the Arawak culture and would have been made around the year 900 A.D. That is what the evidence suggests. We must look at these engravings with respect, for this place was a sacred place, a sanctuary and a place to find water. Gifts of food and other things were presented to the forces, the spirits, evoked by the representations carved on stone.

According to the Tainos' oral tradition, collected by Friar Ramon Pane about 1493, humanity issued from a grotto within a mountain. At the beginning, the earth was flat, except for the Canta mountain, which emerged from the land of Haiti.

The Genesis myth of the Tainos tells of the ascent towards the human stage, the differentiation between the sexes, the establishment of social classes, the nobles on one side (the Tainos), the common people on the other side (the warriors), and the installation of rulership.

During the myth period, animals were not differentiated from humans. Among the Tainos (the Arawaks of the Greater Antilles), male mythic ancestors were fruit-eating bats and female mythic ancestors were frogs. These are the animal evocations with religious meanings, which are most often evoked in the pottery ornamentation and by the petroglyphs. This tells of the importance invested in the faces in Fountain Cavern for those who engraved them almost 1,000 years ago.

One can imagine the sorcerer with men gathered around him in the depths of the cave, under torch light. With a forked tube, known as the "tabacco," everybody sniffs a powder made from the ground-up seeds of a tree, the Piptadenia peregrina Benth., mixed with lime from burnt shells. The hallucinogenic drug "cohoba" opens the eyes, allowing contact to be established with the beyond, with the world of the "zemis."

Zemis are not only "three-pointed stones." They are, first of all, forces of nature which manifest themselves on certain occasions—a tree which falls suddenly or the discovery of an unusual stone—any surprising event can be considered a Zemi manifestation. The shaman gets in contact with the Zemi through the cohoba. He then decides on the shape he must assume. Any Saladoid or Taino artistic expression is of religious essence.

Even though we do not know the exact meaning of the faces in Fountain Cavern, we should view them with consideration and respect as sacred pictures. On the scale of the short history of our islands, these witnesses of the culture of the original ancient inhabitants are of enormous national interest. Petroglyphs, sacred pictures in caves, archaeological sites—these are the beginning of our history and deserve to be protected and studied.

The opening of Fountain Cavern to the public is part of a Caribbean movement, the purpose of which is to improve and protect the Amerindian patrimony.

In St. Martin, research is being started to try and recover the mysteries of Moho Cave. The story of discovery and disappearance has been told by Roland Richardson.

In Guadeloupe an ambitious project is underway for the creation of a West Indian petroglyph museum, next to More Rita cave in Marie-Galante, which is being classified by the State as an historic monument.

The Fountain Cavern project fits perfectly into these projects envisioned for the commemoration of the 500th anniversary of the discovery of the Americas.

Henri Petitjean Roget
Director of Antiquities and Keeper of the Museums, Guadeloupe, French West Indies

PETROGLYPHS AND A STATUE

by C. N. Dubelaar, Ph.D.

The Fountain is one of the best petroglyph caves in the area. The fine advantage of Fountain Cavern over other caves of the region is that it is relatively undisturbed. There has been some visitation, but the cave has not been adversely affected. The orientation of the petroglyphs, water, and the entrance opening create a fine effect.

What is very typical in Fountain Cavern is that the natural shape of the rock is the beginning of the work. The early people found a natural rock that gave them an idea of a face or whatever, and they gave life to it. The shape of the rocks invited the making of the petroglyphs.

It is important not to clean these petroglyphs. While this might make them appear clearer, it could also hinder the dating of the work on the basis of the depth of the lines and the general patina.

Another fine feature is the large statue in the cave. We cannot consider this a petroglyph; it is a statue.

The Indians came to the cave but did not live there. There is not a single example in this region of a village site in a cave. One has to conclude that the cave was used for religious or magical reasons.

I believe these petroglyphs are quite young, but I do not have hard facts to support this. Perhaps they were made about 1,200 A.D. When more archaeological study is done, the information gained will provide clues to understanding the petroglyphs better.

By notifying the public that you will exhibit not only a cave ceremonial site with petroglyphs and a statue but also will have an exhibition area containing archaeological specimens including pottery, you will have a fine attraction for many people.

Dr. C. N. Dubelaar is author of *A Study on South American and Antillean Petroglyphs*, University of Leiden, Ph.D. thesis, published by the Royal Institute of Linguistics, Leiden, Holland, 1986. In press: *Petroglyphs of the Lesser Antilles.*

RECONNAISSANCE GEOLOGY AND GEOPHYSICS OF FOUNTAIN CAVERN

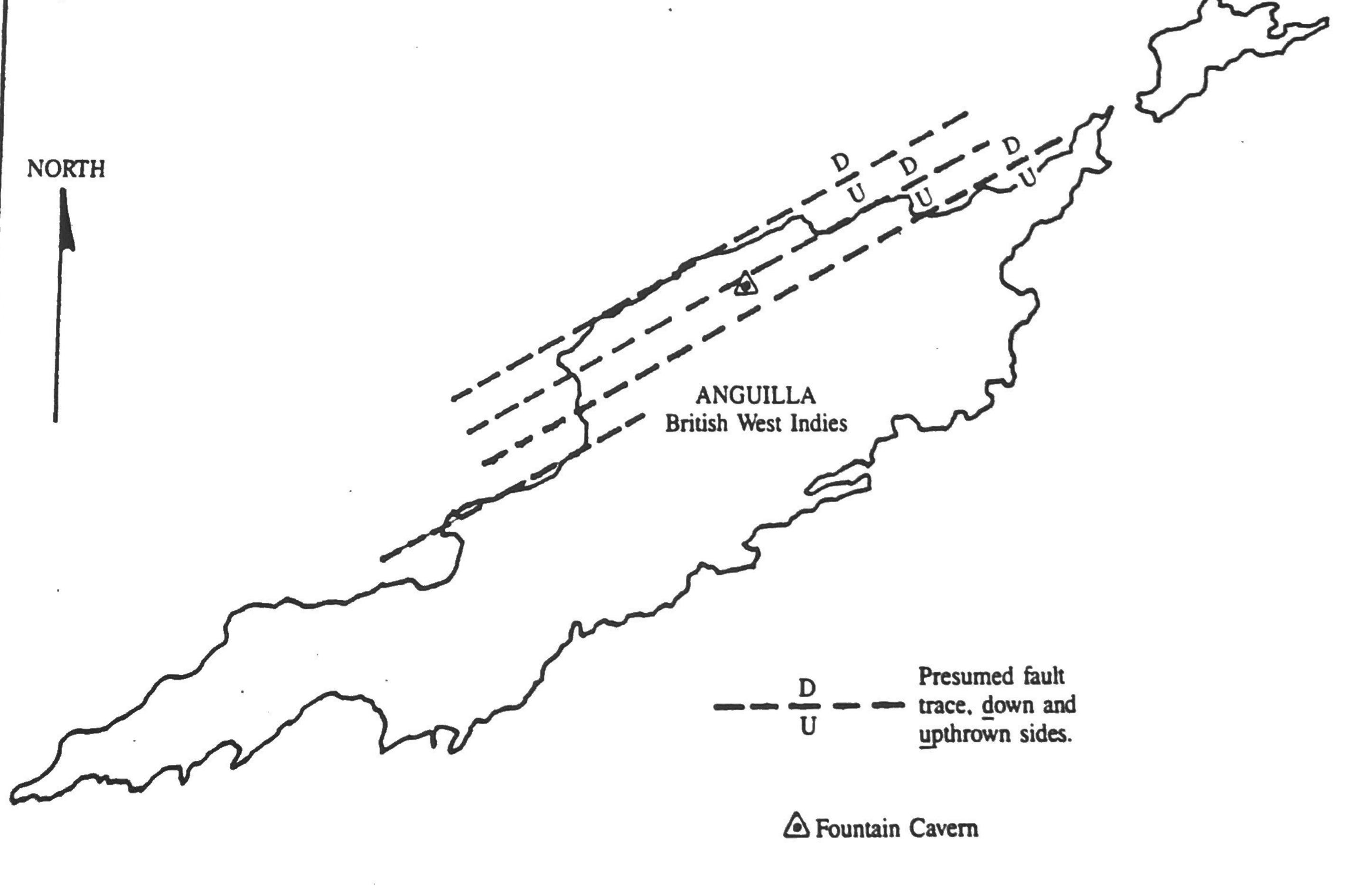
by H. G. Goodell, Ph.D.

INTRODUCTION

The geology of Fountain Cavern, a limestone cave near Shoal Bay on the northern coast of Anguilla, was investigated on March 29, 30 and 31, 1987. Anguilla is an elongated (16 miles by 3.5 miles), low-lying (maximum elevation about 200 ft.) limestone-capped island oriented with its long axis striking approximately N 60° E. Structurally the island consists of a series of differentially uplifted fault blocks (horsts) with their northern margins rotated higher than their southern ones (Fig. 1). The result is a stair-stepped surface topography with relatively steep risers on the north coast and treads dipping to the south. The shoreline of the northern coast reflects the structural control, being composed of straight-line segments, often cliffed. This fault block orientation also controls the major joint/fault system on the island, at N 60° E, and a conjugate (at right angles) system at N 30° W. Coastal reentrants reflex the conjugate joints.

The morphology of Fountain Cavern, located near the crest of the highest elevated fault block at an entrance elevation of 179 ft., reflects this structural control. The cavern is roughly elliptical in shape with its semi-major axis, about 48 meters long, oriented parallel to the major joint/fault system at N 60° E; its semi-minor axis is about 28 meters wide. The cavern is located in a Miocene biohermal and biostromal, cream to buff colored limestone which weathers light gray, often with iron oxide stains and crusts, with

Fig. 1



Velocities were first measured outside the cavern on a near-by access road first parallel to the strike of the regional joint pattern (N 60° E), then perpendicular to the strike (N 30° N) as follows:

Direction	Velocity (meters/sec)
parallel	1450
across	600

The lower velocities across strike are attributed to the presence of 2 major joint/fault zones that were observed between the hammer and the geophone. Even so these velocities are considered low for well lithified limestones.

In most places the roof within Fountain Cavern was inaccessible because of its height. However, near the proposed new entrance on the north side of the cave the roof was low enough to obtain a measurement of roof velocity of 5920 m/s, which is indicative of very high strength and little jointing. A measurement was made through the roof at this point by striking the surface above the geophone location in the cavern roof. The elapsed travel time of .8 millisecond is approximately equal to 5 meters of roof thickness, assuming a velocity of 5920 m/sec. One other reading through the roof was attempted by placing the geophone in the roof pendant, which is partially separated from the cavern roof, and again striking the surface above the geophone location. The elapsed time was more than twice as long, indicating that the pendant rock mass is substantially weaker presumably because of the separation.

The remainder of the seismic investigation was carried out on the surface, over the cave roof. A traverse parallel to the cave axis (Fig. 3) yielded velocities of about 4500 m/s indicating high rock strength.

Velocities on diagonal traverses were somewhat lower, indicating the presence of roof joints. Seismic traverses run perpendicular to cave axis also yielded velocities somewhat lower than those parallel to the axis, with lower values being measured on the south side of the cavern. It is our interpretation that the cavern roof over the south half of the cave is not as strong as the roof on the north side. No velocities were measured which would indicate major structural flaws.

PRECAUTIONARY ENGINEERING

The central roof pendant which shows separation from the cavern roof along its north side weighs in excess of 100 tons. While there is no indication that it is in immediate danger of falling, or even how long ago separation occurred, it would be prudent to support it from below with a concrete pillar which could be subsequently disguised as a massive stalagmite.

The remainder of the roof slab separations are around the margins of the cavern. Several appear to be quite old, for example the one behind the entrance ladder. However, in the interests of the safety of the viewing public, the proposed access trail should be routed as necessary so as to avoid these potential breakdown areas. In addition, some method of stabilizing these areas should be considered.

In mines, roof areas which show a tendency to fail are bolted. This consists of drilling a hole in the roof and inserting a long metal expanding bolt (or resin grouted bolt), a pressure plate and a bolthead. When tightened the bolt clamps together many bedding planes and so strengthens and stabilizes the roof by creating a single massive laminated roof beam. Bolts are up to 16 ft. long and are normally installed on 4 ft. centers (Peng, 1978). In the case of Fountain Cavern drilling and bolt insertion could be done from the surface and the entire roof clamped into a single beam.

Alternatively, and probably far cheaper, would be to prop the roof up from below as necessary with reinforced concrete pillars which would be suitably disguised as stalagmites.

A program of roof-sag monitoring should be initiated as soon as possible. This would require establishing a series of reference bench marks on the cavern floor in order to measure ceiling height as accurately as possible. Any indication of roof-sag would require some remedial action.

CONCLUSIONS

No danger of roof breakdown in Fountain Cavern appears eminent. However, before opening the cavern to the public the exhibition path should be rerouted to avoid locations of roof-sag. Consideration should also be given to some form of long term roof support. The cheapest method would be to prop the roof from below with concrete reinforced pillars. This will require further geotechnical study.

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HISTOPLASMOSIS AND THE PROPOSED DEVELOPMENT OF FOUNTAIN CAVERN

by Donald A. McFarlane, Ph.D.

Histoplasmosis is the clinical manifestation of human infection by the fungus *Histoplasma capsulatum*. *H. capsulatum* is a faculative pathogen (i.e. it is capable of completing its life cycle either as a mammalian parasite or as a free-living organism growing on rich organic soils) which has a very wide geographic distribution in the tropical and warm temperate regions of both the Old and New Worlds. The organism is commonly, although by no means exclusively, associated with both bats and deposits of their guano.

H. capsulatum is endemic to the Caribbean region, clinical symptoms resulting from bat cave exposure having been reported from Puerto Rico (Carvajal-Zamora, 1977a.) and Jamaica (Fincham and De Ceulaer, 1980), and the disease having been isolated from house-dwelling bats in Martinique (Magnaval *et al.*, 1984.) Traditionally, human exposure has been associated with dry and dusty cave environments, but in the Caribbean it has also been shown to occur in moist and wet caves (Fincham, 1978).

The bat population of Fountain Cavern, as observed in June of 1988 by the author, was a colony of the Brown Flower Bat *(Brachyphylla cavernarum)* crudely estimated at 150-250 individuals. Accumulation of guano was minimal. *B. cavernarum* is a species known to harbour the *H. capsulatum* fungus in Martinique (Magnaval *et al.*, 1984) and also in Puerto Rico (Carvajal Zamora, 1977a). Although *H. capsulatum* has apparently not been reported from Anguilla, it is probable that it could be isolated from the tissues of the bats from Fountain Cavern if a study were done. Mycological cultures of bat guano in Jamaica (McFarlane, 1985) and Puerto Rico (Carvajal-Zamora, 1977b.) have demonstrated the difficulty of isolating the fungus from this substrate, even in caves implicated in the transmission of the disease. Attempts to isolate the fungus from guano in Fountain Cavern would probably yield inconclusive results.

Whereas the presence of *H. capsulatum* in the bats of Fountain Cavern is considered likely on geographic and ecological grounds, the development of clinical symptoms in visitors to the cave is considered to be very unlikely. The available evidence suggests that the likelihood of an individual's developing clinical symptoms is proportional to the dose of infective material. Moist Caribbean caves which are known to have been the source of clinical infections typically host bat populations in excess of 10,000 individuals and subject visitors to a notable aerosol of urine and faeces in conditions of 100% relative humidity. These conditions are not in evidence at Fountain Cavern. Additionally, it should be pointed out that Jamaica's most popular tourist cave, Runaway Bay Cave(s) ('Green Grotto') supports a population of the Buffy Flower Bat *(Erophylla sezekorni)* without reported problems.

The destruction of the Fountain Cavern bat population is to be discouraged on several grounds. *B. cavernarum* represents one of only three endemic mammals on Anguilla, and the colony in Fountain Cavern is the largest known on the island. The bats are an important and integral component in the Caribbean terrestrial ecosystem, functioning as both seed-dispersers and pollinators of a variety of important food plants including figs, bananas, and mangoes. Within the cave the guano is the sole energy source for the invertebrate community, which has never been properly studied and potentially includes species new to science. The only primary literature report of Anguillan cave invertebrates reports the rare cave crustacean *Stygiomysis holthusi* from Fountain Cavern (Botosaneanu, 1980), and it is likely that the population is sustained by guano entering the terminal pool in the cave. In addition to the direct ecological impact, destruction or exclusion of the bat colony would set an unfortunate precedent for the people of Anguilla at a time when conservation ethics and values are to be encouraged. Finally, bats have considerable novelty value to tourists and are responsible for attracting tens of thousands of additional visitors to Carlsbad Caverns (New Mexico, USA) each year. Careful positioning of cave lighting and pathways to minimize disturbance to the core of the roost area in order to encourage the continued tenure of the bats would provide an additional tourist novelty in a cave which is somewhat lacking in natural decoration.

CONCLUSIONS

1. *Histoplasma capsulatum*, the causative agent of the disease histoplasmosis, is likely but not proven to occur in the bat colony occupying Fountain Cavern.
2. Epidemiological studies and practical tourist-cave experience elsewhere in the Caribbean suggests that the public health risks entailed by retaining the bat population in Fountain Cavern are minimal to insignificant.
3. The beneficial role of the bats in the local ecosystem and their vital role in sustaining the largely unstudied invertebrate cave community make the retention of the bats a worthwhile goal.
4. The bat population is likely to be a source of considerable interest to tourists in a cave that is somewhat lacking in natural decoration.

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THE BATS OF FOUNTAIN CAVERN

by Hugh H. Genoways

During May 1988, two species of bats—*Brachyphylla cavernarum* (Antillean cave bat) and *Natalus stramineus* (funnel-eared bat)—were captured at the opening of Fountain Cavern. Only *Brachyphylla cavernarum* was captured inside of the cave. The weather was extremely wet during our visit to Anguilla so our work in Fountain Cavern was limited by hazardous conditions. Nevertheless, we did make a thorough survey of the bats inside the cave. There is only one other species on Anguilla—*Monophyllus redmani* (Antillean long-tongued bat)—that might be expected to utilize Fountain Cavern as a roosting site.

Brachyphylla cavernarum

This Antillean endemic is common on islands from Cuba to Barbados and St. Vincent. As its common name indicates, this species prefers roosting sites in caves and mines. They are present in Fountain Cavern in large numbers because of the presence of water in the cave. They probably don't drink the water, but its presence raises the humidity and provides the appropriate conditions for the bats. Bats were observed throughout the cavern, but based upon guano accumulation, they seem to concentrate their activities toward the rear of the cavern where the light levels are lowest.

Antillean cave bats emerge from their daytime roosts about dusk and thereafter. They will fly a mile or two to areas where they can feed. They are strictly herbivorous in their feed habits taking all varieties of soft fruits, nectar, pollen, and even the entire flower.

The colony within Fountain Cavern contains both males and females. The cavern is being used as a maturity colony with young present during our visit in late May.

Natalus stramineus

Only one specimen of this rare species was taken at the entrance to the cavern at about 30 minutes after dark. Anguilla is the northern end of the geographic distribution of this species in the Antilles.

The funnel-eared bat is strictly insectivorous in its feeding habits. Based upon its small size, it probably takes only very small insects.

RECOMMENDATIONS

1. Leave Fountain Cavern in as natural a state as possible.
2. Don't open a second entrance to the cave. It may alter the environmental conditions within the cavern to a point where all animal life may be lost and the archaeological materials themselves may be threatened.
3. Check the cavern for histoplasmosis. If it is not present, all efforts should be expended to maintain the bat populations within the cave. The bats are messy but they are part of the total experience within Fountain Cavern. Bat activity is low in the area of the archaeological materials.
4. Bats serve as the "green plants" of all caves. Their guano furnishes the nutriments on which all of the cave's plants and animals depend.
5. The two bat species taken at Fountain Cavern may owe their existence on Anguilla to the presence of the cavern. If conditions are altered in the cave, these two species may become extinct on the island.
6. The bats can be one of the attractions for Fountain National Park. People travel from all over the U.S. to see the bat flight emerge from Carlsbad Caverns in Carlsbad Caverns National Park in New Mexico.
7. I would plan to develop several walking trails on the surface within the land set aside for your National Park. I saw considerable bird and insect activity in this area. The type of tourist that you will be attracting to the Park will be anxious to take advantage of such an opportunity.

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REPORT ON THE VEGETATION IN FOUNTAIN NATIONAL PARK

by Gina L. Douglas, B. Sc.

The vegetation of Fountain National Park, extending from the shoreline to higher areas inland, comprises a cross-section of different plant communities. Beach areas have a dense growth of seagrape backed by a narrow transitional zone where remains of coconut plantations can be seen. The inland communities begin with a dense growth of buttonwood *(Conocarpus erectus)* thinning upwards into open communities with torchwood *(Amyris elemifera)*, mawby *(Colubrina elliptica)*, ironwood *(Exostemma caribaeum)*, black chink *(Guettarda scabra)*, loblolly *(Pisonia sp.)* and pigeonwood *(Plumeria alba)*. Tree growth is densest in the lower areas and also on the summit of the hill where sizable trees of turpentine *(Bursera simaruba)* mark the highest point of the Park. Limestone terraces have barren areas with open scrub and herbaceous plants. A clump of wild grape *(Coccoloba krugii)* marks the path upwards to Fountain Cavern entrance, which is itself the site of a well grown tree of *Clusia alba*. Behind the cavern the bare limestone pavement areas have xerophytic trees of *Zanthoxylum fagara* and pigeonwood together with balsam and bilbush, especially on areas showing signs of past grazing. To the east, a small area of very broken topography over the cavern has a denser growth of trees, interspersed with open scrub.

A full species list is not yet available and needs considerable further expert work, but 62 specimens were collected in January 1986 and identified with the aid of staff at the British Museum (Natural History). The presence in the National Park of a number of what Harris (1965) identifies as "rare trees and shrubs" such as Mawby *(Colubrina elliptica)*, ironwood *(Exostema caribaeum)* and other native plants leads to the hope that the exclusion of grazing and other human pressures, such as cutting of timber for charcoal manufacture, would lead to the re-establishment in the National Park area of species commonly present in the past such as lignum-vitae *(Guiacum officinale)* and satinwood *(Fagara falava)*.

MANAGEMENT

Goldsmith (1973) recognizes the importance of preserving a range of habitats within a series of reserves as part of the development of the tourist potential in the Caribbean. He sees this, together with associated interpretative facilities, as providing a positive need for which there will be increasing demand. A recent article by Jackson (1986) points out that carrying capacity for tourism in small Caribbean islands is closely linked to good environmental management, as there is a rapid negative response to signs of ecological stress. The future development of the tourist potential of Anguilla needs the provision of "natural" areas from the outset to ensure that these negative responses do not occur. The existence of the National Park adjacent to an area with great development potential has real significance in maintaining a pleasant environment.

At present the unsurfaced road from Shoal Bay divides the Park and provides ready access for free-ranging livestock and permits removal of firewood for charcoal burning and domestic use. It also forms the only vehicular access for visitors to the cavern. The proposed new Shoal Bay to Limestone Bay (North Island) route would form the southwest boundary of the Park and would not only provide better access to the cavern but prevent further deterioration of the vegetation of the National Park area by controlling access.

A Park boundary fence, forming a barrier to vehicular access, and regulations controlling grazing by animals and removal of any items of wood, rock, etc. from the Park area, would enable the natural vegetation of the area to recover. In time, the area could return to a condition resembling the former dry evergreen forest. Additional fencing of a limited area, possibly that immediately over the cavern to the southwest, excluding both goats and people, would provide a basis for research work to determine what level of regrowth might be expected. Such an enclosure would limit access above the cavern and minimize activity there. While no structural danger appears to exist in this respect (see Goodell Report), the long-term visitor pressure on the Park is likely to increase and provision of such enclosures from an early stage would protect possible surface archaeology and provide conditions for assessing the ecological potential for regeneration of vegetation. Access to the cavern through the proposed new entrance would leave the natural entrance undisturbed and permit it to return to the original pre-Columbian conditions.

Reintroduction of plants known to have been present and control of present alien species should only be undertaken after expert advice from those experienced in similar conditions elsewhere in the Caribbean. At present, emphasis should be on protecting the present flora from destruction and enabling those areas which have already suffered damage due to grazing and/or charcoal timber removal (as in the northwest portion of the reserve) to recover.

TOURISM AND DEVELOPMENT

The development of tourist facilities within the National Park area must be done in close association with development of the cavern site. Provision of an interpretative centre for the archaeological work can be linked to the natural environment both in the past and in the present, these being described with reference to aspects of the ecology of the National Park. An area of reintroductions may, initially, be limited to a demonstration garden at the Visitor Centre. At the Visitor Centre leaflets and guides can be provided to identify the vegetation, and the garden environment can be linked to a series of nature trails leading down from the cavern area toward the coast. Ideally the trails could follow the existing topography making use of the natural terraces and slopes thus requiring minimal man-made modifications. Such a network would also serve visitors arriving at the coast level, leading them up toward the cavern. This presupposes some system of controlled entry points with notices to guide visitors.

Apart from essential parking and sanitation facilities associated with a Visitor Centre, provision should be made for simple picnic or rest areas within the Park. A topographic and vegetation survey will reveal areas suitable for such a purpose where existing shade trees or simple wooden structures can be used with minimal effect on the environment. Provision for seating and litter bins should be designed to blend in with the natural landscape. The over-all plan should be created so as to prevent encroachment of both litter and people into areas of denser vegetation cover.

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PART TWO

Fountain Cavern Development Study

NATIONAL SPELEOLOGICAL FOUNDATION

INTRODUCTION

by Jeanne Gurnee

The foregoing material in this publication—covering the archaeology, geology, botany, and other aspects of Fountain Cavern—forms a necessary background before consideration can be given to a way to develop Fountain Cavern for visitors. By combining knowledgeable preservation and construction techniques, careful design, sound financial planning, aesthetic sensibility and scientific background, the developers of Fountain Cavern can modify it to accept visitors, and give them the experience of seeing the environment and petroglyph site of the Arawak (Taino) Indians.

In addition to the technical skills required to exhibit the cave it is desirable to have a deep respect for the art of early people; and respect is the key word for the development of Fountain Cavern (and all historic caves), using the lessons learned from the preservation of early art in other parts of the world. Cave painting preservation in France and Spain has coexisted with tourist visitation since the beginning of the century. The solutions to problems encountered after these early developments aid us in choosing the best preservation techniques of present day. What European countries have learned in the last half-century can be applied directly to the design and management of cave art in this hemisphere. Today's technology enables us to modify a cave, and intrude as little as possible on the natural cave environment.

Those fortunate few people who entered Fountain Cavern and "discovered" the petroglyphs will not forget that experience. Visitors to the developed cave should have the same sense of revelation of the petroglyphs in a safe and aesthetic way. They should see the natural cave, and experience the petroglyphs—revealed one by one as their patterns emerge along the cliff wall. In this way visitors will know some of the excitement of the original explorers.

All the above points have guided the members of the study team of the National Speleological Foundation in preparing the plans to modify Fountain Cavern. The goal is to provide a fine visitor experience while safeguarding the historic integrity of the site.

The following construction guidelines and technical points were discussed with government officials in Anguilla. We recommended that an architect from Anguilla, or the Caribbean, design the administration and entrance building so that the spirit of this region would be reflected throughout the site.

In our September 1986 report, we suggested that the original historic entrance remain sacrosanct and public access be through a new artificial tunnel. Control doors, which would remain closed except when visitors are entering and exiting the cave, would separate the tunnel from the cave in order to preserve and maintain the present environmental conditions underground. The building layout shows only the necessary facilities included in such a building. Other services that Fountain National Park planners may wish to include will vary according to the needs of the park as attendance increases. Financial resources will play a part in these decisions, and so we have shown the entrance facility as a basic functional layout for budget purposes. **It is not an architectural design.**

The particular expertise of the National Speleological Foundation study group is in the cave; and in this capacity, our recommendations are complete. The plans include suggestions for the surface because the cave is part of, and affected by, its surface environment. It cannot be separated from it. For this reason also, the National Speleological Foundation study team has recommended to the Anguillian government that the soil of the cave be tested for traces of *histoplasma capsulatum* and a biological survey be made of the cave water to inventory any cave life. Nature, wildlife, and general topographic conditions are interrelated above and below ground. The objective of the complete master plan for Fountain National Park would encourage the idea that a single spirit pervades all—as it has for thousands of years.

A PROPOSED VISIT TO FOUNTAIN NATIONAL PARK

by Jeanne Gurnee

Access to Fountain National Park is by a new north-coast road. If additional land can be obtained, cars can be left on Park property near this road; however, at the time of the study, this land had not yet been acquired. The alternative plan would be to enter on a private road from the Park's southern boundary and circle away from the area where Fountain Cavern is located below ground. The road ends at a car park, where automobiles, rented cars and taxis can be left during the period the visitor is on Park premises.

The visitor walks from the car park to the Visitor Center, enters the building, and purchases a cave tour ticket. While waiting for a tour to begin, he can view an Arawak Indian collection and then move to a covered veranda of the Visitor Center where he can be seated overlooking a native-plant garden.

The tour begins on the veranda, when a guide gives an introduction to Anguilla, the Park, and the cave. The group then walks through a light tunnel to the cave entrance. (The natural cave entrance hole is not used, so that this feature can be preserved intact. This entrance will be seen later on the cave tour.)

After entering the cave, visitors bear to the right on a trail which leads to three impressive stalagmites in the center of the cave room. The group and guide then follow the trail around these formations, where they have a view of a blue pool, lighted under water, off to the right. A second view of the large stalagmites is seen from the reverse side at a grouping point where the guide describes the natural cave features.

The group then continues slightly downward around an embankment toward the second pool of the cave. Visitors view this lighted pool, moving around it on a flowstone bank, until they come to a stopping and viewing platform for the outstanding carved stalagmite, Jocahu. A second lighting effect illuminates this feature as Arawak and Anguillian history are described.

Visitors then proceed upward toward the natural entrance of the cave. They stop at a platform which allows viewing of the other petroglyphs of the cave. The special lighting features the etched designs in the rock, as the guide continues his interpretive program.

After this viewing, the group continues on a trail which returns to the tunnel entrance.

Upon exiting the cave, visitors who may not have had time to view the museum collection may do so, or they may purchase mementos of Fountain Cavern and Anguilla in the Visitor Center gift shop.

Visitors may return to the car park or walk northward toward the sea, where there is a facility for changing to bathing suits in order to enjoy the fine beach and sea bathing.

For visitors who have only a short time available, the cave may be seen in an hour. For others, an enjoyable day can be spent visiting the cave, visitor center, museum, native-plant gardens and oceanside.

The experience will be a fine introduction to the natural history of Anguilla, and will also show the archaeology and anthropology of the island—from its ancient roots to the Anguilla of today.

DESCRIPTION OF THE BLUEPRINT SERIES

LOCATION AND SITE PLAN

Plan No. 1.

The small drawings show the location of the island of Anguilla in the Caribbean and Fountain National Park on Anguilla.

The plat of the property includes the location of the entrance road, proposed building, parking area, and disposal system. These recommendations assume that local architects and sanitary engineers will provide complete working plans for the building, landscaping, and utilities in conformity with local codes. The National Speleological Foundation study group strongly recommends initiating a program to obtain more land for the park. In particular it would be important to secure the property to the south where surface drainage might affect the cave. If land acquisition is not possible, a zoning restriction on the surrounding property could be brought into effect which would prevent commercial use that might cause pollution and destroy the natural aspect of the region. A suggested use for the surrounding land might be to establish a residential or agricultural zone. This would also discourage unwanted commercial satellites.

The black-top Park road is shown in a position away from the cave below, and all surface activities are also directed away from the surface recharge area. The disposal field, downhill of the parking area, should be landscaped in conformity with the natural vegetation.

Section A-A shows a profile view of the cave related to the surface. It graphically indicates the need to protect the surface area above the cave. The planning of construction work (sometimes involving heavy equipment) for both the building and cave modifications must consider the location of the cave and its structural requirements so that the site is protected and preserved.

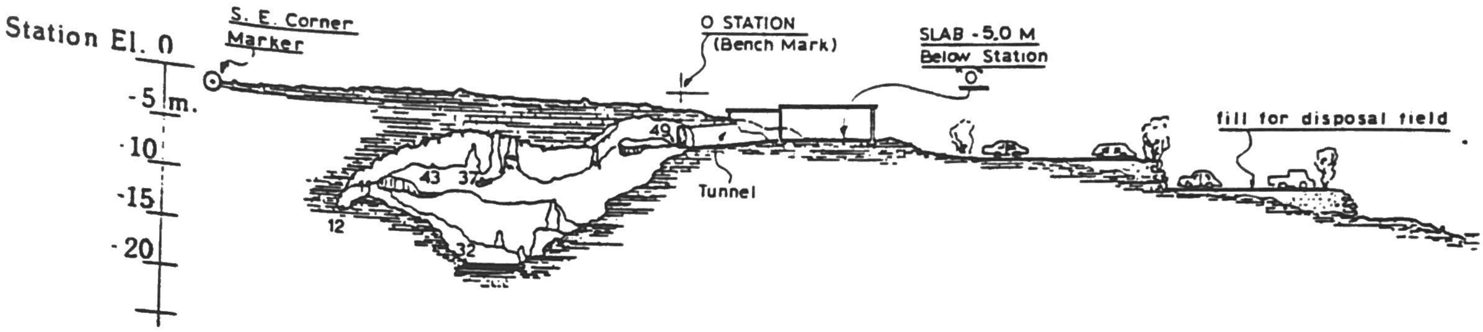
ENTRANCE BUILDING

Plan No. 2.

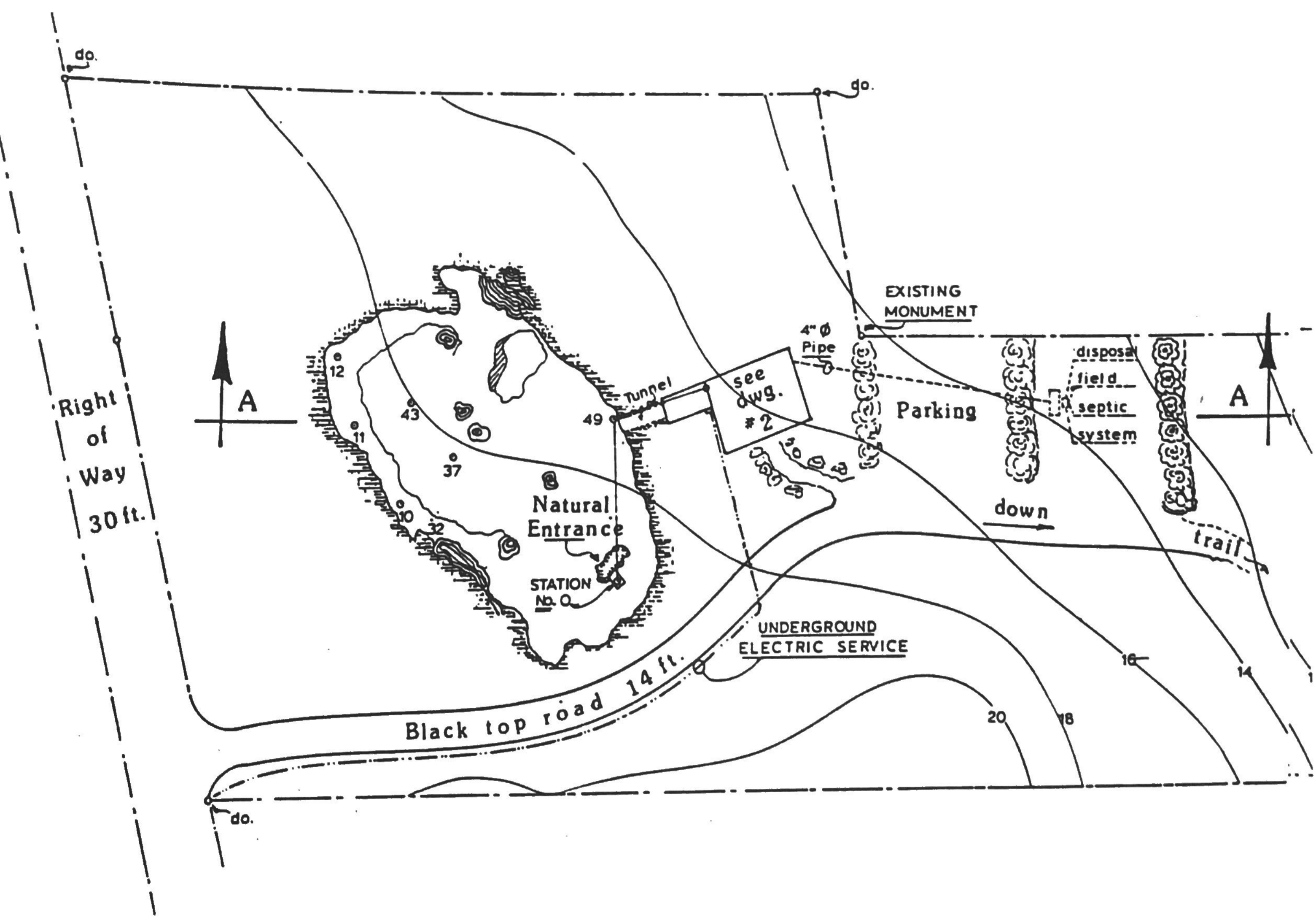
The Block Diagram (not to scale) gives the relationship of the new public road, its connection to the Park road, the cave beneath the park, and the sea.

The preliminary building layout is for budget purposes and planning for visitor flow through the facility (not for design). The most critical dimensions are the elevation of the floor and the location of the building in relation to the tunnel. Elevations must conform with the trail and structure of the cave roof. Doors (see Section C-C looking south) are to be kept closed, except when visitors are entering or exiting, so that ambient air does not enter the cave and affect the cave environment.

The veranda waiting area has a fine view of surface vegetation for visitors. Plans for the careful introduction of natural plants and irrigation will help display the relationship of the cave to the surface.



Section A-A



PLAT OF THE FOUNTAI

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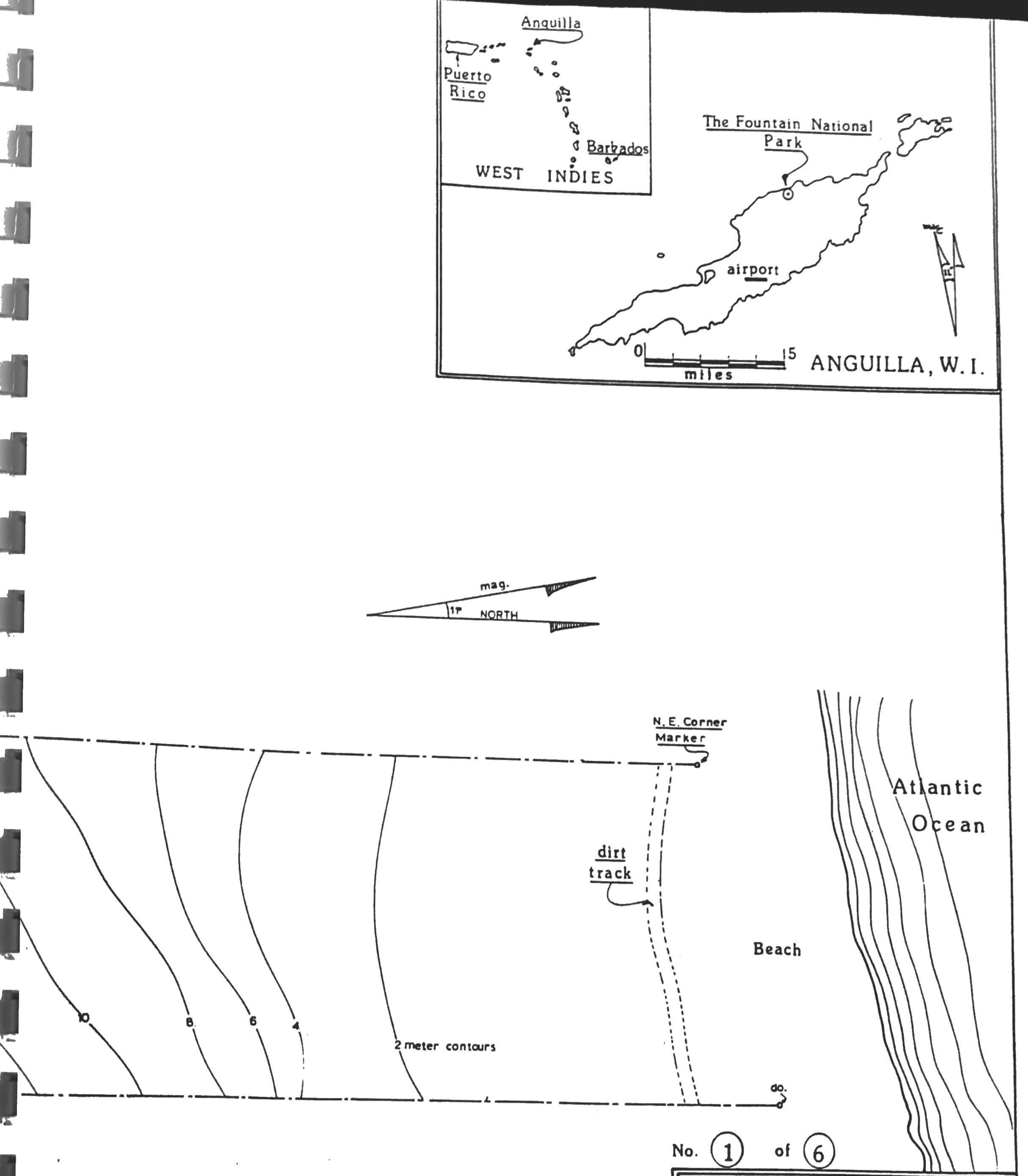


No. 1 of 6

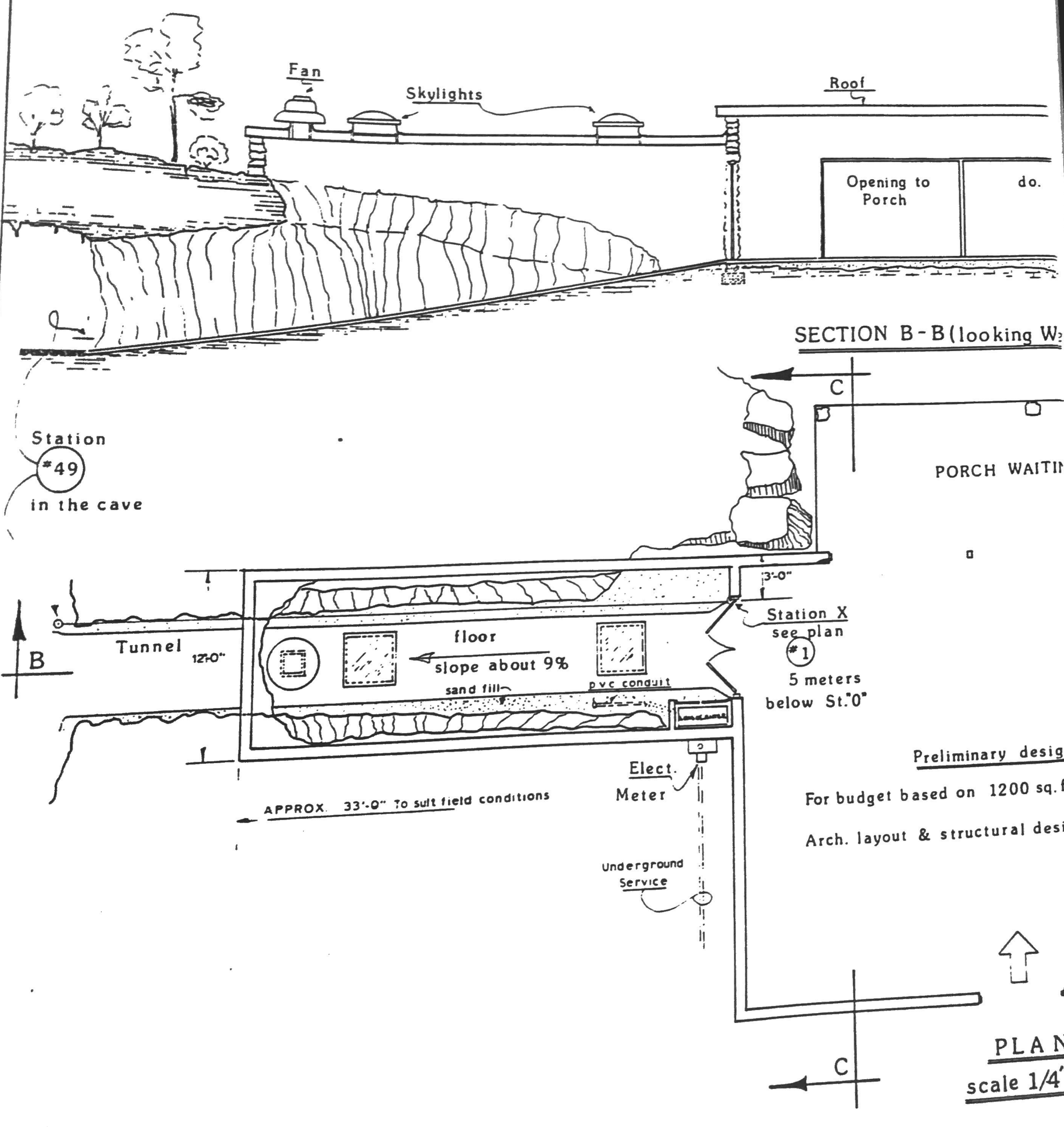
THE FOUNTAIN

ANGUILLA, B.W.I.

LOCATION & SITE PLAN

Survey By: W. Stone, P. Stone, J. Burch, R.& J. Gurnee	Date: May 1986	National Speleological Foundation U.S.A.

THIS IS NOT AN ARCHITECTURAL PLAN. Structure shown for si



Preliminary design

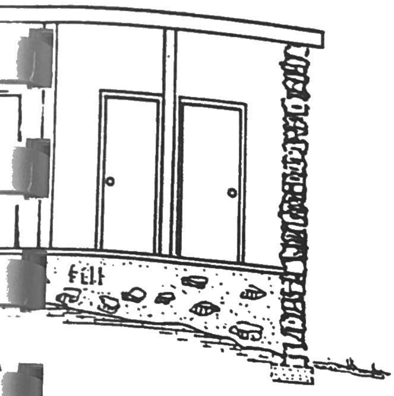
For budget based on 1200 sq. ft

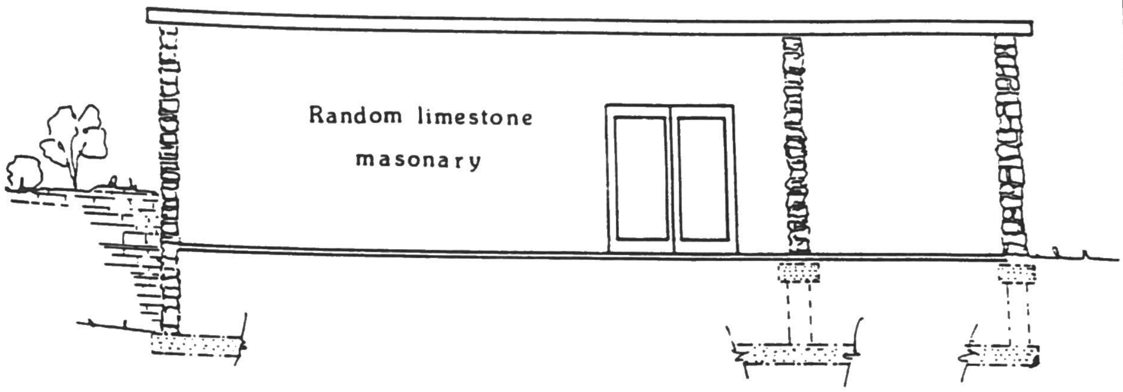
Arch. layout & structural desig

PLAN

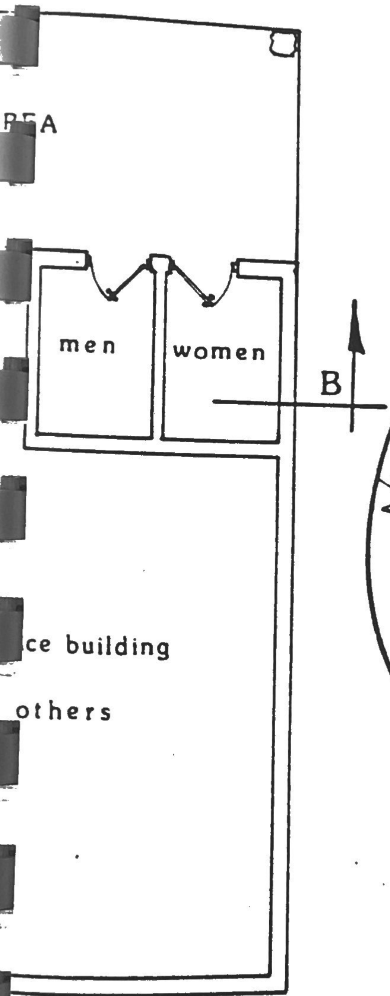
scale 1/4" =

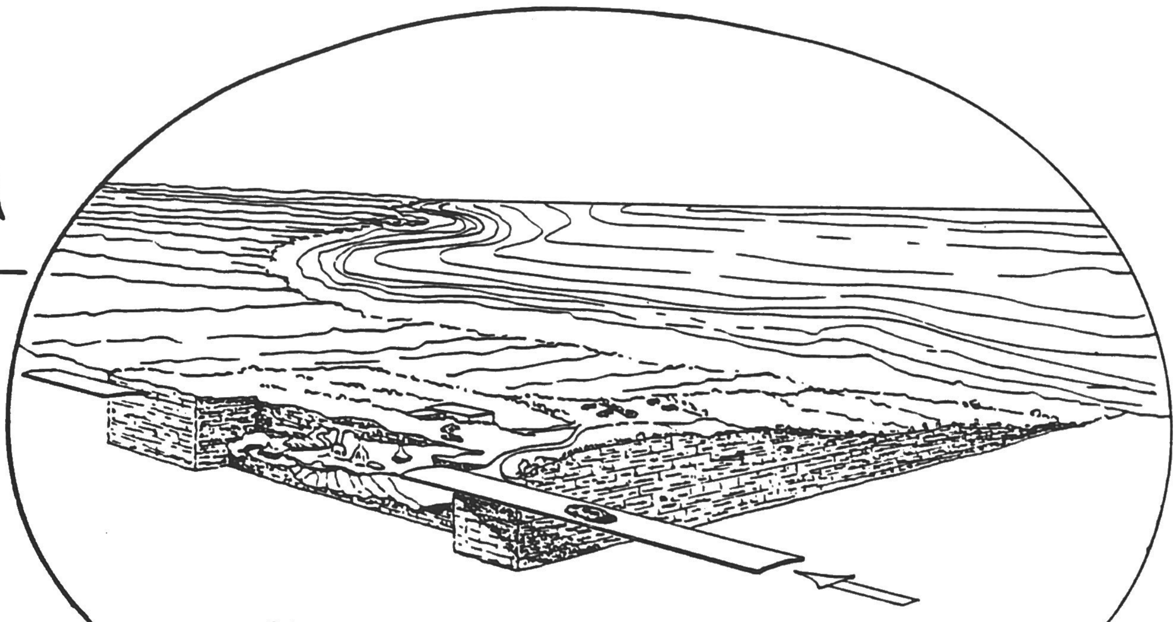
…on and estimating purposes only.





SECTION C-C (looking South)





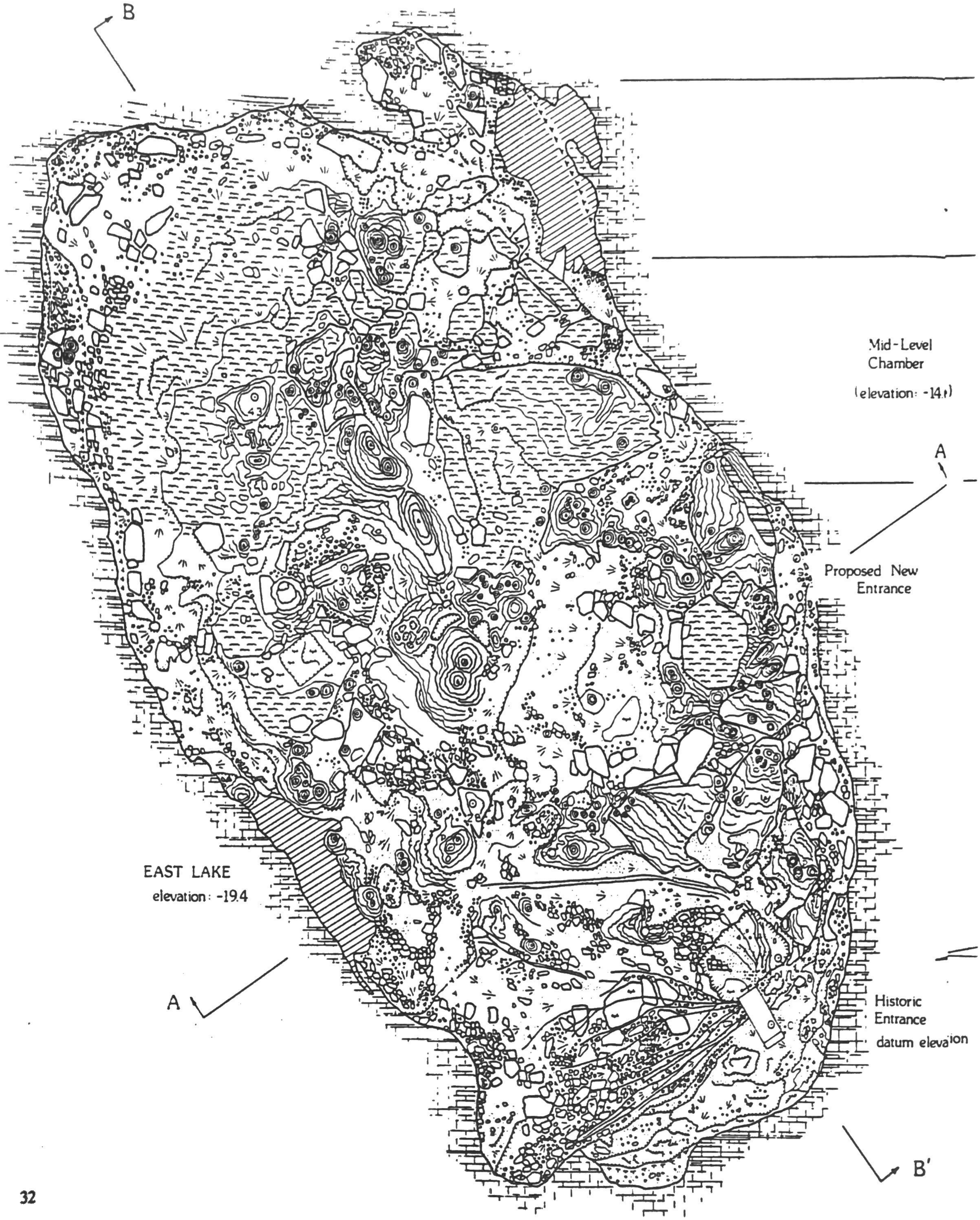
Block Diagram (no scale)

No. 2 of 6

THE FOUNTAIN
ANGUILLA, B.W.I.

ENTRANCE BUILDING

Survey By:	Date:	
W. Stone P. Stone J. Burch R.& J. Gurnee	May 1986	National Speleological Foundation U.S.A.


B
Mid-Level
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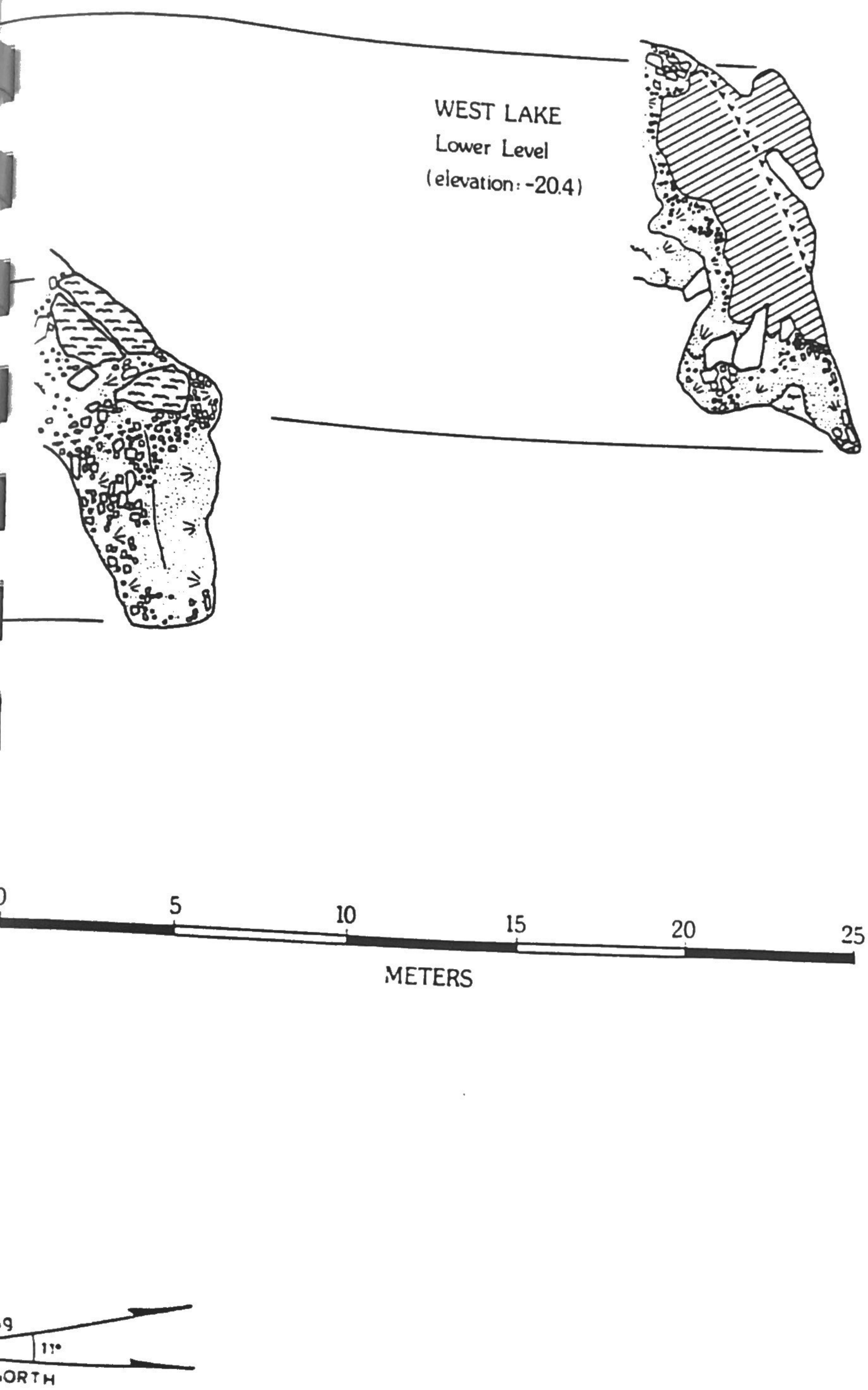
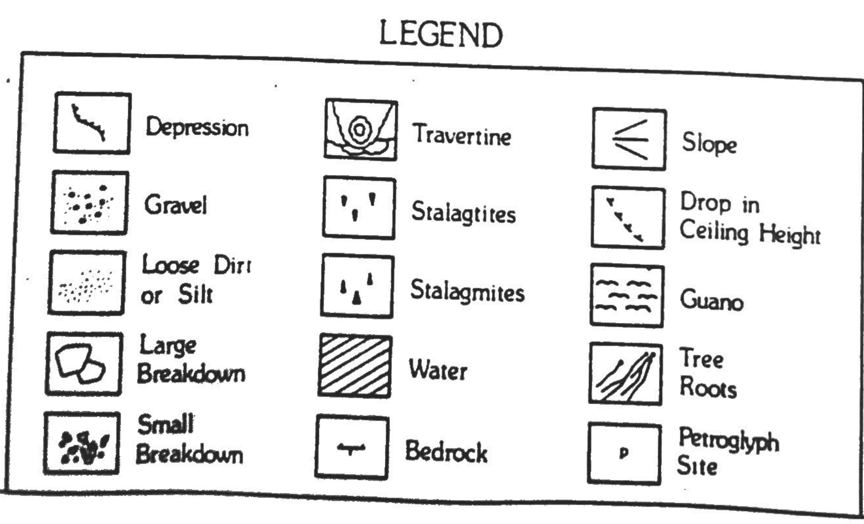




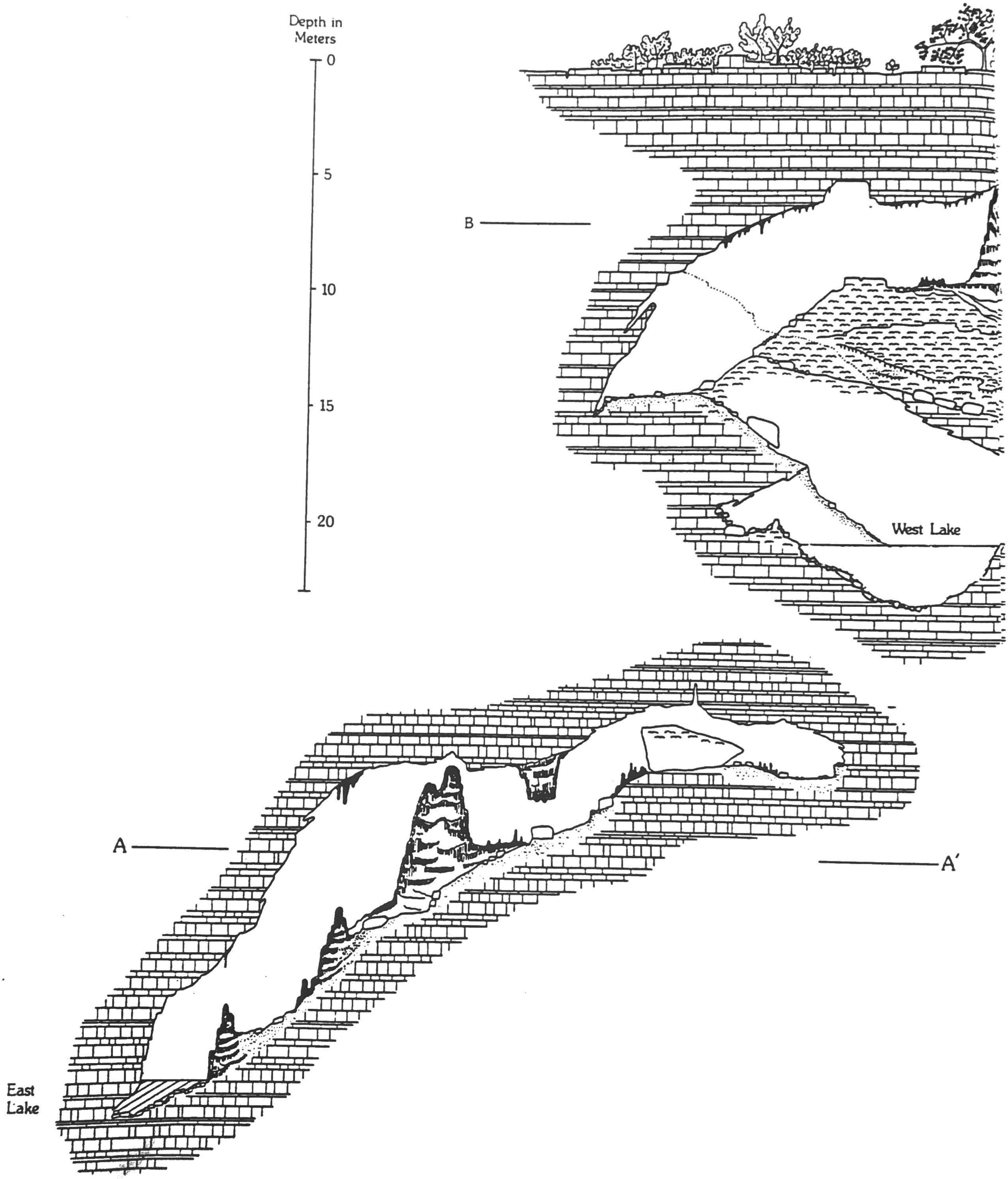
No. 3 of 6

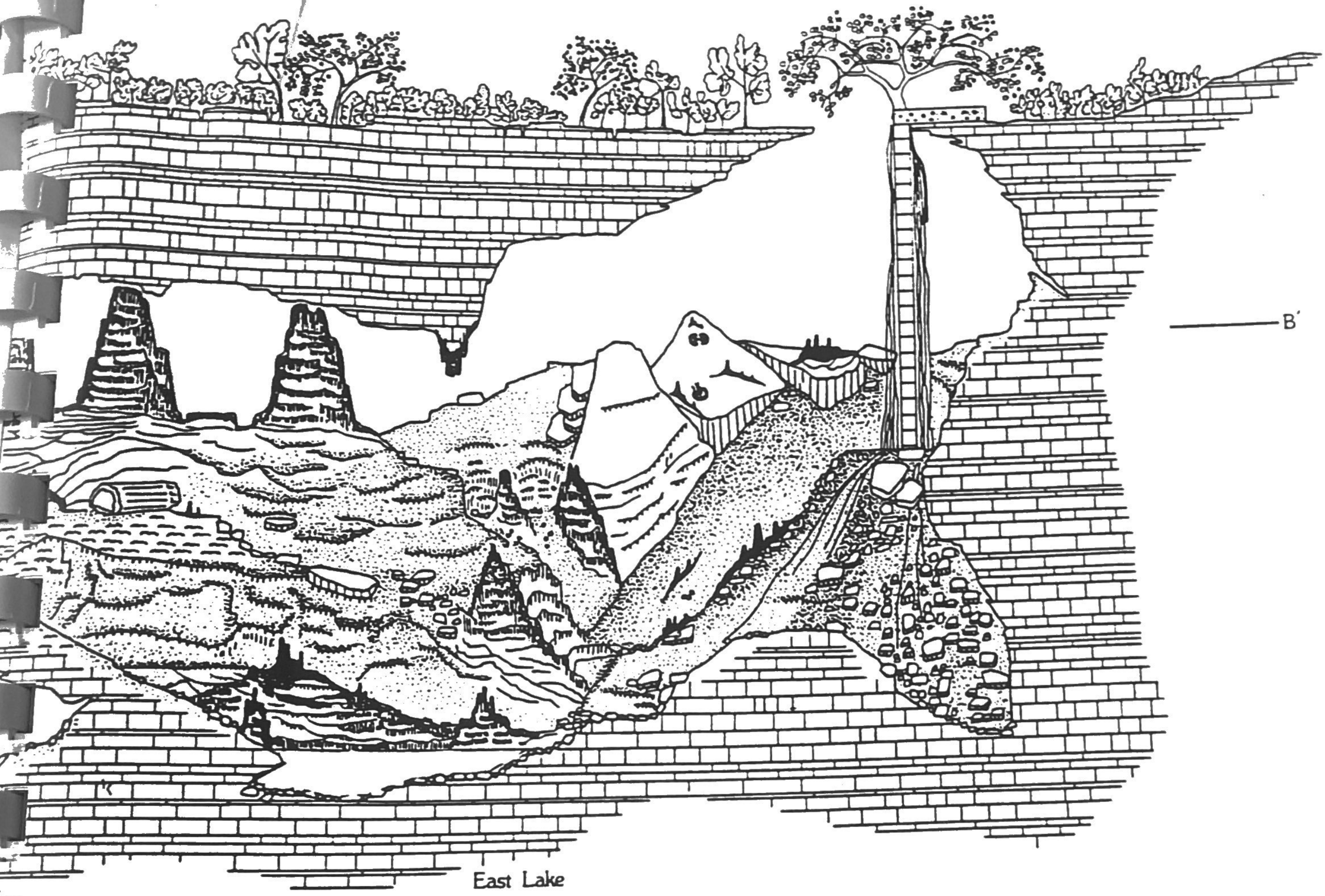
THE FOUNTAIN

ANGUILLA. B.W.I

PLAN VIEW

Survey By:	Date:	
W. Stone P. Stone J. Burch R.& J. Gurnee	Aug. 29, 1986	National Speleological Foundation U.S.A.


Depth in Meters
0
5
10
15
20
B
West Lake
A
A′
East Lake



in
ers
- 5
- 10
15
20

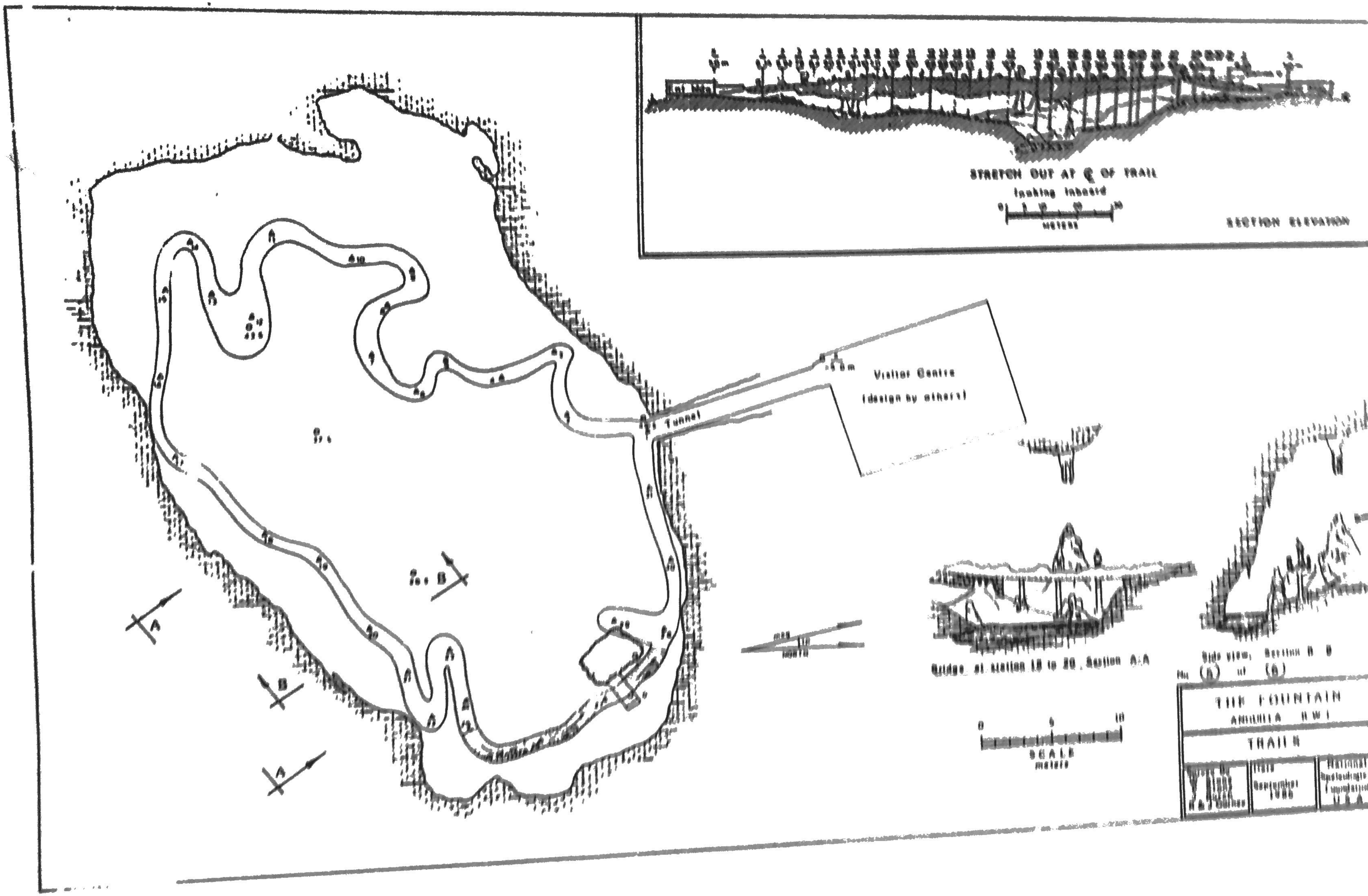
No. 4 of 6

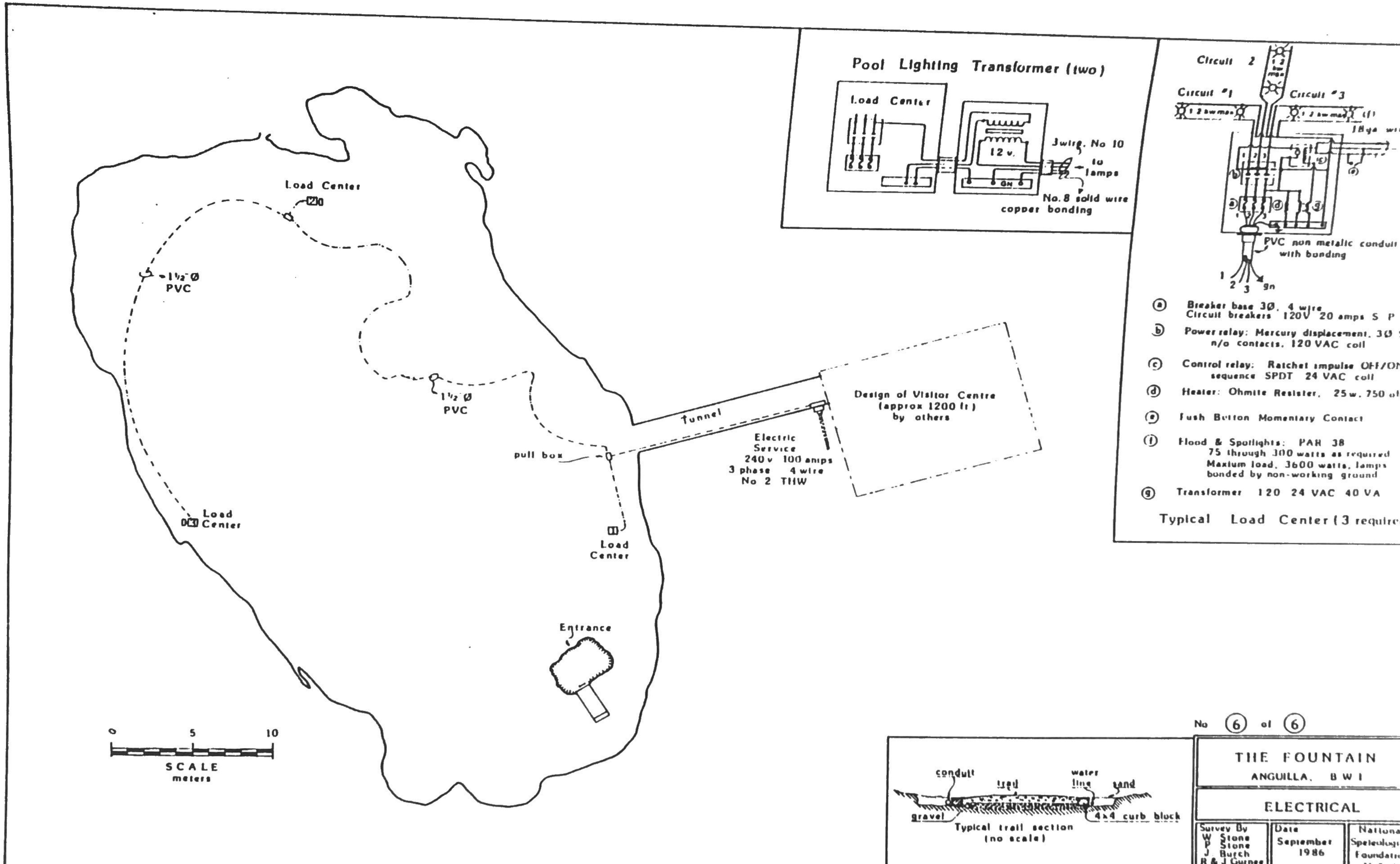
THE FOUNTAIN

ANGUILLA. B.W.I.

PROFILE SECTIONS

Survey By:	Date:	National Speleological Foundation U.S.A.
W. Stone P. Stone J. Burch R & J Gurnee	Sept. 2, 1986	


STRETCH OUT AT ℄ OF TRAIL
looking inboard
metres
SECTION ELEVATION
Visitor Centre
(design by others)
Tunnel
A
B
Bridge at station 18 to 20, Section A-A
Side view, Section B-B
SCALE
metres
0
5
10
THE FOUNTAIN
ANGUILLA B.W.I.
TRAILS
September
1986
National
Speleological
Foundation
U.S.A.



Pool Lighting Transformer (two)
Load Center
12 v.
GN
3wire, No 10
to lamps
No. 8 solid wire copper bonding
Circuit 2
Circuit #1
Circuit #3
18ga wire
PVC non metalic conduit with bonding
1
2
3
gn
(a) Breaker base 3Ø, 4 wire
Circuit breakers 120V 20 amps S P
(b) Power relay: Mercury displacement, 3Ø ST n/o contacts, 120 VAC coil
(c) Control relay: Ratchet impulse OFF/ON sequence SPDT 24 VAC coil
(d) Heater: Ohmite Resister, 25 w. 750 ohm
(e) Push Button Momentary Contact
(f) Flood & Spotlights: PAR 38
75 through 300 watts as required
Maxium load, 3600 watts, lamps bonded by non-working ground
(g) Transformer 120 24 VAC 40 VA
Typical Load Center (3 required)
Load Center
1½ Ø PVC
1½ Ø PVC
pull box
Load Center
Load Center
Tunnel
Electric Service
240 v 100 amps
3 phase 4 wire
No 2 THW
Design of Visitor Centre (approx 1200 ft) by others
Entrance
0
5
10
SCALE
meters
No 6 of 6
THE FOUNTAIN
ANGUILLA, B W I
ELECTRICAL
conduit
tread
water line
sand
gravel
4x4 curb block
Typical trail section (no scale)
Survey By
W Stone
P Stone
J Burch
R & J Gurnee
Date
September 1986
National Speleological Foundation
U S A

PLAN VIEW

Plan No. 3.

An accurate floor plan of the cave is essential for the planning of a show cave development. This plan was prepared with steel tape and compass using a plane table for sketching. All stations and elevations were calculated on a computer program in the field as well as in the drafting room. The locations of all rocks, one meter or larger, are shown in their correct positions. All changes in elevation are noted, and the legend shows the textures of various materials. With this plan it is possible to obtain a "cut and fill" estimate for the trails and an outline for the electrical system.

PROFILE SECTIONS

Plan No. 4.

The cross sections (A-A and B-B) refer to the previous Plan View and provide an accurate profile of the cave in relation to the surface above and the lakes below. Like the Plan View, this drawing depicts the natural conditions within the cave and (except for the existing steel ladder) does not show any alterations to the site.

TRAILS

Plan No. 5.

The plan view of the TRAILS layout is an overlay of the base map. The location of the trail has been plotted on the field map, and all elevations have been taken from the station points. The Section Elevation is a stretch-out of the route to be traveled by the visitor and shows the changes in gradient throughout the tour.

The trail design permits visitation to the cave by handicapped persons in a wheelchair. The petroglyphs can be seen without ascending or descending the stairway shown between Station Points 25 and 28.

The normal tour, however, would traverse the cave in a counterclockwise direction from the entrance tunnel. This route would include a close view of the three major stalagmites, the West Lake, a long view of the entrance ladder, the East Lake, and a close-up view of a principal focus of the cave experience—the carved stalagmite called "Jocahu."

The bridge shown in Section A-A is designed to prevent damage to any possible archaeological site beneath the trail. The posts as shown would rest on small footings carefully excavated before any concrete is used.

The stairway is to be cut back into the wall at the lower level, and extreme care would be taken to assure the security of the ceiling and wall structures at that point. The visitor will pass beneath the natural opening and ascend to a viewing platform (Station 28 and 29) where all the remaining petroglyphs can be seen. This will be the final important location that will remain in the visitor's memory: the archaeological evidences and a view of the striking natural entrance opening of the cave.

ELECTRICAL PLAN

Plan No. 6.

The electrical wiring plan shows the location of the load centers and plastic conduit as installed in the cave. The Trail Section indicates the position of the conduit built into the trail design.

The positions of lights and fixtures are not shown, as individual consideration must be given in the field to the location of each light at the time of installation. Light switches are operated by the guides, and the position of the switches would not be evident to visitors. Installation of the trails and electrical conduits is made to blend into the cave scene. Conduits, switches, boxes and any exposed wires would be concealed with natural materials compatible with the cave environment. Guides would extinguish all lights between tours in order to avoid lampenflora—the growth of plants and algae on the formations.

EXPLORATION OF THE SUBTERRANEAN LAKES OF FOUNTAIN CAVERN

by Pat Wiedeman-Stone and William Stone, Ph.D.

Prior to the government-sponsored mapping efforts conducted in April of 1986, very little quantitative information was available concerning the two freshwater lakes contained in Fountain Cavern. The East Lake was known to have been used for hundreds of years as a source of drinking water by local people and maritime traders passing through the islands. Rumors surrounded both lakes. The water level was reported to fluctuate with the tide, indicating a possible connection to the nearby ocean at Shoal Bay. This theory merited further investigation, both because of the depth of the lakes below the surface, and because it is a phenomenon known to exist on other Caribbean Islands, notably in the "Blue Holes" on Grand Bahama and Andros. The West Lake, furthermore, was reported to have been explored by a local Scuba diver who claimed to have discovered a large flooded chamber continuing beneath the southwest wall of the cavern. Because such underwater tunnels can lead to extensive air-filled continuations in limestone caverns, preparations were made to effect a thorough investigation of both lakes during the course of the National Speleological Foundation mapping project.

The East Lake lies at the bottom of a steep talus slope which descends directly from the base of the metal ladder at the entrance and is 19.4 meters beneath the surface. This is, coincidentally, approximately the same vertical differential between the entrance datum and mean sea-level. It was therefore anticipated that a saltwater/freshwater "halocline" would be discovered if the lake proved to be very deep. A halocline is formed where brackish water intrudes into a freshwater aquifer. The denser saltwater occupies the lower level and the interface is marked by a mirror-like surface. However, exploration of the East Lake proved fruitless. The only underwater passage consisted of a small horizontal fissure which continued westward just under the south wall for a distance of five meters before becoming impassable. The floor throughout this section was comprised of clean coarse gravel and stone with very little sediment. At the northeast end of the lake, a small air-filled crawl leads for several meters beneath the breakdown floor of the cavern before being stopped by a total collapse blockage. The water temperature was approximately 25 degrees C, consistent with the mean air temperature in the cavern.

The West Lake presented the most likely candidate for a continuing underwater tunnel. Its elevation was 20.4 meters beneath the surface; it was located closer to the ocean; and the surface area was approximately twice that of the East Lake. Furthermore, a dark blue passage appeared to be present and leading northward underneath the cavern wall. All of this tended to support the original stories of an underwater extension to the cavern. Exploration of this lake revealed a small pocket extending some five meters beneath the north wall. This ended in a dome-shaped room measuring two meters wide by four meters long. The walls were heavily eroded limestone bedrock which showed no signs of instability. The floor was covered by clean washed boulders, similar to those found in the East Lake. These rocks formed a continuous talus slope from the lake edge to the point in the underwater pocket where they came to rest against the north bedrock wall. An attempt was made to remove some of the talus in an effort to see if it was blocking access to an underwater continuation. This was unsuccessful and it would appear that the talus is several meters deep at this point.

The nature of the East and West lakes, along with the general morphology of the main cavern, indicate that Fountain Cavern was formed in several stages as an isolated phreatic pocket. Phreatic development occurs by chemical dissolution of the cavern walls in limestone stratum during a period when the level of the stratum lies beneath the surrounding groundwater aquifer. Chambers of substantial size can be developed in this manner, with ceiling spans being supported by the water, which is essentially incompressible. When the groundwater table (in large part governed by sea level on Anguilla) lowered to its present datum, the vertical ceiling support provided by the water was removed and an eventual collapse occurred, leading to the formation of the skylight entrance and the present mountainous rubble floor which dominates the cavern topography. The East and West lakes represent remnants of the original aquifer, interrupted by the collapse rubble, which apparently drains toward the north, as evidenced by the elevation differences between the two lakes. The brief extent of these lakes, the solid nature of the limestone roof and walls, and the rubble floor, are all consistent with the morphological model of a collapsed phreatic chamber. This would indicate that a humanly passable connection with the sea is unlikely, as is the possibility of a continuing underwater tunnel beneath the talus leading into the lakes.

SHOW CAVE MAINTENANCE

by Jack C. Burch

Just as with any area where many people are present day after day, a maintenance program is an important element to be built into the over-all plan for Fountain Cavern.

Several procedures are needed to maintain a good cave environment; others are the procedures normally necessary at any heavily traveled visitor center. The points below refer only to the interior of the cave.

1. Algae, moss, and moss protenema will eventually grow near lights and, as this is not natural to the cavern environment but caused by the introduction of artificial light into the underground, it must be removed periodically. Some strong light sources can produce plant growth as far away as 40 feet. To reduce excessive growth, cave lighting should be turned on only when necessary for tours.

Unwanted plant life can be killed by steam (not less than 100 degrees C.). An alternate treatment is a light spray of undiluted bleach (5% sodium hypochlorite ion).

2. A person familiar with the extremities of the cave and its lighting system should be appointed for the following purposes:

   a. To replace light bulbs. This will be a continual replacement need, both from normal use and from hot bulbs that might crack or explode from contact with splashed water.

   b. For electrical trouble shooting. There probably will not be power failures within the cave often; however, an experienced electrician, following normal trouble-shooting procedures, should be able to spot and repair these while tours of the cave continue.

   c. To remove any trash accumulation from visitors. Flash bulbs, candy wrappers, cigarette butts, match sticks, film refuse, etc. must always be kept out of the cave. Any coins must be cleaned out of the two cave pools, as coins are harmful to cave life and will discolor cave formations.

   d. To wash away periodically any type of dirt that might accumulate on the cave trail. Clay must be kept off the steeper trails, as this could cause accidents by slipping.

3. Speleothem growth is very slow, and in a well traveled cave such as Fountain Cavern, only a few delicate formations remain. The trails have been laid out to provide space to prevent visitors from touching the formations, but unintentional vandalism by those who are employed in a cave is very common and should be guarded against.

4. A schedule of inspection and maintenance should be set up to remove lint, dust and bat droppings periodically from the trails and tunnel. Skylights in the tunnel should be systematically cleaned of salt and grime accumulation.

5. Periodic checking of the walls and ceiling by an engineering team to check the reference bench marks for any roof-sag (as mentioned in Goodell report) should also be built into a scheduled maintenance program.

6. Guides should always be looking for anything in the cave which needs attention and report this to the cavern management.

SPECIFICATIONS

The specifications for the development of Fountain Cavern follow the general outline set forth by the Construction Specifications Institute (USA) with modifications for the special nature of the work. As some Division numbers (10, 11, 12, 13 and 14) do not apply to this project, they do not appear below.

Division 1. GENERAL CONDITIONS

The following assumptions are made regarding the proposed construction:

1. A Caves Authority Committee (or similar entity) appointed by the Anguillian government will act as General Contractor.
2. Supervision and interpretation of the Design Plans to be carried out by the Cave Developer, engaged by the Caves Authority.
3. Local sub-contractors to be used wherever possible.
4. All general labor, technicians and mechanics to be hired from local sources by the Caves Authority, to be supervised and directed by the Cave Developer.
5. Material, sub-contracts, rental equipment, professional services, insurance and all other development costs to be the responsibility of the Caves Authority.
6. All permits, licenses and fees required for construction to be obtained by the Caves Authority.

Division 2. SITE WORK

The following modifications of the site will be made before cave development commences:

1. Excavation, grading, and filling of new alternate roadway to the building and tunnel site from the right-of-way along the south property line. This work to be done by proper mechanical equipment, using experienced and skilled operators. No blasting to be done in the vicinity of the cave without authorization of the Cave Developer and proper local authorities. No vibrating roller equipment is to operate in the immediate vicinity of the cave.
2. A new electric service to be extended from the main highway to the southeast corner of the property. Utility company shall provide poles, transformers, and service drop. The service shall be installed underground from the pole to the proposed entrance building. This will be in appropriate conduit and be protected with a poured concrete surround to reduce the depth of the trench, and minimize the disturbance of the cave ceiling. Construction work will be carried on by means of a temporary service run overhead. The final system will be buried as shown.
3. The construction site will be equipped with all necessary facilities for the construction and completion of the work including, but not limited to, the following:
   a. Sanitary facilities for all personnel on site. Portable toilets are recommended, which can be rented from and serviced by a local contractor.
   b. Potable water from an approved source.
   c. Temporary electric service for office trailer or construction shed, security lights, work lights in the cave, and storage rooms.
   d. A public telephone for the office area.
   e. A fence should be placed around the natural entrance to the cave for the protection of workmen and to avoid accidents. Location of this fence should be far enough away from the entrance so it cannot be seen from within.

Upon completion of the cavern development, the construction site is to be returned to its natural state by removing all temporary buildings, storerooms, office trailer, sanitary facilities, and construction equipment. The area will be left in a clean state with no trash or debris. A maintenance plan for protection of the natural vegetation should be prepared and suitable provisions made by the Caves Authority to provide security and personnel to do the work.

Division 3. CONCRETE WORK

Concrete work within the cave falls into two categories: general concrete and structural concrete. The general concrete consists of trails, waterproofing, and the cosmetic covering of pipes, cables, and light cairns.

The trail concrete work lies on compacted, tamped gravel or crushed stone, as shown on Plan No. 6, with a center crown to avoid puddles. This concrete will be capped with a finish coat of tinted white Portland cement (colored to match the adjacent floor) and sharp silica sand with a brush finish for traction. Mix 1:3. It is not necessary, or desirable, to reinforce the trail concrete with steel mesh in this instance. There is no expansion or contraction of concrete in the cave environment. Moisture, however, is continually present and could rust steel and cause splitting of the concrete. Where reinforcing rod is used, it will be coated to prevent rusting. Mix for general trail work is 1:2:3 with appropriate aggregate and water to achieve a 3,000 PSI test at 28 days. Test cylinders are to be taken for inspection and results recorded.

Structural concrete applies to areas where the trail spans an area (see Trail Plan No. 4) where the original floor is not to be disturbed. Here the trail shall be 6 inches thick and be reinforced with PVC-coated rod and cast in a monolithic pour. Sleeves, railing pockets, conduit for electric and water will be installed before casting the slab. Forms will be kept on for at least four days after pouring before stripping and finishing.

Division 4. MASONRY

In trail building it is desirable to utilize the existing rock in the cave as wall material and footing supports. In certain instances where cut materials are visible to the visitor, it is necessary to blend any marks or fractures in the rock with color to make it appear natural. This is done with a mixture of white Portland cement and sharp sand tinted to match exactly the color of the rock or mud.

[illegible]

Division 5. STEEL

No structural steel is to be used in the cave except as reinforcing support for the ramp and narrow trails. There a PVC-coated No. 3 reinforcing rod will be inserted and grouted into the bedrock to provide additional support for the stairs and platforms.

Retaining walls are to be made of masonry with irregular outline and random pattern. They are to provide safety for the visitor on the ramp and to define the boundaries of the trail. The masonry wall will be fully grouted and high enough to support and conceal from view a continuous PVC handrail mounted on the adjacent rock. Offset sections of masonry steps will provide safe and adequate access for the visitor. New irregular wall will be reinforced as required.

All disturbed rock, masonry walls, stairs, and supports will be coated with a mixture of Portland cement and [illegible] tinted with masonry coloring to match surrounding rock. Camouflage mortar will be used on supporting walls of trails visible.

At Stations 19 and 20 (Plan No. 4) the natural floor will not be disturbed, except for the footings of the platform.

Division 6. CARPENTRY

There will be no permanent wood structures within the cave. Only temporary forms, staging, platforms, and concrete frames will be permitted. These are to be fabricated in a workmanlike manner, properly braced and supported to provide secure and stable concrete forms.

All temporary handrails, ramps, signs, and wood storage sheds will be removed at the completion of the cave development work.

Division 7. THERMAL AND MOISTURE PROTECTION

Since it is not possible, or desirable, to eliminate the moisture within the cave, it is necessary to provide protection for those items and areas that could deteriorate.

All electrical switches, boxes, and relays will have resistance heaters that provide an input of heat within each enclosure. These heaters increase the dry-bulb temperature in the boxes and therefore reduce the relative humidity and eliminate condensation.

All materials selected to be used in the cave will be protected from or be tolerant of moisture. There will be no aluminum wire, boxes, or switches used in the cave. No wood or organic matter will be used for permanent construction underground.

Reinforcing rods will be coated with PVC or similar material to seal them from moisture.

[illegible]

Division 8. DOORS, WINDOWS AND GLASS

[illegible]

Division 11. EQUIPMENT

There is no permanent heavy equipment required for the operation and maintenance of the cave. [illegible]

[illegible]

Division 15. MECHANICAL WORK

There will not be sanitary facilities within the cave. No potable water source other than a potable water drinking fountain is to be provided underground.

Division 16. ELECTRICAL WORK

The electrical system installed in the cave is not designed for public use. All tours through the cave will be under the supervision of a guide who will control the lighting switches.

Only experienced and trained electricians will be operating the lighting and electrical systems within the cave. Two lighting systems are required: one for use during the Construction Stage and another for the Exhibition Stage.

Construction Stage. A temporary work-light system supported overhead or on the side walls out of reach of workmen is required. Feeder lines are to be [illegible], bonded and fused for maximum circuit overload protection. Hand tools, such as drills, saws, etc., should have double insulation.

Surface lighting, from a temporary source, will provide lighting for an office trailer and security lights. They will be removed at the end of construction. All work will be done by experienced technicians and be in conformity with local codes.

Exhibition Stage. A permanent lighting and power system will be installed during the Construction Stage. All work and supervision will be by experienced personnel, all equipment and material installed to be compatible with the cave environment.

Primary power will be 120/240 volts, 3-phase, 60 cy., 4-wire. (Single-phase system is adequate if no air conditioning for Visitor Center in excess of 5 tons is anticipated.) A lightning surge arrester will be located at the service entrance.

Panel board in the entrance load center to be UL labeled and rated for service voltage as scheduled on drawings.

Cabinets and Boxes

Cabinets and boxes to follow National Electrical Code: gauge steel covered with PVC, or UL-approved PVC boxes [illegible] terminals. Power relays shall be mercury displacement, hermetically sealed, three-pole, single-throw normally open contacts. Coil voltage: 120 volts AC. [illegible] UL approved, [illegible] quick-make/quick-break.

Each start/stop box, switch box, or control panel will be equipped with resistance heaters on the power side of the line to provide constant heat within the enclosure to reduce condensation (25 watts, 750 ohms). Remote control station switches will be non-metallic with start buttons, single-pole momentary contact.

Piping and Wiring

Primary service will be brought to the main disconnect switch in accordance with the local utility requirements and by the jurisdiction required.

Cable from the main disconnect switch will be copper quadruplex (3 THW-insulated conductors and one bare neutral), spiral wound in PVC conduit buried along the side of the trail as shown. Sub-feeding from disconnect to individual load centers will be through PVC 1-1/2 inch conduit properly joined with cemented couplings and long sweep ells. Pull boxes as required will have waterproof covers of PVC.

Cable to individual load centers will be No. 10 copper, 4 conductors, THW insulated. A separate No.10 copper non-working ground will provide bonding for conduit.

Individual 120-volt bulb lines will be No. 12 2 conductor + ground; either UF or NM insulation.

Control lines for operating relays for lighting circuits are to be No. 18 3-conductor [illegible] or equivalent.

No wire nuts will be used for the cave lighting system. All connections will be soldered.

Sequence of Operation

Momentary contact light switches energize an impulse ratchet-type control relay which in turn energizes the coil of mercury plunger power relays. This provides power through individual bulb circuits to light a section of the cave. A second impulse to the relay causes the power to deactivate the coil and permits the mercury switch to return to a normally open position.

Placement of Lamps and Concealment of Wires

The arrangement of lights for a cave tour are a matter of personal and artistic judgment. First, the lights provide a safe illumination for visitors. Second, they provide a dramatic presentation of the cave features. This is a skillful balance generally not in the experience of most electricians.

The placement and control position of the lights will be made on the site during the Construction Stage by the cave developer. All wires and cables will be concealed from the visitor's view.

THREE STAGES OF CAVE DEVELOPMENT

The work required to modify Fountain National Park as a show cave development and visitor attraction has been divided into three parts. Each part requires different skills and supervision to accomplish.

DESIGN STAGE

The fundamental design is the most important step in making a decision to modify a natural cave to be opened to the public. Design considerations for a show cave require specific skills not usually found in general architectural and engineering practice. Environmental and aesthetic factors weigh heavily on the choices available; and in the case of Fountain Cavern, the protection of the archaeological remains is critical.

CONSTRUCTION STAGE

The Construction Stage covers the physical modification of the site and includes all necessary labor and material for the preparation of the cave for safe visitation by the public. The modification of the cave requires expert judgment, and the on-site decisions must be made by experienced and competent workmen and engineers. Additional skills are needed to perform the work specified in the Design Stage including administrative and legal advice to provide the contracts and agreements necessary to bring the project to completion. A financial plan and estimate are important in seeking capital and will contribute to the success of the venture. (This financial plan was included with the September, 1986 report to AAHS.)

EXHIBITION STAGE

Management and promotional skills are required to make this portion of the work successful. Few of the people participating in the Construction Stage can progress to the Exhibition Stage. The physical operation and maintenance of a show cave do not require a large staff. Most of the personnel will need interpretive skills for guiding and handling large groups of people. The advertising and promotion of the cave require professionals in these fields; and the educational aspect of the cave requires teaching and instructional training for the personnel. A sound business plan is necessary for the survival of the project. A security system as protection for the cave is an expense that must also be included.

A BUSINESS PLAN FOR FOUNTAIN NATIONAL PARK

by Russell H. Gurnee

If the Anguillian Government would like to proceed with the plans and proposals presented in Part Two of this study, the following steps are recommended by the Study Group to bring the project to completion.

RESPONSIBILITY OF THE GOVERNMENT

1. Establish an ad hoc Cave Authority Committee to act as General Contractor for the project (hereafter called Owner).
2. Arrange for project financing to be administered by the Cave Authority Committee.
3. Contract for a local Project Manager and personnel to be on site to provide administrative duties in the following:
   a. Hiring of local subcontractors and tradesmen.
   b. Payroll accounting.
   c. Timekeeper, storekeeper, and security.
   d. Approve purchases and maintain cost records.
   e. Arrange for and keep records of necessary permits, inspections, insurance requirements, and local regulations.
   f. Contract for machinery rentals, utilities, and enforce safety regulations.
4. Contract with a Construction Management Team to act as Construction Manager during the period required to complete the work shown on the plans.
5. When the development is near completion, hire a professional staff to operate the cave as a visitor attraction including promotion, presentation, and maintenance.

RESPONSIBILITY OF CONSTRUCTION MANAGEMENT TEAM

The Construction Manager will act as the representative of the Owner in bringing to completion a turn-key cave site ready to receive visitors. He will also train and instruct a local staff in the exhibition and maintenance of the cave.

To achieve this goal the Construction Manager shall provide on-site personnel during the entire construction phase for the purpose of supervising the work as shown on the documents. The work would be accomplished in three phases:

Phase One is related to the Design Stage and includes:

a. *Schedule.* Develop a Project Time Schedule to coordinate and integrate the plans with construction schedules.

b. *Project Construction Budget.* Prepare a detailed construction estimate based on a quantity survey of drawings and specifications.

c. *Construction Planning.* Recommend for purchase and expedite the procurement of long-lead items to ensure their delivery by the required dates.

d. *Division of Work.* Make recommendations to the Owner regarding division of work to facilitate bidding and awarding of trade contracts.

Phase Two covers the Construction Stage and includes:

a. *Project Control.* Maintain a competent full-time staff at the project site to coordinate and provide general direction of the work and progress of the trade contractors on the project. Establish on-site organization and lines of authority in order to carry out the overall plans. Schedule and conduct progress meetings at which the trade contractors, Owner, and Construction Manager can discuss procedures, progress, problems, and scheduling. Provide summary reports of work progress to Owner. Recommend courses of action to the Owner when requirements of a trade contract are not being met.

b. *Physical Construction.* Provide the hands-on supervisory labor required to complete the work shown on the work documents. Provide specialized engineering equipment to perform the necessary inspections and verifications of work in accordance with good workmanlike practice.

c. *Cost Control.* Develop and monitor an effective system of project cost control. Identify variances between actual and budgeted or estimated costs and advise Owner whenever projected cost exceeds budgets or estimates. Coordinate with the Project Manager on actual costs and accounting (original records kept by him) and preserve these records for a period of three years.

d. *Change Orders.* Develop and implement a system for the preparation, review and processing of change orders. Recommend necessary or desirable changes to the Owner for review and assist in negotiating change orders.

e. *Payments To Trade Contractors.* Develop and implement a procedure for the review, processing and payment of bills submitted by trade contractors.

f. *Inspection.* Inspect the work of the trade contractors and make recommendations to Owner regarding any defects or deficiencies.

g. *Reports and Project Site Documents.* Record the progress of the project. Submit written progress reports to the Owner including information on trade contractors' work and the percentage of completion. Keep a daily log available to the Owner.

h. *Substantial Completion.* Determine substantial completion of the work and prepare a list of incomplete items and a schedule for their completion.

i. *Start Up.* With the Owner's maintenance personnel, direct the check-out of the utilities, operations systems and equipment for readiness and assist in their initial start-up and testing by the trade contractors.

j. *Final Completion*. Determine when development is complete and provide written notice to the Owner that the work is ready for final inspection. Secure and transmit to the Owner all keys, manuals, record drawings and maintenance stocks.

Phase Three consists of the Exhibition Stage of the development and requires a staff to perform different duties from those required during the Construction Stage. The Construction Manager should be prepared to supply the following:

a. *Guide Training*. A manual should be provided to personnel selected by the Owner with information for presentation of the cave to the public. Training sessions should be held to permit the personal exposure of the trainee to the conditions in the cave and Visitor Centre.

b. *Marketing*. Develop and implement a plan for advertising to announce the park and cave to various markets. Work in cooperation with the Government agencies involved.

c. *Maintenance*. Prepare a schedule for the use of permanent personnel giving information on the maintenance and repair of the systems and features in the park.

d. *Administration*. Develop a job description list of the permanent personnel required to operate this show cave facility. Prepare a program for hiring suitable personnel.

It will be necessary to start the Construction Management Team contract at least two months before the construction crew is on the site in order to provide lead time to assemble materials and arrange for contracts.

The selection of a Construction Manager is a serious and important consideration. Proper performance of the role described above will coordinate the stages and phases of the job, reduce the time between changes in activities, and permit an orderly flow of material, personnel, and work. Direct hands-on supervision by specialists in cavern development and management will assure an orderly transition from a wild cave/natural site to a fine cavern park with all details of construction, marketing, and training completed and on-line by opening day. This will also assure the return on investment, not only in money, but in the preservation of Anguilla's valuable natural resource.

NATIONAL SPELEOLOGICAL FOUNDATION

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> "The organization is created exclusively for scientific, literary, or educational purposes, including purposes serving the science of speleology and the conservation of caves..."

There are no paid employees of the Foundation and all directorships are voluntary. The principal activity of the Trustees of the National Speleological Foundation is related to the several Funds held in trust for the National Speleological Society. All income from these funds is distributed in accordance with the purposes of the charter and the directions of the fund agreements.

One activity of the Foundation has been the sponsorship of studies of individual caves in various parts of the world. In February, 1986, the Foundation appointed Jeanne Gurnee to chair the Fountain Cavern Project Committee with the following associates:

Jack Burch, trail and lighting engineer
Patricia Stone, diver and surveyor
Bill Stone, cartographer and photographer
Russell Gurnee, coordinator and estimator
Jeanne Gurnee, chairman, land use, trails

Jack C. Burch - Occupation: Engineer of trails and lighting for show caves. Designed and executed trails, bridges, lighting, etc., for Sonora Caverns, 1960; Natural Bridge Caverns, Texas, 1963-1969; consultant to Inner Space Cavern, 1966; consultant to Iowa State for the development of Cold Water Cave, 1973; consultant to U.S. National Park Service regarding maintenance of Carlsbad Caverns, New Mexico, 1977; chief engineer on trails and restoration, Harrison's Cave, Barbados, 1980; designed and supervised trails and roadways for Rio Camuy Cave, Puerto Rico, 1983-1984; designed trails for Ensueno Cave, Puerto Rico, 1986. Has explored caves since 1938; was President of the Texas Speleological Association, 1967.

Patricia Wiedeman-Stone - Occupation: Physical therapist. Expedition-related skills include vertical caving, cave diving, first aid, and surveying. She is a fully certified cave diver and has participated in expeditions to Pena Colorada Cave, Mexico, 1981, 1982, and 1984.; National Speleological Foundation Rio Camuy Cave Study, Puerto Rico, 1982; cave diving team at Wookey Hole Project, England, 1985. In 1982 she was a member of a climbing/exploration team to Mount McKinley, Alaska during which she participated in an intensive exploration program of the ice caves of the Muldrow Glacier. On the same expedition she was a member of the summit assault team which successfully reached the top of McKinley after 40 days on the mountain.

William Stone, Ph.D. - Occupation: Professional structural engineer with the National Bureau of Standards and President of Cis-Lunar Development Laboratories, Inc. Leader and organizer of 20 international expeditions; skilled in vertical caving, cave diving, technical climbing, cave rescue, cartography, and underwater photography. Recipient of many speleological awards, he has been a key figure in the introduction of helium-based breathing gases for the exploration of deep submerged caves. He has surveyed and mapped water caves in Mexico, Great Britain, Puerto Rico, and Florida. He was chief cartographer on the NSF/Rio Camuy Study in Puerto Rico, 1985.

Russell Gurnee - Occupation: President, R. H. Gurnee, Inc., engineer, industrialist, author. Has studied caves over 35 years; past president, National Speleological Society; past president The Explorers Club, currently President, National Speleological Foundation. President of the Eighth International Congress of Speleology, 1981, currently US representative to the governing Bureau of the Union International de Speleologie and co-chairman of the International Commission on Show Caves. He has led expeditions to Puerto Rico, Guatemala, Venezuela, Peru, Ecuador and throughout the U.S. Currently President of Cave Management Associates, Inc. (developer of Harrison's Cave in Barbados and the Rio Camuy Cave in Puerto Rico), he led a consulting team which prepared show cave analyses in Aruba, Curacao, Puerto Rico and El Salvador.

Jeanne Gurnee - Occupation: Editor and Publisher, science and exploration magazine, *The Explorers Journal;* environmentalist; geographer; speleologist; author. Officer, municipal zoning board; Chairman, Environmental Commission reviewing site plans for municipal construction, writing and publishing work on land use, architectural history, master plans, and recreational and park sites. She was a national officer of The Society of Woman Geographers, Washington, D.C. and recipient of many speleological awards including Honorary Membership, National Speleological Society, Cave Research Foundation, and Sociedad Espeleologica de Puerto Rico. She has edited and written for speleological publications for 30 years and is co-author of the books *Discovery at the Rio Camuy* and *Gurnee Guide to American Caves*. She has participated in speleological work on six continents.

All of the services, reports and maps by National Speleological Foundation specialists have been donated by the individuals involved. The editor's design, editing and publishing of the monograph have also been donated. Only expenses for accommodation on Anguilla, transportation and direct printing costs have been provided.

SUMMARY

by Jeanne Gurnee

A Study of Fountain National Park and Fountain Cavern, Anguilla, British West Indies is composed of two parts: The first consists of studies made by scientists who have examined a particular element of the cave. The second part presents the all-over view and the methods by which the cavern can be developed for visitors, prepared by specialists through the National Speleological Foundation.

In order to draw conclusions from the two parts of this monograph, it is helpful to refer to other show caves in the world, whose planners have faced many of the same considerations as those cited in Part One of this publication.

As an example, in the report on histoplasmosis, Dr. McFarlane mentions that the likelihood of an individual's developing clinical symptoms is proportional to the dose of the infective material. While the casual visitor would probably not be in danger of infection, guides and those who work for long periods of time underground would want to be assured that the cave is safe. In a study carried out by the authors in Aguas Buenas Cave, Puerto Rico in 1968, skin tests were taken for histoplasmosis by the expedition physician prior to and following the week-long expedition period. All participants who were previously "negative" were "positive" after the exploration period. Two members were subsequently hospitalized. As a precaution, we would suggest soil samples be taken from Fountain Cavern for analysis.

Regarding cave life, there are many show caves in which cave life and visits by tourists are compatible. For 169 years and with a visitation of over 23 million people, Postojna Jama in Yugoslavia has been the home of *Proteus anguinus* (the "man" fish). Mammoth Cave, Kentucky, contains the troglobitic fish, *Typhlichthys subterraneus*, as well as crayfish, crickets and other cave-dwelling animals. Colossal Cave in Arizona is used by migrant Mexican hognose and longnose bats as a nursery in summer. The caverns of Carter Cave State Park, Kentucky, contain a major bat hibernation colony. The Ozark Underground Laboratory in Missouri, open for educational groups, has a fine colony of 150,000 gray bats, and there are 70 additional animal species known in the cave.

Probably one of the most spectacular show caves containing cave life is Waitomo Cave in New Zealand, where glowworms, *Arachnocampa luminosa*, live in a subterranean water chamber. Visitors ride in boats under the area where the glowworms are located. Guacharo Cave, a national park in Venezuela, is the home of over 3,000 guacharo birds, *Steatornis caripensis* (oilbirds), that live their life cycle in caves, exiting only for food. Sea Lion Cave in California contains a fine display of these marine animals. The development has been designed well and the mammals are easily seen and heard but not disturbed. More remote, but also a show cave, is Juxtlahuaca Cave in Guerrero, Mexico, which has a large bat population near the entrance. Carlsbad Caverns, New Mexico, is well known for its evening bat flights, and there are many other show caves in temperate zones that contain bats during the winter hibernation period.

In Fountain Cavern, it is important that the bats' daily habits are not changed radically. As shown earlier in this report, environmental control doors have been designed at the end of the entrance tunnel. These would remain closed at all times when people are not entering or exiting the cave in order to preserve the cave environment. Other cave administrators have found that the cavern environment can be preserved using this technique i.e. Sonora Caverns, Texas; Natural Bridge Caverns, Texas; Wind Cave, South Dakota; Lehman Caves, Nevada to name a few. By using a second entrance for visitors to Fountain Cavern, the original, natural entrance remains unchanged and the bats may use it as in centuries past. If a visitor staircase were designed in the natural entrance of Fountain Cavern, the bats' exodus would be disturbed; also the evidences of construction would interfere with the beauty of the natural opening as viewed from below and above.

Perhaps the most important factor in providing protection of cave life is the maintenance of the bats' feeding conditions. It is important that the material on which the bats feed remains as before. It has happened in the U.S. that all conditions inside a cave have been carefully preserved, but that the food on which the bats forage has been removed (surface vegetation altered or insect life destroyed). The Park landscape design and surrounding land use plans should take this need into consideration.

In a number of caves bats have adapted to their joint occupation with visitors by moving their roosts from tour areas to more remote places in the cave. This may occur in Fountain Cavern. Other caves on Anguilla can also serve as habitations for bats, as they do today.

An over-all objective when preparing Fountain Cavern for visitors is to maintain the natural environment—not only for the preservation of the cave life, petroglyphs and cavern itself but also in order to provide an opportunity for visitors to view the cave in a state that is as close as possible to that of the early visitors who came to The Fountain to place their etchings on the rocks or to gather water there over 1,000 years ago.

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