Chapter 1

Introduction

A Cognitive-Processual Approach

Renfrew and Bahn (1991:431-434) propose that archaeology has entered a new phase they have termed "cognitive-processualism," a recent movement in archaeological thought that is directed toward studies of ancient ideologies. Renfrew and Zubrow (1994:1) argue that studies of ancient ideology have traditionally been either interpretationist, anti-scientific and literary, or linguistic frameworks, that stand in juxtaposition to the new method, which is rooted in scientific tradition and empirical methodology.

Ideology and cognitive processes were areas of study not traditionally undertaken by early processualists. Binford (1968:23) observed that information about nonmaterial aspects of ancient culture such as psychology and philosophy are accessible to scholars but that methodology to access this information was lacking. Hence, one of the aims of cognitive processualism is to develop methodology designed to study ancient ideology and cognition drawing on cognitive, mathematical, and computer sciences (Renfrew and Zubrow 1994). By examining the way that symbols are used, cognitive-processualists

hope to gain knowledge into how shared ideas in ancient communities worked and insight on how that working affected behavior (Renfrew 1994a:5-9).

The following study is an intrasite spatial analysis of a ceremonial cave using a Geographic Information System (GIS). It was conducted in the Main Chamber, a dark zone area of Actun Tunichil Muknal, an ancient Maya ceremonial site, located in Western Belize (Fig. 1-1) dating to the Terminal Classic Period (A.D. 830-950). Using a cognitive-processual approach, ancient Maya ritual behavior is examined by analyzing spatial patterns of artifact deposition within the chamber. The investigation examines the proximity of artifacts to natural morphological features of the cave as well as the relationship of artifacts to one another. Interpretation of artifact patterning aids in the determination of rituals conducted in the cave's interior and helps to clarify their function and meaning.

Context and Classificatory Schemes

In traditional interpretations, artifacts are divided into three types: 1) *technomic* artifacts that articulate with the physical environment, 2) *sociotechnic* artifacts that function primarily with the social subsystem, and 3) *ideotechnic* artifacts that reflect the cognitive elements of culture (Binford 1962). However, ethnoarchaeological work suggests that these categories are not mutually exclusive. Hayden and Cannon (1984:239) found that, in the Maya highlands, artifacts rarely function in one of the above realms to the exclusion of the others. It was the context that determined how an artifact was being used and therefore, which interpretive framework needed to be applied.

The cave context is critical for determining the artifact category since caves in the Maya lowlands are almost exclusively ritual venues. In his survey of Maya lowland caves, Brady (1989:5) was unable to produce a single example of cave habitation. He noted that caves in general were uncomfortable places to live and were typically inhabited only in instances of cold-weather adaptation (1989:1-6). Available light played an important role in this assessment and cave interiors were divided into three categories: 1) the "light zone" which described areas with direct light, 2) the "twilight" zone, which described an area of indirect light such as a dimly lit entrance, and 3) the "dark zone" which described the interior areas of total darkness. It has been observed that ancient people did not live in the deep dark recesses of caves (Hole and Heizer 1965:47) and Faulkner (1988) noted that dark zones are cross-culturally considered to be ritual spaces. Additionally, according to Chard (1975:171), most "caves" used as refuge were actually rock shelters.

In tropical areas, caves are particularly dank and are often infested with bats and insects, which carry a number of deadly diseases including histoplasmosis, rabies, and chagas. Many areas within caves that were intensively utilized by ancient people are difficult to access and are often located far into the dark zones, rendering them useless for even temporary habitation. Brady's (1989:5-6) conclusion was that, "it can be stated categorically that habitation within the dark zone is practically inconceivable."

A Brief History of Maya Cave Archaeology

Reports of caves have a long history in Mesoamerican studies, beginning with the work of Henry C. Mercer. Mercer's survey of 29 Yucatan caves, *The Hill-Caves of*

Yucatan (1975), was originally published in 1896 but most copies were lost in a print shop fire and not republished until 1975. Another important early contributor to cave studies was Edward Thompson who excavated at Loltun Cave in Yucatan (1897). Early investigators of note were George Gordon (1898) who produced a study of the caves near Copan, and Eduard Seler (1901) who reported on the caves of Quen Santo in the highlands of Guatemala. Although these early reports exceeded the standards of the period, they failed to recognize the ritual importance of caves, and the European view that caves were habitational sites prevailed. A number of cave reports were published in the first half of the 20th century, but none attempted to synthesize the cave data until J. Eric Thompson published his 1959 article, *The Role of Caves in Maya Culture*. The work was originally published in Germany and later revised as the introduction to Henry Mercer's 1975 publication of *The Hill-Caves of Yucatan.* Thompson discussed a number of cave uses, emphasizing the role of religious ceremony. These uses included 1) sources of drinking water, 2) sources of "Virgin" water, 3) venues of religious rites, 4) places for burials, ossuaries, and cremations, 5) art galleries, 6) deposition of ceremonially discarded utensils, 7) places of refuge, and 8) other uses (which included mining).

Following Thompson's article, the next major breakthrough was the work on the cave beneath the Pyramid of the Sun at Teotihuacan by Doris Heyden (1973; 1975). Heyden's emphasis on the meaning of the cave was an important contribution to the general recognition and acceptance of caves as sacred spaces. Barbara MacLeod and Dennis Puleston (1978) contributed to this line of inquiry by suggesting that caves were the entrance to *Xibalba,* the Maya Underworld. The concept of caves as sacred space has been increasingly accepted, and in his dissertation, James Brady (1989) conducted one of

the first projects devoted completely to the excavation and interpretation of a Mesoamerican ritual cave at Naj Tunich, Guatemala. This work firmly established Maya Lowland caves as ritual spaces and initiated the specialized subfield of Mesoamerican cave studies.

Spatial Analysis

One of the problems in Maya cave studies is that only a few reports mention relationships between artifacts and cave features (Andrews 1970; Brady 1989; Graham, McNatt, and Gutchen 1980; Reents-Budet 1980). Most notably, Brady (1989:402-406) addresses spatial issues at the cave of Naj Tunich. He proposes a model of private-use and public-use areas based primarily on the configuration of the ritual space in terms of size or accessibility. Brady's study touches on the issue of the use of space in caves, but no formal analysis was undertaken. Although notable intrasite spatial analyses were conducted in French paleolithic caves (Riguad and Simek 1991; Simek and Larick 1983), to date there has been no systematic intrasite spatial analyses conducted in caves of Mesoamerica.

The following study will provide a rigorous spatial analysis by using Geographical Information Systems (GIS) technology. Although archaeological studies using GIS have most often been regional analyses (see Allen et al. 1990 for examples), the general spatial infrastructure of GIS is not scale dependent and the flexibility of the system allows it to be used in smaller geographic spaces. For this reason, GIS is the most powerful tool on the market today for the display and analyses of archaeological material. It will be used to geo-reference and tally artifacts, examine their spatial distribution, and

assess artifact proximity to the morphological features of the cave. These goals would be difficult to achieve by more standard methods of map preparation and examination

Ritual Patterning

Both the ethnographic and ethnohistoric records demonstrate that Maya caves were and are used as ritual spaces (Christenson 1998:85-8; LaFarge 1947:127-128; B. Tedlock 1982:148-149; J. E. Thompson 1970:267-268; Tozzer 1907:148-149, 1941:78-79; Vogt 1969:386-387). Ideologically rich in symbolism, they are thought of as entrances to the underworld, whose function was to permit travel between the corporal world and the spiritual world of the gods (MacLeod and Puleston 1978; Schele and Miller 1986:302; J. E. Thompson 1970), as well as birthplaces of ancestral humans (Brady 1989:40; Heyden 1975; LaFarge 1947:127-128; Taube 1986; J. E. Thompson 1970:314, 316; Vogt 1969:375). They are also considered to be the stone dwellings of gods that promoted rain and fertility (Brady 1988; 1989:37-38; Boremanse 1998:27; Heyden 1975; Holland 1963:93; LaFarge and Byers 1931:243; Nash 1970:14i; Toor 1947:473; J. E. Thompson 1970:267-268; Vogt 1969:303). Given these Mesoamerican beliefs, it is hardly surprising that caves were and are important ritual venues.

This overall functional homogeneity is advantageous to the archaeologist since the formal and repetitive characteristics of ritual facilitate its study in the artifact record. As Roy Rappaport (1979:176) observed, ritual is repetitive and must be performed in prescribed ways. This agrees well with ethnographic evidence from the Maya area provided by Evon Vogt (1965:602-603). Working in the Tzotzil village of Zinacantan, he described a phenomenon that he termed “replication,” which referred to patterned

aspects of ritual behavior observed in a variety of contexts, settings, and scales. This does not suggest that all aspects of a ritual performance are expected to be identical, but rather, that there exists an underlying structural pattern of ritual behavior. Although Turner (1982:81) argued that there also exists an organic and improvisational aspect of ritual performance, he emphasized that the looser elements operated solely within the framework of the formal structure. Therefore, we may expect that artifact deposition in ritual contexts will not be haphazard or structurally amorphous, but that some spatial patterns will reflect the ritual structure and that the structure will be visible in the artifact record.

Contextualized spatial data patterns and the artifacts associated with them are potentially capable of producing archaeological "signatures." In his article on the structure of archaeological data, Mark Aldenderfer (1987:95) defines signatures as "unambiguous indicators of a behavioral process." They are represented archaeologically as patterned data associations between artifacts and their contexts. Due to the formal and repetitive characteristics of ritual behavior, one would expect specific rituals to leave specific signatures. As Marcus and Flannery (1994:56) have observed, "artefacts used in ritual should exhibit a pattern of use and discard which is non-random and yields insights into the nature of the ritual itself." Andrea Stone (1997) has suggested that interpretations of spatial patterning of artifacts within caves may be compared with spatial models developed by ethnographers and ethnohistorians.

Use of Analogy

When artifact patterns can be established, the next problem becomes their interpretation. Kent Flannery (1976:331) suggested that interpretation could be problematic in ritual contexts when he stated that, "Mesoamerican archaeology has absolutely no coherent and consistent theoretical frame work by means of which ritual or religious data can be analyzed and interpreted." To this end, Marcus and Flannery suggest both the use of contextual analysis and the employment of the Direct Historical Approach (1994:55). The latter, used for some time in Mesoamerica, was formally named by Waldo R. Wedel (1938)in an article "The Direct Historical Approach in Pawnee Archaeology." The method works back in time from the known to the unknown using ethnographic and ethnohistoric data to interpret the archaeological record and is considered, as Marcus and Flannery have suggested, a strong analogical argument.

Binford (1967:1-2) defined analogy as, "an inferential argument based on implied relationships between demonstrably similar entities." Although he offered guidelines for its use, he only condoned analogy as a method of creating testable hypotheses. As part of his guidelines, Binford suggested that for an analogy to be a successful, the inferred property should account for analogical similarities and a high degree of correlation should be demonstrated between analogs. One of Binford's most crucial criteria for drawing an analogy is the historical continuity between the archaeologically observed unit and the ethnographically cited society.

In juxtaposition to Binford's stance on hypothesis testing, Alison Wylie (1985) argued that strong arguments could be drawn from the closeness of fit between a formal

analogy and its relational counterpart. She suggested that archaeologists must work toward establishing the principles of connection upon which analogies are evaluated.

What can be derived from these debates is that the success of an analogical argument is largely dependent on: 1) the degree to which it relates to a specific question, 2) the pervasiveness of the ethnographic analog over time and space, and 3) the rate of the analog's known occurrence. A commonly occurring referential analog is more likely to be correct partially due to probability. Additionally, if distinct recognizable patterns or specific elements of the referential analog can be sufficiently isolated, a strong inference may be made when those patterns or traits are identified in the archaeological record.

This study demonstrates that a detailed analysis of a single site can increase our understanding of ancient rituals conducted within cave interiors by using strong ethnographic analogy. It identifies spatial patterns of artifact deposition and compares them to models of spatial organization reported in ethnographic and ethnohistoric texts. Models produced by the study provide a basis for future comparisons with other caves that will help to determine whether occurrences of specific spatial patterns are limited to local areas or more widely distributed. Additionally, since archaeologists suspect that there may have been a good deal of variation in use from one cave to another, this is an important step in isolating that variation.

Location of Belize, Central America

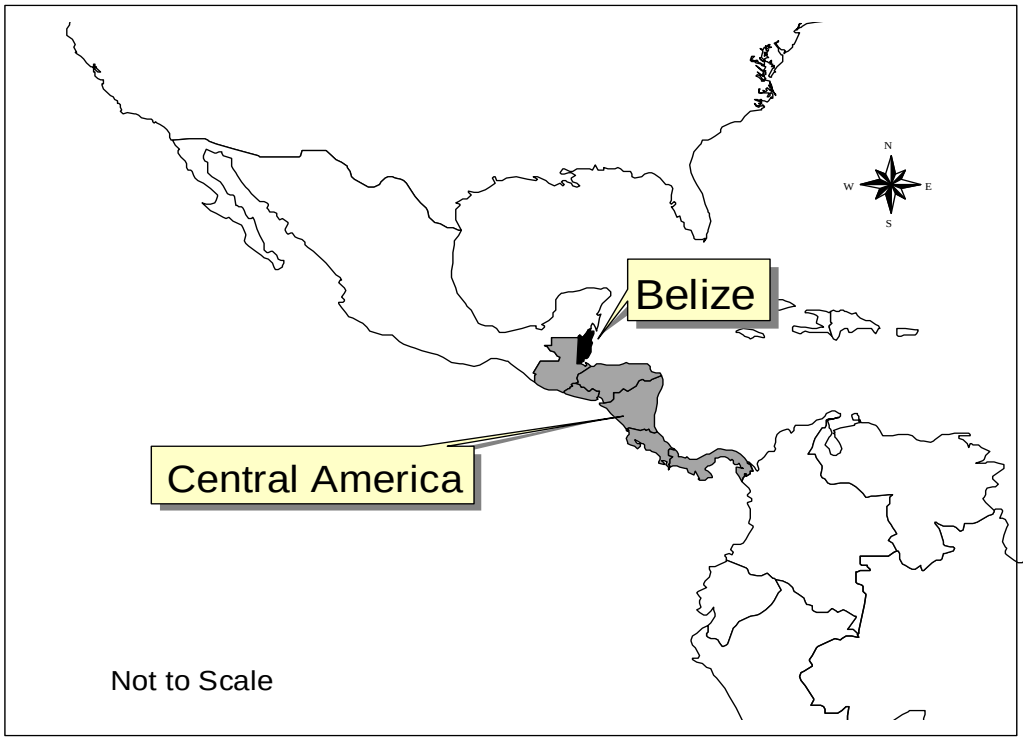


Fig. 1-1

CHAPTER 2

The Setting

The Project

Data used in these analyses were collected by the Western Belize Regional Cave Project (WBRCP) under the direction of Dr. Jaime Awe. The three-year project was funded by a grant from the Social Sciences and Humanities Research Council of Canada. Its aim was to investigate and record five ancient Maya cave sites located in the El Cayo district of western Belize: Uayazba Cab (Handprint Cave), Yaxteel Ahau (New "Green" Lord), Actun Chapat (Caterpillar Cave), Chechem Ha (Poisonwood Water), and the venue of this study, Actun Tunichil Muknal (Cave of the Stone Sepulcher).

Actun Tunichil Muknal was discovered and named by a geomorphologist, Dr. Thomas Miller (Miller 1989, 1990), who produced a map of the cave system (Fig. 2-1), and reported on the Main Chamber. Afterward, the chamber was visited by a British speleological expedition that also reported on the cave (Roberts 1990; Marochov and Williams 1991). Dr. Jaime Awe began investigations in 1993 and continued work at the site in 1996 as the primary investigator of the WBRCP (Awe et al. 1997).

In the summer of 1996 I visited Actun Tunichil Muknal with the WBRCP to begin mapping the Main Chamber and recording the human remains. In 1997, I returned as a staff member to supervise the mapping and recording of artifacts. This was accomplished during the 1997 summer field season that lasted from May until August.

On two return visits during the 1998 summer field season, corrections were made to the data. Seven additional artifacts were added to the assemblage and mapping of the Main Chamber was completed.

Description of the Cave

Actun Tunichil Muknal is located on a tributary of Roaring Creek near Teakettle village (Fig. 2-2). Flowing through the 5 km of cave passage is a perennial stream that culminates in a deep blue pool at the eastern entrance. Cultural remains were found in four major loci: the Main Entrance Chamber, the Sinkhole Tunnels, the Stela Chamber and the Main Chamber (Awe et al. 1997).

Based on ceramic cross-dating with Gifford's Barton Ramie collection, material from the Main Entrance Chamber and the Sinkhole Tunnels suggests that the cave may have been used from the Early Classic (A.D. 300-600) to the Late Classic Period (A.D. 700-950 (Griffith 1998). The Main Chamber, which is focus of this study, was probably utilized only during the Terminal Classic Period (A.D. 700-950) (see Chapter 4 for a discussion of the ceramic chronology), since no earlier or later material was located in the area to suggest otherwise.

The Main Chamber was the use area located farthest from the cave entrance. It was selected for detailed spatial analysis because it was the most extensively and intensively utilized area and its secluded location left it undisturbed by looters. The chamber is located 500 meters from the eastern cave entrance where a high level passage splits off from the main passageway. It measures 183m in length and is 35m at its widest

point and 5m at its narrowest. The long axis is oriented in an east/west direction. The total area is approximately 4,450m^2.

Water Turbation and Artifact Movement

Much of the floor of the Main Chamber consists of a series of rimstone (or travertine) dams formed by precipitation of calcium during water evaporation. These dams create a honeycomb of gour pools that cover descend gradually toward the eastern entrance. Initial speculation was that the chamber had been dry for quite some time. However, in July of 1997, torrential rain caused the chamber to fill with water. Natural drainage began almost immediately, but some standing pools persisted for up to three weeks. It is likely that the chamber has been wet on and off since ancient times, which would account for the thick calcite build-up.

Although many of the artifacts in the chamber were broken, it would be expected since commonly in Maya rituals ceramic vessels were smashed during ceremonies. Therefore, post-depositional water movement would not account for their condition. Turbulent water movement appeared to have been minimal since repeated episodes of heavy and rapid water flow would have caused erosion of ceramic slips and even to edges of sherds. Although many artifacts were cemented to the floor by calcite, heavy encrustation of artifacts occurred primarily at the base of gour pools that ranged from 10-40cm in depth. Some artifacts, particularly ceramic vessels, were located on top of rimstone dams and situated in upright positions. These were lightly encrusted at their bases. This suggests that from the time of deposition there had been little water flow over the dams and that it was not enough to cause displacement of artifacts.

Additionally, were artifacts displaced by water movement they would expected to collect around impediments to down-slope water flow. In viewing the distribution of artifacts found in the pools on the up-slope side of large cave features such as boulders or stalagmitic columns, an even artifact distribution was observed.

Light artifacts such as human bone were more likely to have undergone post-depositional water movement than heavier ceramic sherds. In a few cases disarticulated remains of human skeletons provided evidence that some movement occurred. However, in each case, the bones remained in the gour pools in which they were deposited and there was no evidence of heavy water turbation.

Main Chamber Description by Area

For purposes of description and field use, the Main Chamber was divided into the following areas: 1) the Creek, 2) Boot Hill, 3) the Passage, 4) the Burial Chamber, 5) the Ransom Chamber, 6) the Cathedral, 7) the Angel's Room, 8) the West Wall, and 9) the Crystal Sepulcher. Boot Hill, the Burial Chamber, and the West Wall contained the highest artifact concentrations (Fig. 2-3). Names were given to the areas by various members of the WBRCP. The names are an artifact of spelunking tradition and in no way intended to overlay any Christian beliefs onto a Maya ceremonial site. Spelunkers typically name caves or areas in caves for people that discovered them or choose whimsical names to describe impressive formations that are best described by an analogy. Although one might consider this a colonialist practice, it could be argued that it is no more so than numbering assigning more "scientific" numbers to areas. Names are much easier to remember and immediately recall the space and its contents.

The Creek

The Creek is an ascending section of passage that commences at the river where the passage leading to the Main Chamber splits off from the main tunnel system and leads to the entrance of Boot Hill (Fig.2-4). An accessible route along the passage defines a pathway leading to a small opening (squeeze) located in the area of breakdown which forms the west wall. The squeeze provides an entryway to Boot Hill, the first large room in the Main Chamber.

Two alcoves open onto the north end of the Creek. The western alcove (Alcove 1) is an elbow-shaped muddy area, approximately 1.5m wide and 8m long, containing one artifact, the top half of a wide mouthed jar, situated against the wall. The other alcove (Alcove 2), is approximately 2m in length 2.5m in width contains several sherds both at the entrance and rear wall.

The Creek floor is composed of a series of rimstone dams that function as a stairway and terminate in the muddy level area. The east side of the passage consists of a mud bank and several groups of boulders. Clusters of artifacts associated with carbon scatters and ash lenses line the path. On the north side, an obsidian blade was located in the interior of a jar sherd. Metate fragments and sherds were found along the south wall in a niche near the squeeze.

Boot Hill

On the northwest wall of the Creek is the entrance to Boot Hill. A constriction in the cave walls partially blocked by a boulder creates a squeeze forcing one to crawl into the chamber. Once the squeeze is traversed, the area opens into a large cathedral-like

room measuring 30m from north to south and 14m east to west. (Fig. 2-5). The odd name of "Boot Hill" was given to the chamber because the crew were required to remove their boots upon entry to prevent damage to the pristine crystalline calcite encrusted floor.

On the north side of the entrance, beneath a large freestanding boulder is a vertically erected slab of limestone exhibiting cut marks (Fig. 2-6). The square-cut stone measures 33cm in length, 28cm in width, and 108cm in height. The top one-third of the stone tapers into a point giving it a stela-like appearance. It appears to have fallen over and rests on the boulder behind it. At the base of the stone are the sherds of a smashed narrow-necked red-slipped jar and a red-slipped bowl. Based on the shape of the stone and the associated artifact assemblage, it is considered a monument. The monument sits on an elevated rimstone dam that appears to have functioned as an altar. Sitting atop the dam is a mano and metate the top half of a wide-necked jar. All three artifacts are calcite encrusted.

Approximately 3m above the monument in the cave wall is an elevated alcove (Alcove 3) containing sherds of four jars strewn among a number of medium to large-sized boulders. Many of the sherds exhibit interior charring suggesting they may have been used as incensarios.

An ancient waterfall of white crystalline calcite cascading down a group of large boulders defiines the western side of the chamber giving the appearance of moving water frozen in time (Fig. 2-7). It ranges between 2 to 3m above floor level. To the east, beneath the calcite waterfall, is a low-lying area designated "the Pit." The floor is honeycombed with rimstone dams. Ceramic vessels and speleothems were deposited in the gour pools and around small boulders throughout this area. A large freestanding

boulder is located on the north side of the Pit (Fig. 2-8). Sherds and speleothems surround the base.

The north side of Boot Hill is flanked by a muddy slope that ascends to the top of an ancient dried-up waterfall of crystalline calcite. Alcove 4, or "the Tube," cuts into the north wall. This crawl space extends behind the wall to the west for approximately 8m and is 1 to 2m in width and approximately 1m in height. A large ceramic monochrome bowl, with a rim diameter of 56cm is placed in the center of the floor in an inverted position (Fig. 2-9), and sherds are located at the terminus.

To the south, a sandy slope ascends to "Balcony," a raised platform that ranges from 1 to 2m above the Pit. The floor of the Balcony is covered by rimstone dams and on the south side with an area of mud. Ceramic sherds are scattered among rimstone dam pools and a number of artifacts are located between the rocks at the edge of the walkway. These artifacts consist of sherds, speleothems, and a mano fragment. A red-slipped bowl is located on an elevated shelf near the cave ceiling at the southernmost boundary, directly across the chamber from the Tube.

The Passage

Between Boot Hill to the Burial Chamber the cave narrows creating a corridor-like east to west passageway referred to as "the Passage"(Fig. 2-10). Six meters to the southeast of the top of the ancient waterfall is a large stalagmitic column (Fig. 2-11). North of the column, the floor is comprised of rimstone dams. Jar sherds and partially intact ceramic vessels are scattered among the rimstone dams and on shelves within the

stalagmitic column. On the north side of the Passage is a wall, and the south side is composed of breakdown that extends to the south wall.

Moving west, the Passage gradually ascends and is split by a large isolated area of breakdown topped by stalagmitic formations. The flat topped area of breakdown is referred to as "the Boat," due to its resemblance to a boat in dry dock. South of The Boat, the floor consists of loamy sand and small areas of flowstone (unmapped) that culminate at a large area of loamy sand measuring approximately 7m x 5m, referred to as "the Beach." Two features were noted in the sandy area. A broken speleothem measuring 15cm in diameter and 21cm in height was erected in the center of the area (Fig. 2-12), and located at the western edge of the sand is a crude hearth, delineated by two speleothems and a large sherd (Fig. 2-13). The hearth contained a scatter of charcoal and measured 37cm in diameter. A 1x1m unit (Unit4) was placed over the hearth. Upon excavation, it was discovered that the hearth sat in a shallow indentation of flowstone. The indentation was filled in with sterile sand to 15cm below datum. In the top 2 to 3cm the sand was mixed with ash and charcoal, and in the top 1 to 2cm, 6 small sherds (<10cm), a quartzite flake, and a shell fragment were found. The unit was closed and back-filled to resemble its original appearance (Griffith 1998).

On the western end of the Boat, a large flat boulder creates a table-like surface that measures between 50cm to 1.5m in height and 1m in width (Fig. 2-14). This feature is referred to as the "Olla Altar." Sherds of seven jars, a dish, and nine speleothems were found on top of this low, flat, protruding feature.

Proceeding along the north side of the Passage, moving from east to west, the floor consists of a number of rimstone dams. A constriction occurs at the west end of the

corridor and a large stalagmitic column creates a natural entranceway to the next chamber (Fig. 2-15). A steep mud slope leads to an alcove (Alcove 5) that runs behind the north edge of the stalagmite. Alcove 5 contains ceramic sherds, speleothems and metate fragments.

Near the entranceway, there are two areas where the rimstone dams appear to have been excavated in ancient times as evidenced by breaks in the flowstone exhibiting regrowth. One area (Fig. 2-16), is 63cm long, 13 cm wide, and 9cm deep. The other area, located 1m to the east is 7cm in length, 13cm in width, and 1cm deep. Because the excavations were located on the down-slope side of the dams, they may have functioned as drains. However, this seems unlikely since they would have had little effect. It is also possible that calcium carbonate was mined as raw material, but little evidence exists to support this idea.

The Burial Chamber

The Burial Chamber (Fig. 2-17) was the most intensively utilized area of the Main Chamber, evidenced not only by high artifact concentration but increased variation of artifact classes as well. The name of the chamber was derived from the number of human remains in the area. Particularly striking is a calcite-encrusted skeleton of an adult male (HR1) located in the center of the floor. The cranium exhibits deformation and the four maxillary incisors have been filed in the Romero type A-2 style (Gibbs 1997a:106) (Fig. 2-18). The floor of the chamber is comprised of a honeycomb of rimstone dams with a number of artifacts placed on crests or within pools.

Adjacent to the entrance a mud bank lines the south wall. A high concentration of charcoal was observed in the mud matrix and artifacts are located on the floor along the edge of the mud/flowstone juncture. Farther west, a large mud slope abuts the wall. Animal teeth, metate fragments, a modified shell, and sherds were located on the slope. The sherds included a single fragment of a Tohil Plumbate jar. A 1 x .5m unit (Unit 5) was placed on this slope but was closed and backfilled at the first level due to lack of subsurface deposits. The unit was back-filled and surface deposits were placed in their original positions (Griffith 1998).

Approaching the western end of the chamber, stalagmitic and stalacto-stalagmitic formations line the southern wall. Concentrations of artifacts are located among these formations in niches and alcoves. Sitting on a flat-topped rock in this area is a carved speleothem object, a pyrite tessera, and a few small sherds. A similar carved speleothem identified as a "labret" by Reents-Budet and MacLeod (1997:67) was found at Petroglyph Cave. Cached in a stalagmitic formation were sherds from five vessels including a large red-slipped tripod dish and a jaguar metatarsal (Norbert Stanchley 1998, personal communication).

An imposing stalagmitic column dominates the chamber (Fig. 2-19). A number of artifacts are scattered around the base and cached within the column. Three human cranial fragments and one humerus, possibly representing a single individual (HR14) (Gibbs 1997b:5) was found on the west side. To the south of the column is a small ancient calcite waterfall that cascades into a dry calcite pool containing the remains of two adult males of uncertain age (HR2and3) (Gibbs 1997a:106) (Fig. 2-20). It should be

noted that the rimstone dam containing the human remains became a standing pool of water after the 1997 storm.

At the top of the waterfall, a natural raised platform, approximately 1m above the chamber floor, runs 18m west along the southern wall. An overhang creates a large niche at the floor level containing sherds from nine vessels, three speleothems and a jaguar pelvis (Fig. 2-21). On the north side of the platform placed in and around the central stalagmitic column are vessel sherds and two greenstone celts are cached under a large boulder.

On the south wall of the platform, a niche located under a small overhang on the floor contains speleothems, bat bone, ceramic sherds, a tiny animal claw, and an obsidian blade fragment. Also along the southern wall at the western end of the platform, are white, crystalline, scalloped, calcite formations that appear to cascade to the floor in a waterfall-like formation. Ceramic sherds and a human deciduous molar were placed in and around this formation. Contained within a red-slipped bowl sherd was a flat gray river cobble. A carbon scatter was located directly adjacent to the south wall.

An area of breakdown covered by stalagmites and stalacto-stalagmitic columns forms the north wall of the Burial Chamber. Adjacent to the wall is a flat low-lying calcite covered area that became a pool during the 1997 storm. A carbon scatter was located in the pool and artifacts are found in niches on the chamber floor under small overhangs.

On the northeast side of the Burial Chamber is a large freestanding boulder surrounded by ceramics and speleothems. A ceramic whistle in the form of a dog was

discovered in a cleft on the north side of the boulder (Fig. 2-22). The floor surrounding the boulder is covered with dry calcite pools that filled with water after the 1997 storm.

Moving west in the chamber, a medium-sized freestanding boulder is surrounded by artifacts situated in a pool similar to the spatial configuration mentioned above. Another large boulder is located west of this feature. Ceramic sherds are located on the flat top surface as well as on the floor beneath a small overhang located on the north side of the boulder.

A side passageway splits off from the Burial Chamber and runs in a northeast direction towards a small squeeze leading to the Ransom Chamber. The passage is constricted by large areas of breakdown topped by stalagmites and stalacto-stalagmitic columns on the western side. Located in a niche in the wall on the floor of the chamber are three child burials. The niche itself is 1.5m wide and approximately 2m long, its opening framed with flowstone drapery. The human remains, encrusted with calcite, were submerged after the 1997 storm. The bones are co-mingled and ages of the indiviuals ranged between one and three years (Gibbs 1997a:107, 1997b:2-3).

The Ransom Chamber

To the northeast of the Burial Chamber, accessed through a tiny, narrow, squeeze hole, is the Ransom Chamber (Fig. 2-23). The room measures 12m in length and 9m in width and was named for one of the crewmembers. Two alcoves are located at its eastern and western boundaries. A large area of mud-covered breakdown forms the eastern and northern walls of the room. The chamber floor consists of rimstone dams, only some of

which were mapped. To the east of the squeeze, vessels and speleothems were found in and around rimstone dams adjacent to the south wall.

A slope of sandy loam abuts the north wall. The slope ascends to a high elevation clearing with a sandy floor within the breakdown. It is devoid of artifacts except for a solitary bone tube located in the center of the sandy floor. The tube measures 8.1cm in length and is 1.5cm in width. One end is smoothed and the other appears fractured.

Alcove 7 is located at the southeastern terminus of the chamber. At the alcove entrance is large stalacto-stalagmitic column and a number of small stalagmites (Fig. 2-24). The remains of an adult (HR8) are scattered throughout a low-lying calcite pool that filled with water after the 1997 storm (Fig. 2-25). Due to the thick calcite build-up covering the bones, neither age nor sex could be determined (Gibbs 1997a:107). Accompanying the skeleton are three broken speleothems placed at the edge of the pool. Since there were no formations overhead from which they could have fallen, the speleothems arrived at their current position by intentional placement.

Alcove 8 is located at the western terminus of the chamber and is accessed by descending through a vertically oriented squeeze. It is a low-lying, highly decorated roughly circular area, 3m in diameter. An infant skeleton (HR7) lies behind a fallen stalagmite at the westernmost edge of the alcove (Fig. 2-26). After the 1997 storm, the alcove filled with water submerging the infant remains. The age of the infant was estimated at one year (Gibbs 1997a:107).

The Cathedral

Between the Burial Chamber and the Angel's Room, the cave narrows creating a corridor-like area extending approximately 50m to the west (Fig. 2-27). This high vaulted passage was called the "Cathedral" because of its large open expanse and elaborate stalagmitic and stalacto-stalagmitic formations lining the north wall, reminiscent of church spires (Fig. 2-28). The floor of the Cathedral is composed of rimstone dams, many of which are newly formed and the calcite is not hard enough to support the weight of a person. In some areas, the dams consist primarily of mud. After the 1997 storm, the entire floor of the Cathedral became a large lake.

This area is devoid of artifacts with the exception that, near the Burial Chamber on the north wall, placed high up in an area of breakdown among stalagmites, is a solitary shoe-shaped vessel (shoepot) (Fig. 2-29). The vessel is completely intact and measures 23cm in length, 15cm in height, with a rim diameter of 5.4cm. It appears to be unused and exhibits fire clouding at its base.

At the west end of the Burial Chamber, along the south wall, a large calcite pool that filled with water after the 1997 storm, extends 15m to the west and culminates at a large stalagmitic spire. The pool contains a number of vessel sherds, many of which were covered completely by calcite and are identifiable only by their shape (Fig. 2-30).

A large area of breakdown ($1000m^2$), separates the Cathedral from the western area. At its base, wedged between large boulders, are human remains (HR9). Although the bones are poorly preserved due to the damp conditions of the cavern, Gibbs (1997a:74) estimated that the skeleton was that of a 40-year-old female. Also located in

this area, 5m to the southwest of HR9 in a high level niche, is a partially intact unslipped jar that exhibits signs of interior and exterior charring.

The Angel's Room

West of the Cathedral is the terminus of the Main Chamber referred to as The Angel's Room (Fig. 2-31). The area is highly decorated with stalagmites, stalactites, stalacto-stalagmitic columns, and flowstone draperies. This dual-lobed area is approached from the Cathedral via a squeeze constricted by active stalagmites. The floor of the first room is mud-covered. The only artifact located in this area is a metate, which sits on top of a stalagmitic formation. Except for a broken corner, the metate intact and accumulates water during heavy rains (Fig. 2-32).

At the west side of the room, a constriction in the cave wall forms a "doorway" leading to the westernmost lobe of the room. Stalactites hang from the top of the squeeze, several of which were broken in antiquity as evidenced by their subsequent regrowth (Fig. 2-33). At this northwestern terminus, the chamber begins to ascend to a point at the northwest wall and standing becomes impossible as one moves farther west (Fig. 2-34). On this slope, positioned between small boulders, beneath a stalacto-stalagmitic column are the skeletal remains of an infant (Fig.2-35), estimated to have been between 1 and 1.5 years old (Gibbs 1997b:3). Spray-painted onto the column is an "A8," that is presumably a field designation placed there by previous speleologists.

Moving south toward the northern edge of the breakdown is a feature that has been named, the "Speleothem Bridge" (Fig. 2-36). Nested in a crevice in the cave floor are at least 48 broken speleothems and several sherds (Fig. 2-37). The bridge measures

1.5m in length and 30cm in width. It is referred to it as a "bridge" because one must step over the feature to gain access to the West Wall activity area.

West Wall

Beginning at the Speleothem Bridge, an area of breakdown divides the Angel's Room from the West Wall area (Fig. 2-38). The route is strewn with a number of artifacts and a human skeleton (HR10; Fig. 2-39). The individual, estimated to have been between 6.5 and 7.5 years old (Gibbs 1997b:3), was placed between several large boulders in a small alcove (Alcove 9) in the midst of the breakdown.

Continuing west, the breakdown culminates in a flat low-lying muddy corridor that turns east towards the Crystal Sepulcher. This area is characterized by heavy charcoal concentrations present in the mud matrix and an ash lens located beside a large boulder that exhibited charring. Ceramic sherds are scattered along the walls of the corridor and a cluster of eight speleothems are located along the north wall. After the 1997 storm, the corridor was immersed and resisted drainage for several weeks.

Crystal Sepulcher

At the easternmost end of the West Wall corridor, a small high level chamber opens onto the westernmost wall (Fig. 2-40). This area is a room running on an east/west axis referred to as the Crystal Sepulcher. Two skeletons were located in this area, both covered in crystalline calcite, providing inspiration for the chamber's name.

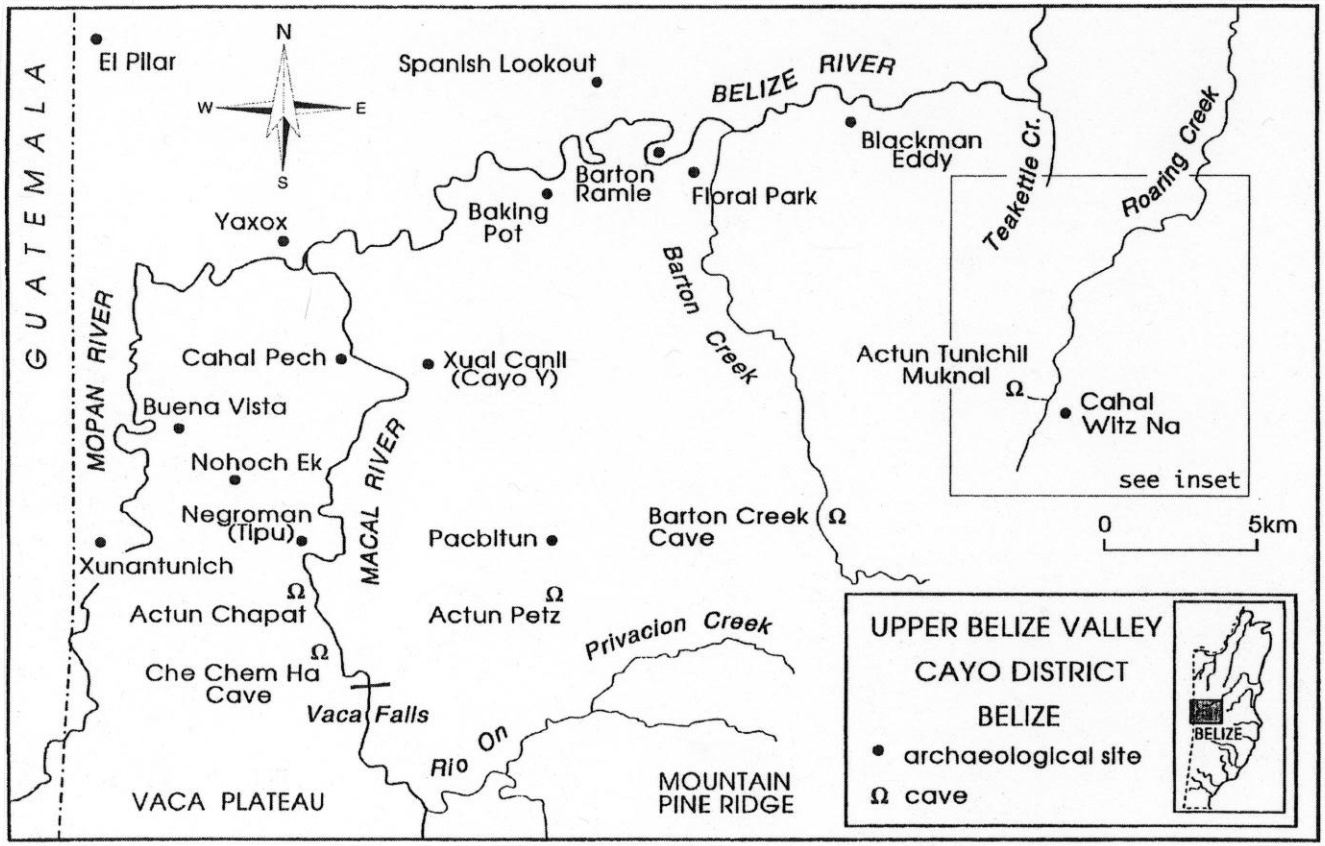
The opening to the Crystal Sepulcher is at a height of approximately 3.5m above floor level and is most easily accessed via a ladder (Fig. 2-41). The chamber is a flat

narrow space, which became completely submerged after the 1997 storm. The first skeleton (HR12) is located near the entrance of the room situated in a rimstone dam pool abutting the north wall of the chamber (Fig. 2-42). Although the bones are heavily encrusted in a thick layer of calcite, Gibbs (1997b:5), has estimated that the individual is no more than 15 years old. The cranium exhibits deformation in the tabular oblique style and may have been placed in a flexed position with hands tied behind the back.

The second skeleton (HR13), located 4m west of HR12, lies in a supine position with the cranium to the southwest (Fig. 2-43). Of interest is the odd position of the right arm that lays outstretched above the head. The individual is thought to be a female approximately 20 years old (Gibbs 1997b:5).

The chamber contains few artifacts. Adjacent to HR13 sitting on top of a large boulder is a piece of unworked slate. To the north of the skeleton, on the floor of the chamber are two charred sherds and a charcoal scatter. Sitting atop a large boulder located in the north wall of the chamber is a greenstone celt.

The west end of the chamber opens up into a tunnel system that eventually rejoins the river. This tunnel devoid of artifacts with the exception of sherds from three jars and a cluster of speleothems (Mike Mirro 1998, personal communication). These jars are noted by Miller (1989) as the artifacts located farthest from the cave entrance in Figure 2-2.



2-1. Map of Belize Valley showing location of Actun Tunichil Muknal.

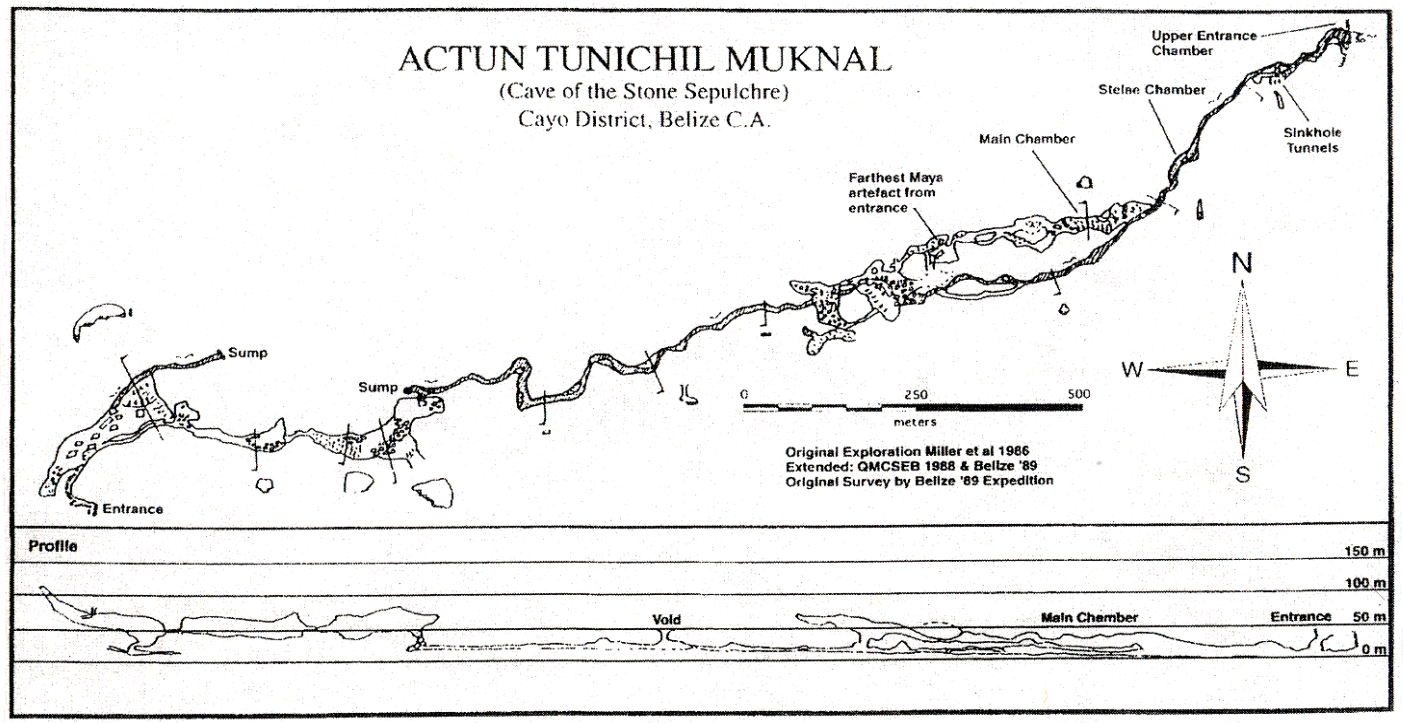


Fig. 2-2. Map of the tunnel system of Actun Tunichil Muknal (after Miller 1986).

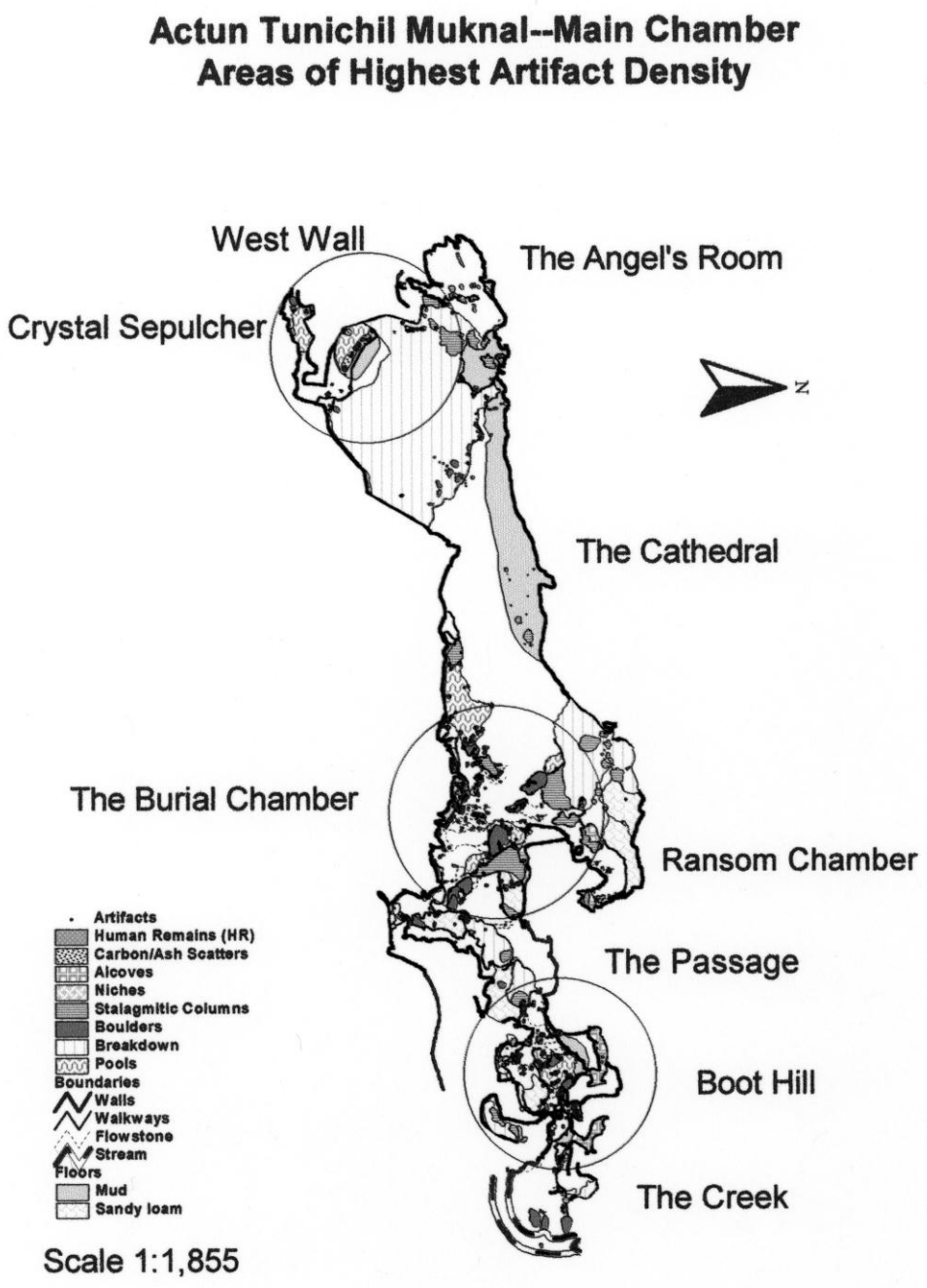


Fig. 2-3. Circles indicate high density areas.

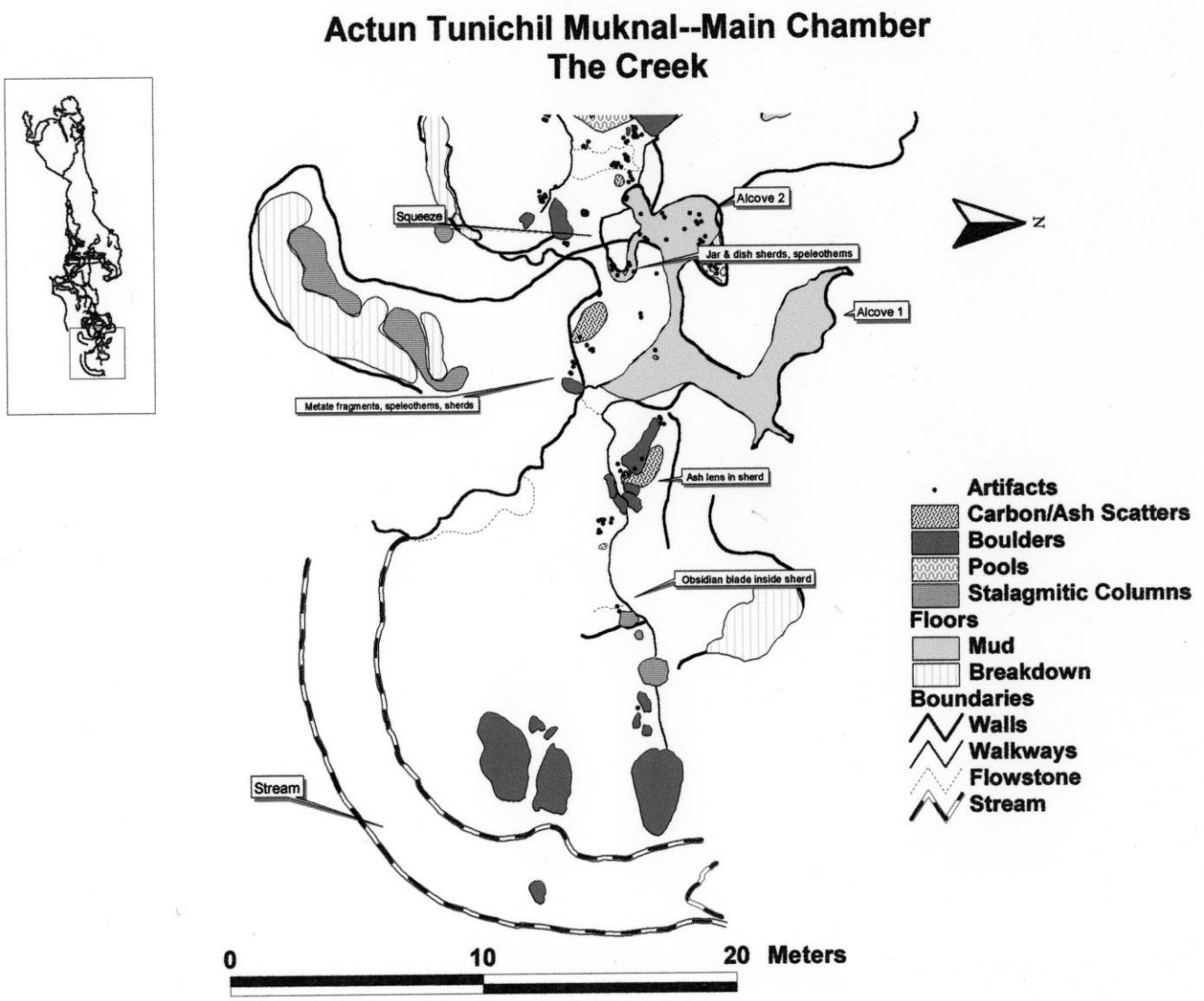

Actun Tunichil Muknal--Main Chamber
The Creek
Squeeze
Alcove 2
Jar & dish sherds, speleothems
Alcove 1
Metate fragments, speleothems, sherds
Ash lens in sherd
Obsidian blade inside sherd
Stream
N
0
10
20 Meters
Artifacts
Carbon/Ash Scatters
Boulders
Pools
Stalagmitic Columns
Floors
Mud
Breakdown
Boundaries
Walls
Walkways
Flowstone
Stream

Fig. 2-4

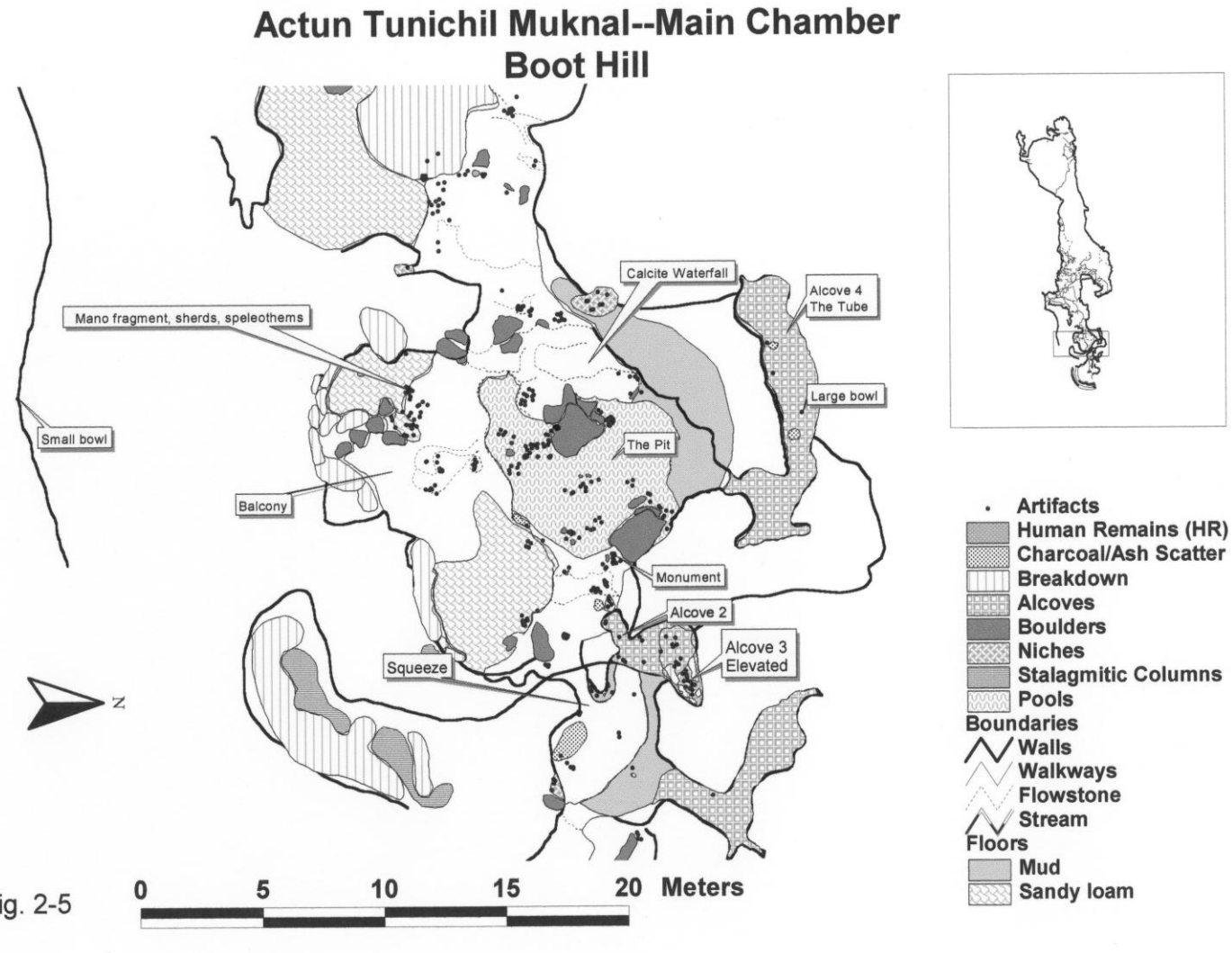

Actun Tunichil Muknal--Main Chamber
Boot Hill
Calcite Waterfall
Alcove 4
The Tube
Mano fragment, sherds, speleothems
Large bowl
Small bowl
The Pit
Balcony
Monument
Alcove 2
Alcove 3
Elevated
Squeeze
N
0
5
10
15
20
Meters
Artifacts
Human Remains (HR)
Charcoal/Ash Scatter
Breakdown
Alcoves
Boulders
Niches
Stalagmitic Columns
Pools
Boundaries
Walls
Walkways
Flowstone
Stream
Floors
Mud
Sandy loam

Fig. 2-5

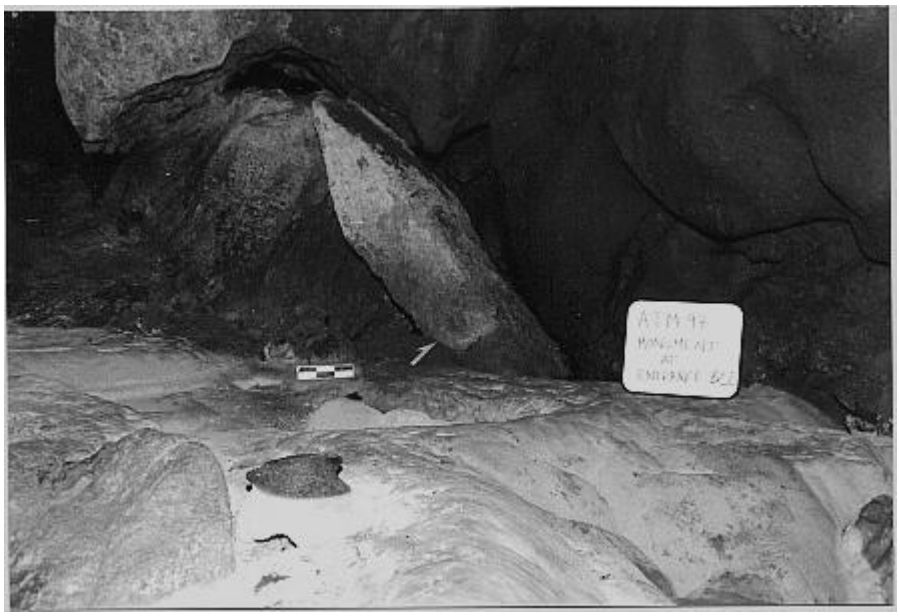


Fig. 2-6. Monument to the north of the entrance at Boot Hill. The rimstone dam altar is in the foreground.

Fig. 2-7. Ancient waterfall defining the eastern boundary of Boot Hill.

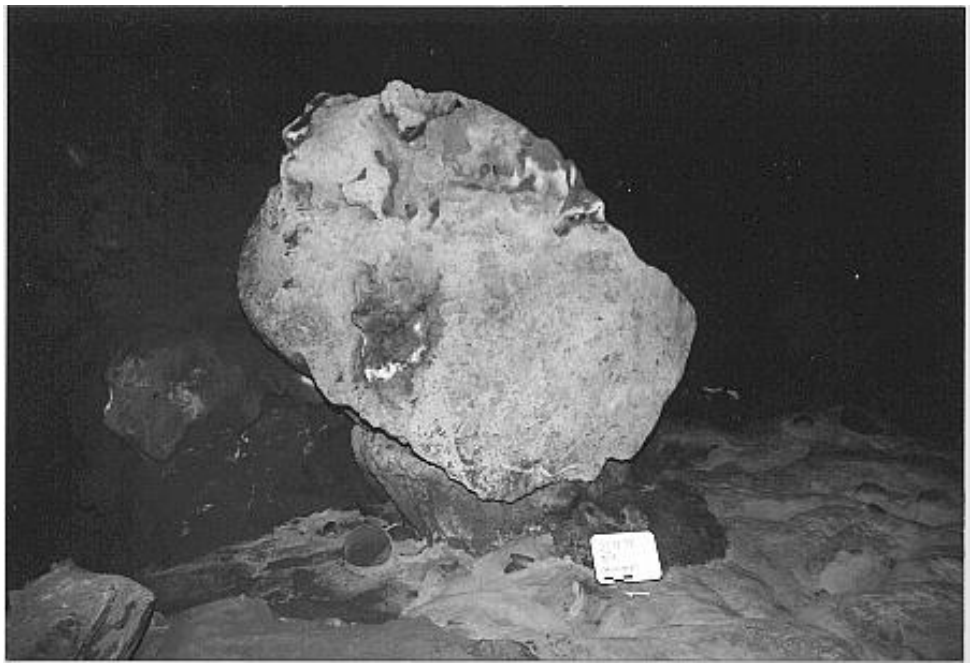


Fig. 2-8. Freestanding boulder and associated artifacts dominating the north side of Boot Hill.

Fig. 2-9. Large bowl located in Alcove 4 (the Tube), Boot Hill.

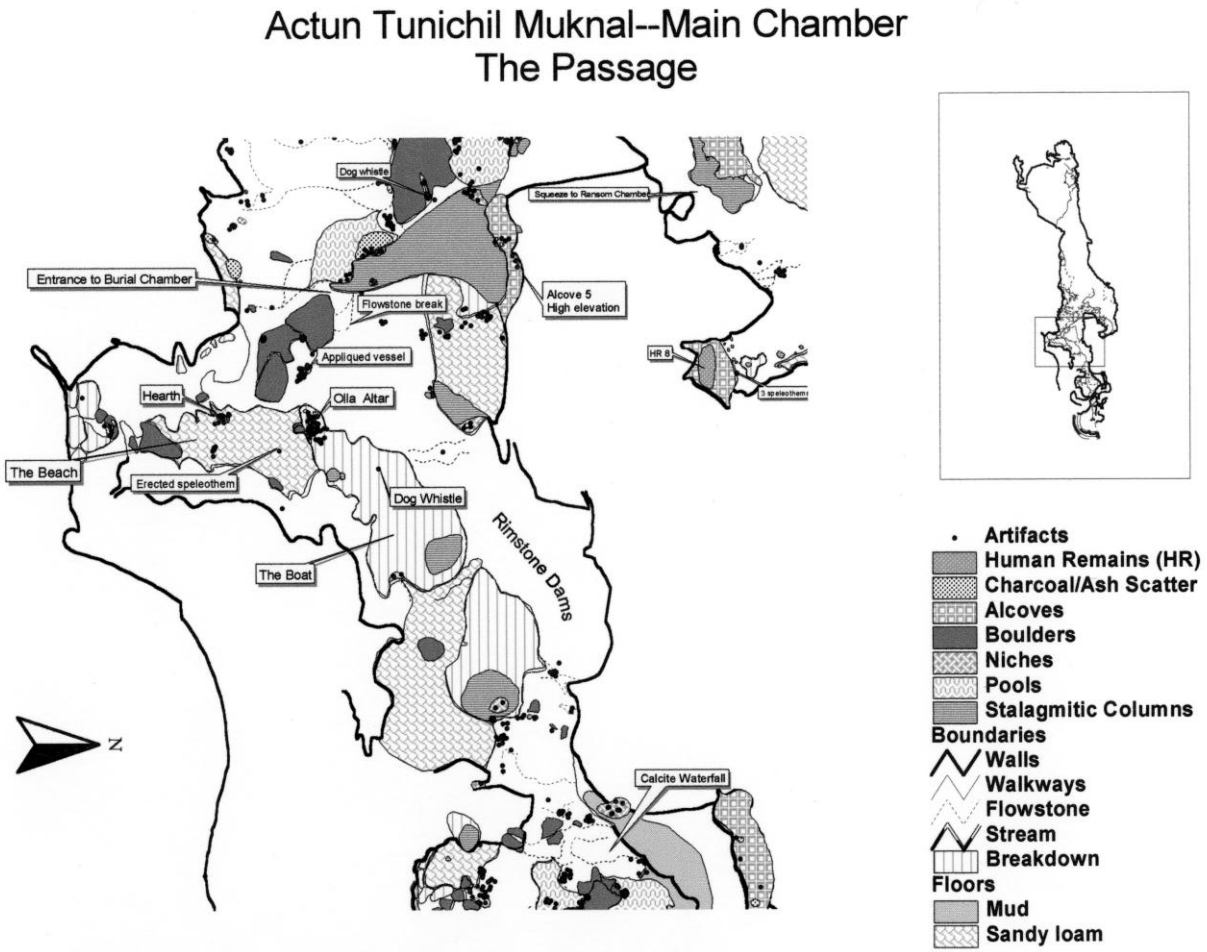

Actun Tunichil Muknal--Main Chamber
The Passage
Dog whistle
Squeeze to Ransom Chamber
Entrance to Burial Chamber
Flowstone break
Alcove 5
High elevation
Appliqued vessel
HR 8
Hearth
Olla Altar
The Beach
Erected speleothem
Dog Whistle
Rimstone Dams
The Boat
Calcite Waterfall
N
0 4 8 12 16 20 24 28 32 Meters
Artifacts
Human Remains (HR)
Charcoal/Ash Scatter
Alcoves
Boulders
Niches
Pools
Stalagmitic Columns
Boundaries
Walls
Walkways
Flowstone
Stream
Breakdown
Floors
Mud
Sandy loam

Fig. 2-10

Fig. 2-11. Stalagmitic column at the east end of the Passage with artifacts at its base.

Fig. 2-12. Vertically erected speleothem near center of the Beach (facing north).

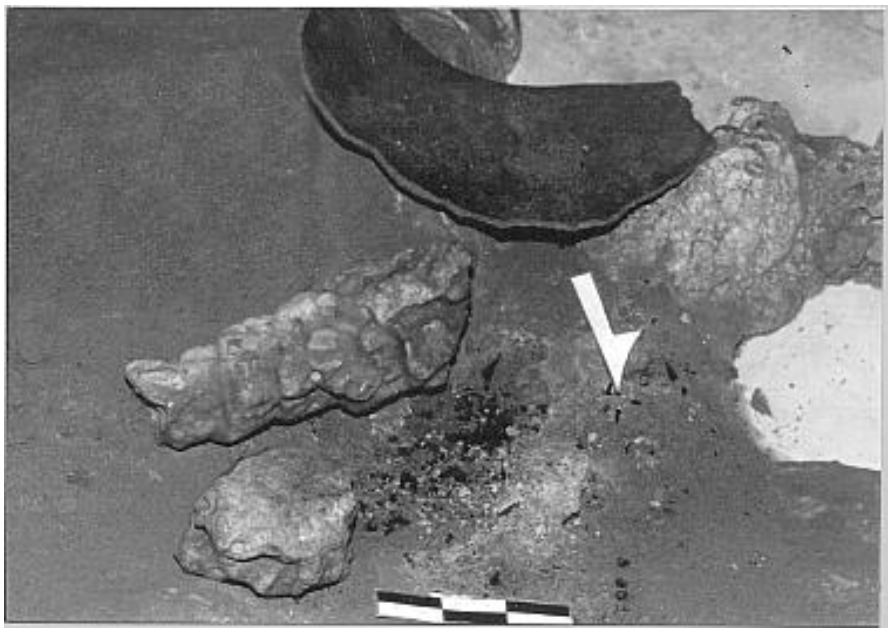


Fig. 2-13. Hearth located at edge of the Beach.

Fig. 2-14. Olla Altar photographed facing southeast.

Fig. 2-15. Entrance to Burial Chamber facing east.

Fig. 2-16. Excavated flowstone located at the entrance to the Burial Chamber.

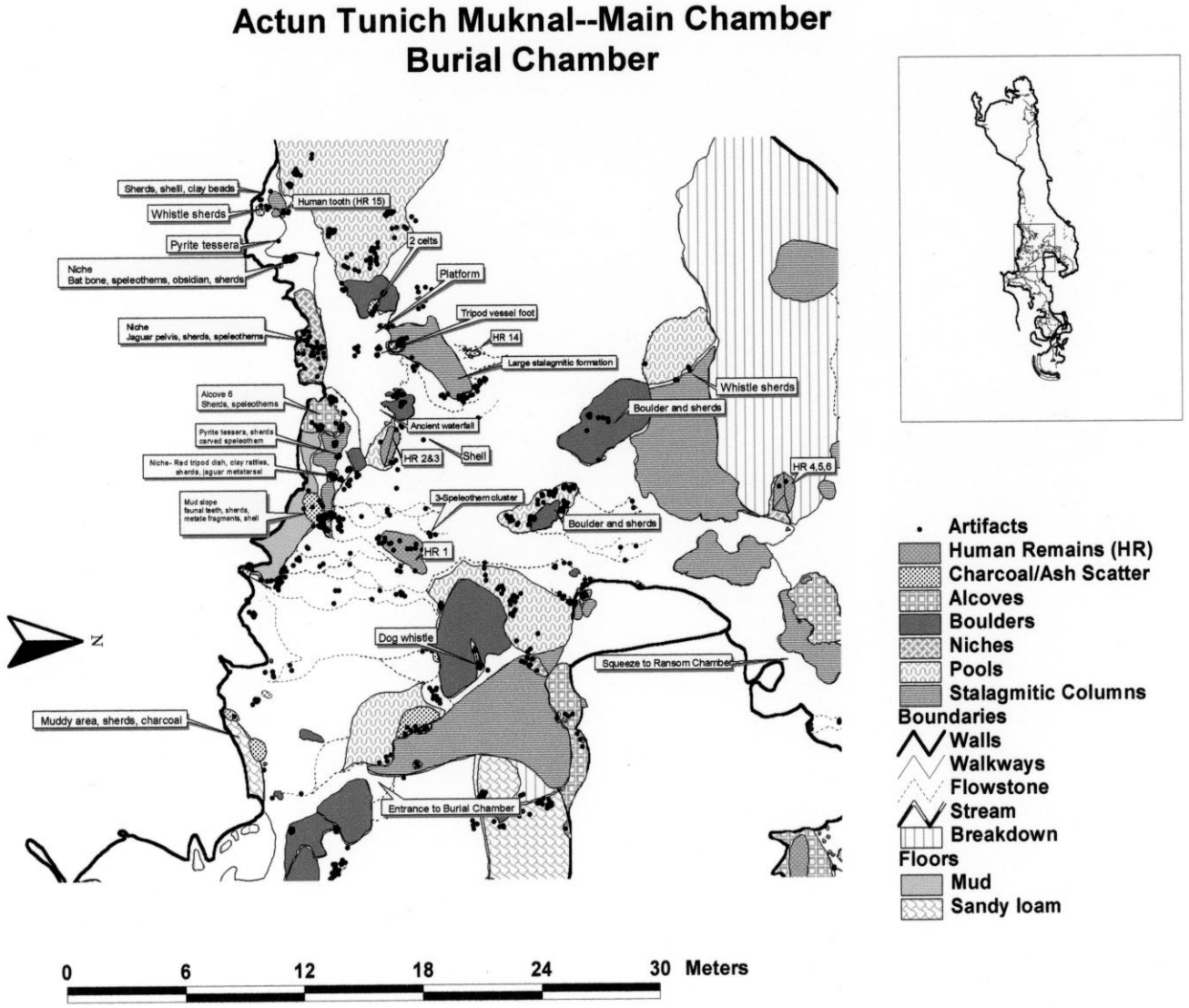

Actun Tunich Muknal--Main Chamber
Burial Chamber
Sherds, shell, clay beads
Human tooth (HR 15)
Whistle sherds
Pyrite tessera
2 celts
Niche
Bat bone, speleothems, obsidian, sherds
Platform
Tripod vessel foot
Niche
Jaguar pelvis, sherds, speleothems
HR 14
Large stalagmitic formation
Alcove 6
Sherds, speleothems
Whistle sherds
Boulder and sherds
Ancient waterfall
Pyrite tessers, sherds
carved speleothem
HR 2&3
Shell
Niche- Red tripod dish, clay rattles,
sherds, jaguar metatarsal
HR 4,5,6
Mud slope
faunal teeth, sherds,
metate fragments, shell
3-Speleothem cluster
Boulder and sherds
HR 1
N
Dog whistle
Squeeze to Ransom Chamber
Muddy area, sherds, charcoal
Entrance to Burial Chamber
Artifacts
Human Remains (HR)
Charcoal/Ash Scatter
Alcoves
Boulders
Niches
Pools
Stalagmitic Columns
Boundaries
Walls
Walkways
Flowstone
Stream
Breakdown
Floors
Mud
Sandy loam
0
6
12
18
24
30 Meters

Fig. 2-17

Fig. 2-18. Skull exhibiting cranial deformation and tooth decoration located in center of Burial Chamber.

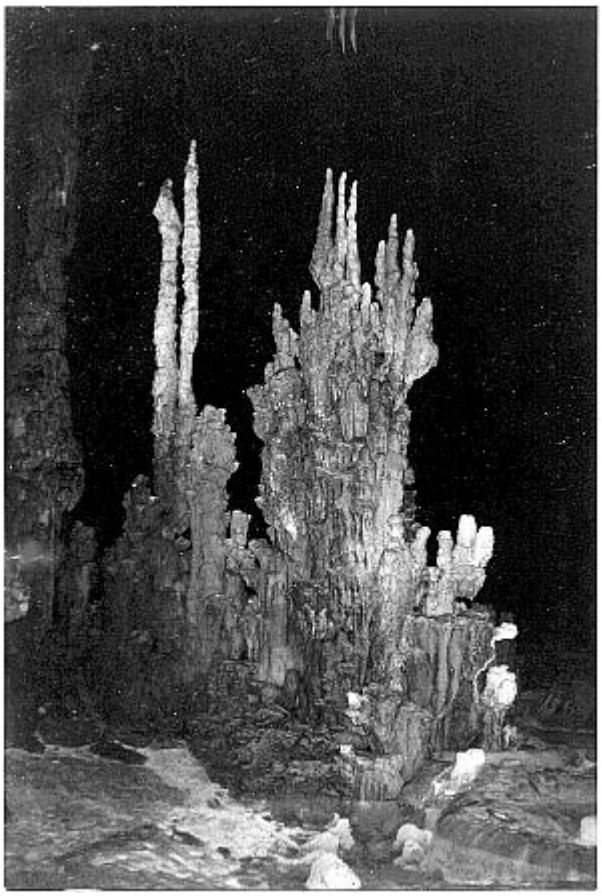


Fig. 2-19. Large stalagmitic column dominating the center of the Burial Chamber.

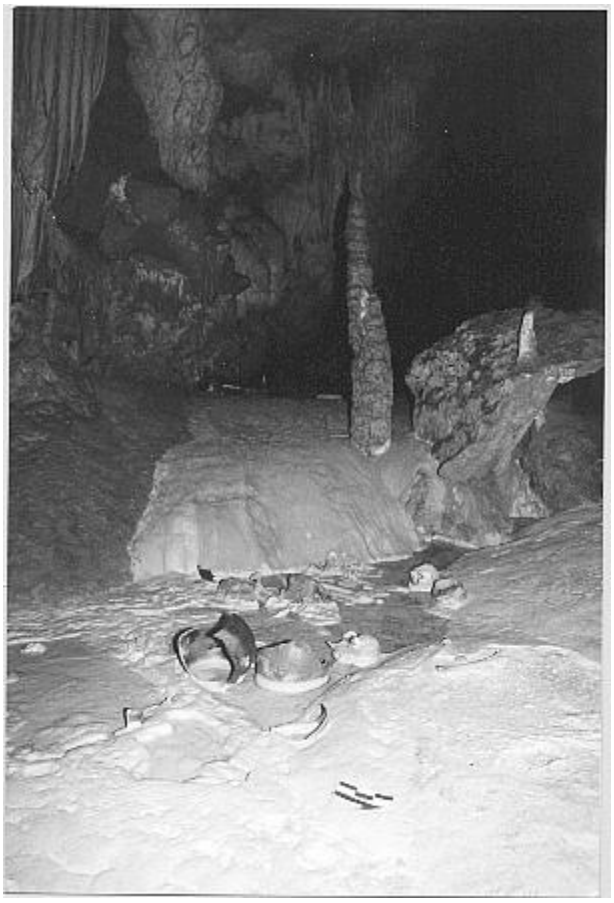


Fig. 2-20. Ancient waterfall in Burial Chamber, two adult male skeletons at base.

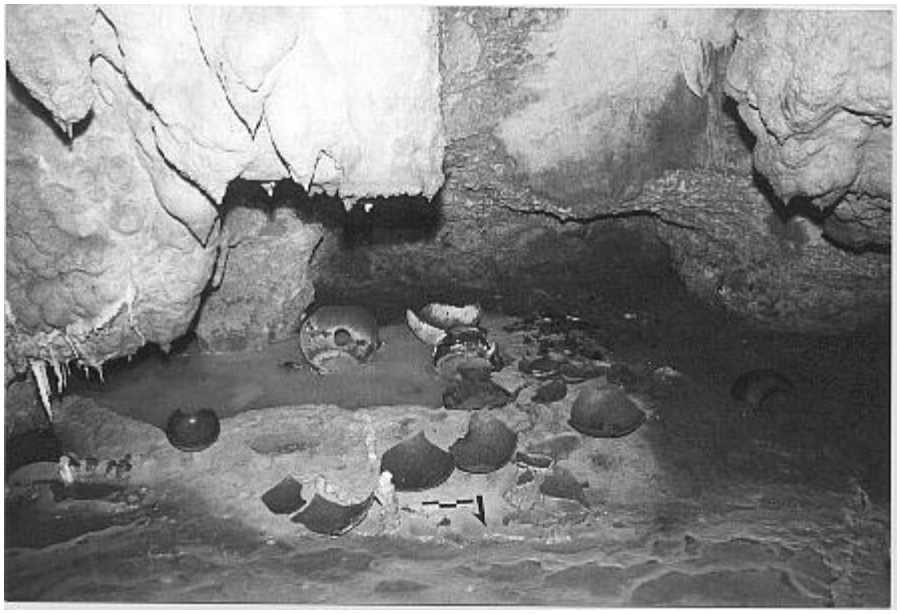


Fig. 2-21. Niche under wall overhang in Burial Chamber off platform, with vessel sherds, speleothems, and jaguar pelvis.

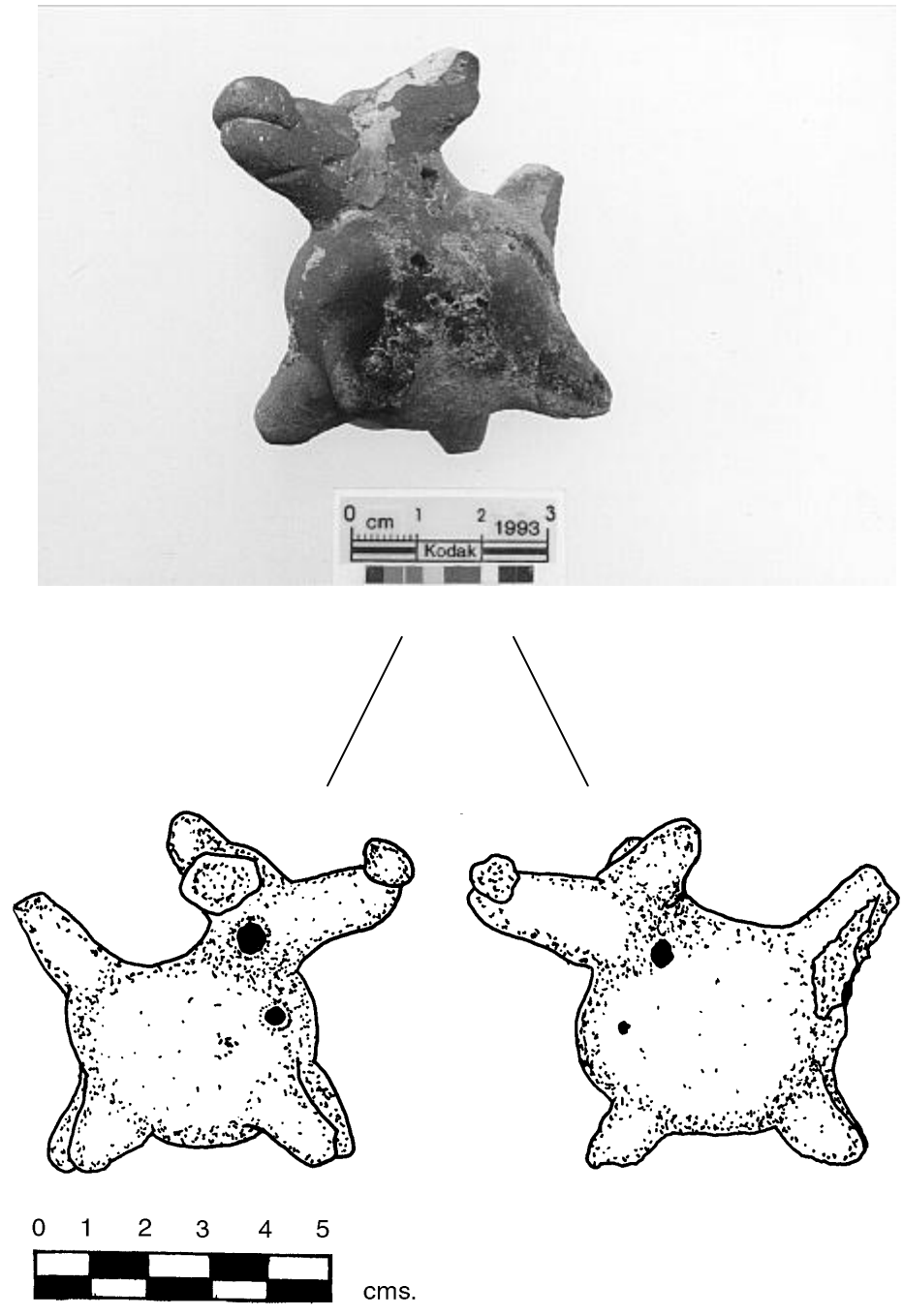


Fig. 2-22. Dog whistle figurine found in the Burial Chamber in cleft of large boulder.

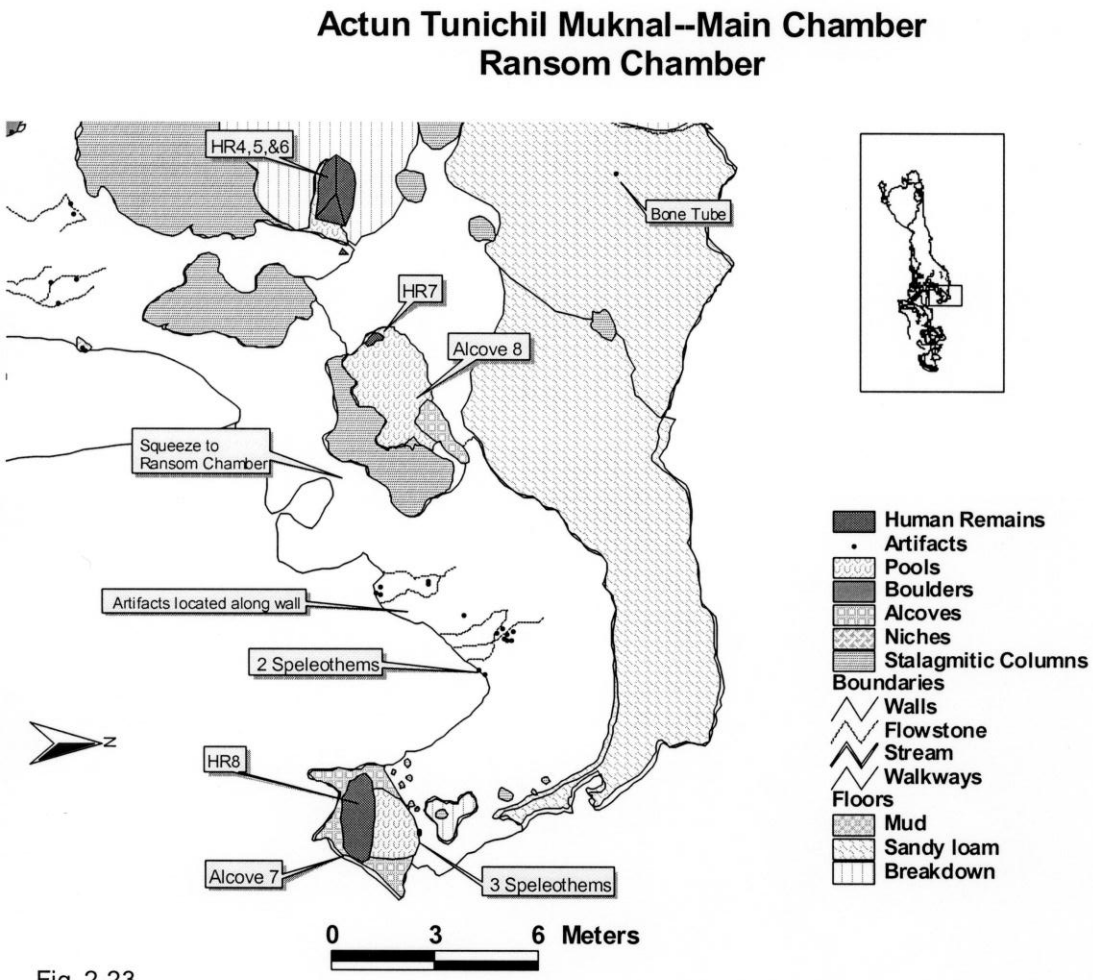

Actun Tunichil Muknal--Main Chamber
Ransom Chamber
HR4,5,&6
Bone Tube
HR7
Alcove 8
Squeeze to
Ransom Chamber
Artifacts located along wall
2 Speleothems
HR8
Alcove 7
3 Speleothems
N
0 3 6 Meters
Human Remains
Artifacts
Pools
Boulders
Alcoves
Niches
Stalagmitic Columns
Boundaries
Walls
Flowstone
Stream
Walkways
Floors
Mud
Sandy loam
Breakdown

Fig. 2-23

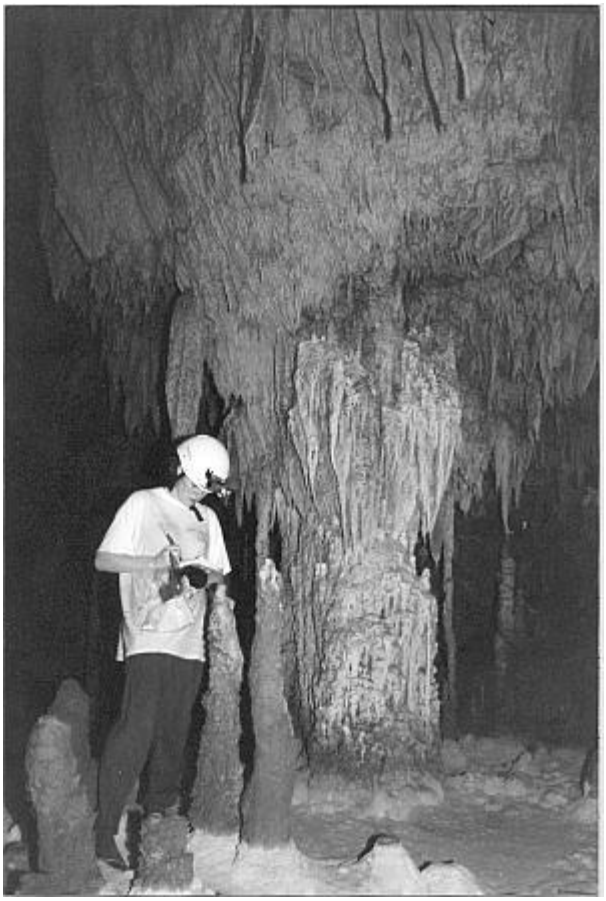


Fig. 2-24. Entrance to Alcove 9, crew member Nicole Nowak standing beside stalacto-stalagmitic column.

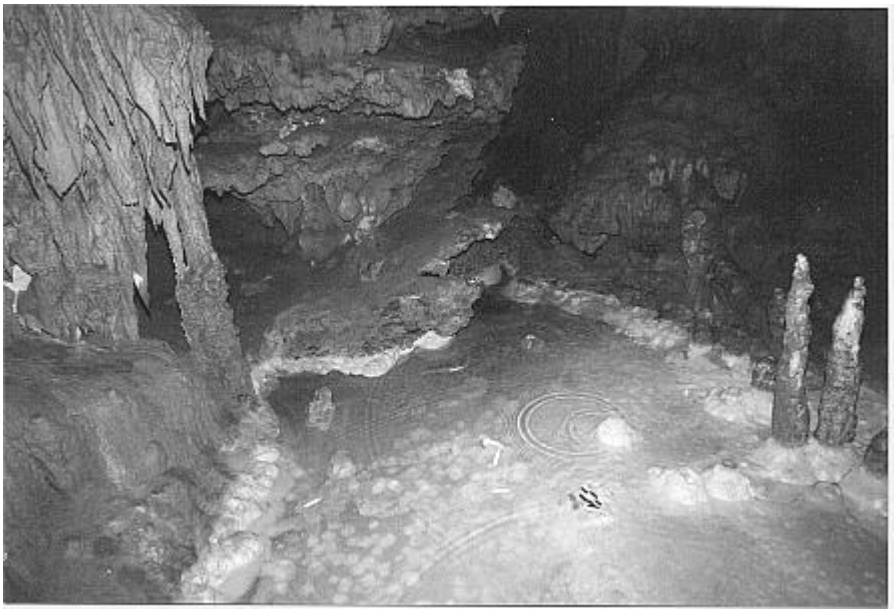


Fig. 2-25. Alcove 9 pool containing HR8. Photograph taken during 1997 flood.

Fig. 2-26. Alcove 8 located in Ransom Chamber. Arrow points to infant skeleton.

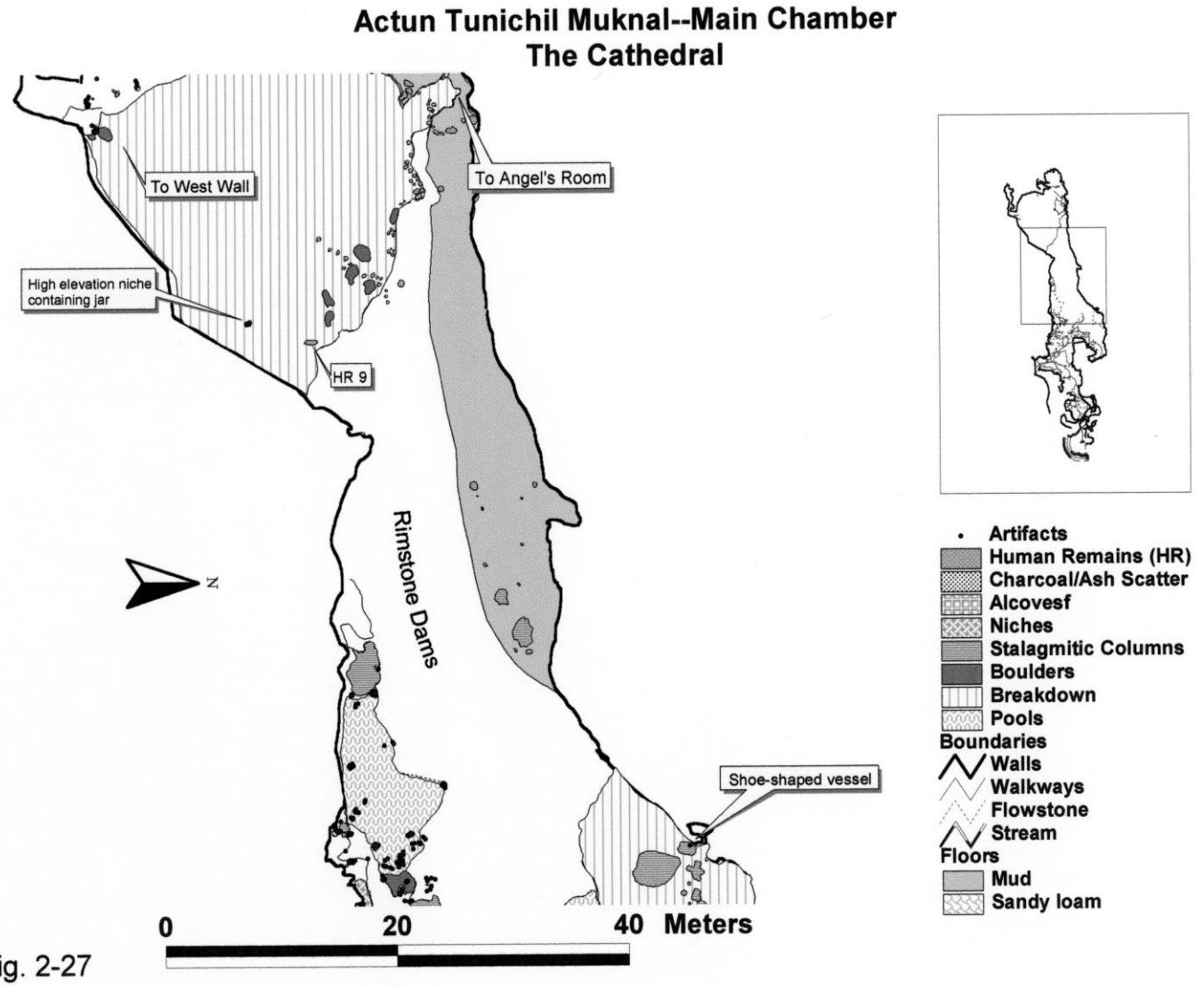

Actun Tunichil Muknal--Main Chamber
The Cathedral
To West Wall
To Angel's Room
High elevation niche containing jar
HR 9
Rimstone Dams
N
Shoe-shaped vessel
0
20
40 Meters
Artifacts
Human Remains (HR)
Charcoal/Ash Scatter
Alcovesf
Niches
Stalagmitic Columns
Boulders
Breakdown
Pools
Boundaries
Walls
Walkways
Flowstone
Stream
Floors
Mud
Sandy loam

Fig. 2-27

Fig. 2-28. Stalagmites and stalacto-stalagmitic columns along north wall of the Cathedral.

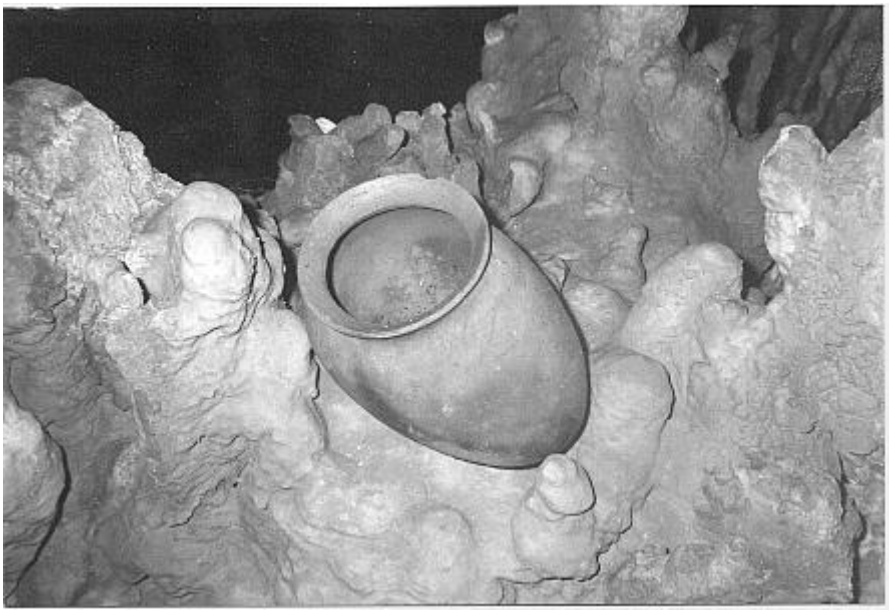


Fig. 2-29. Intact shoe-shaped vessel located among stalagmites in the Cathedral.

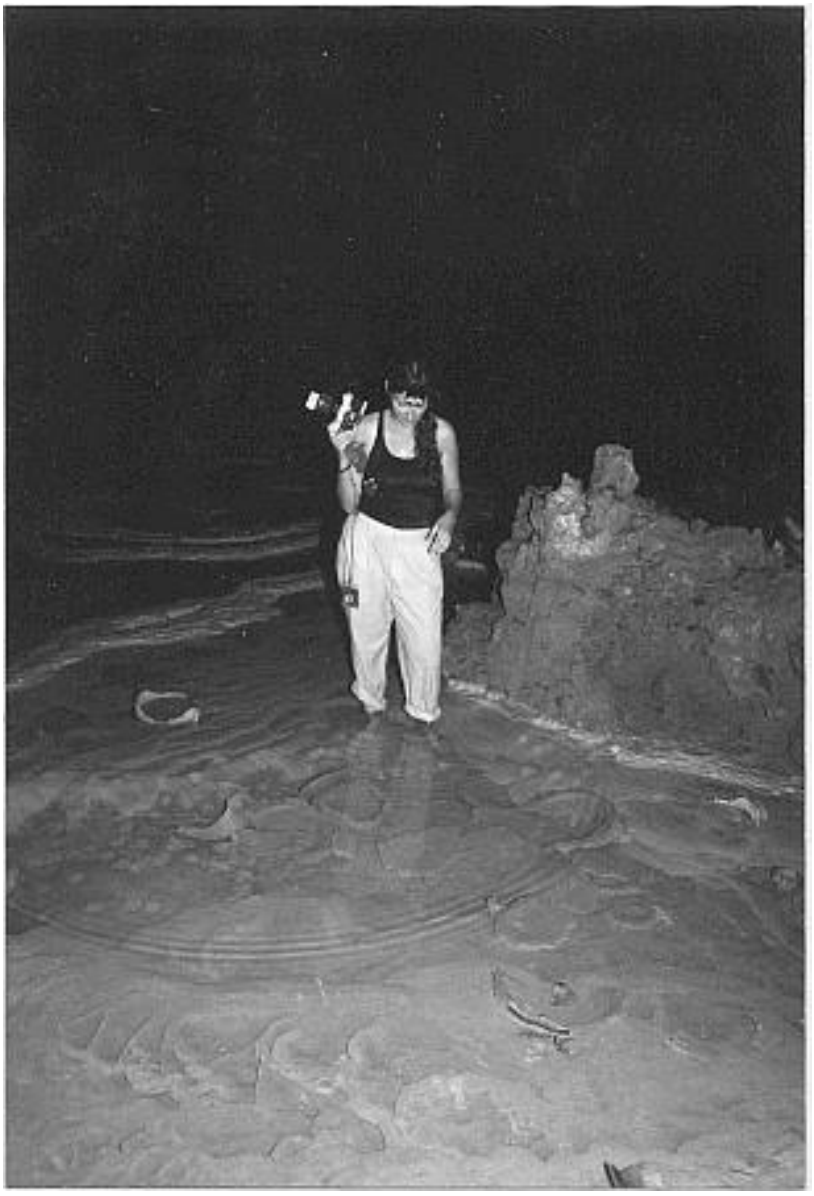


Fig. 2-30. Sherry Gibbs standing in flooded ancient pool on southeast border of the Cathedral.

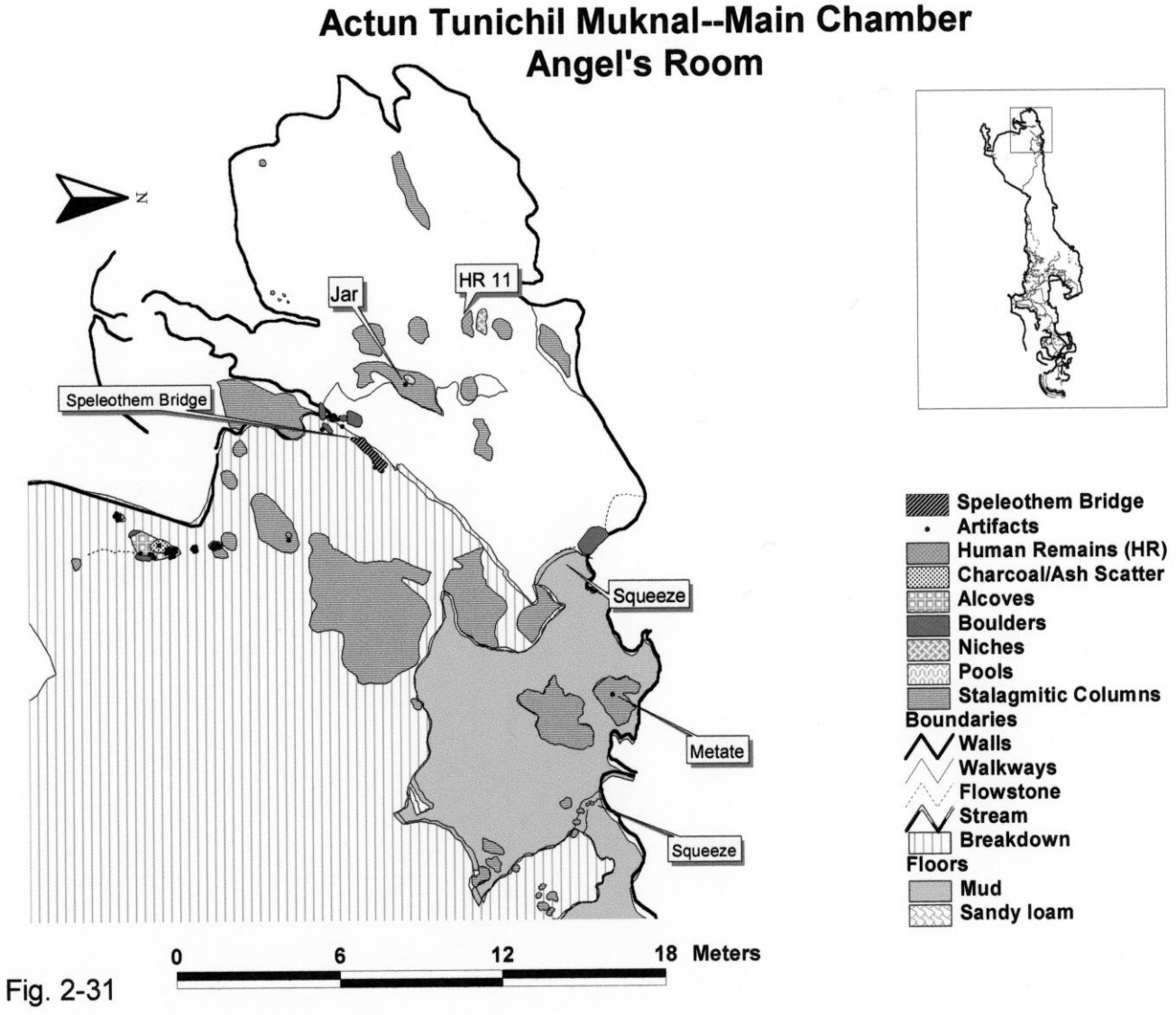

Actun Tunichil Muknal--Main Chamber
Angel's Room
N
Jar
HR 11
Speleothem Bridge
Squeeze
Metate
Squeeze
0
6
12
18 Meters
Speleothem Bridge
Artifacts
Human Remains (HR)
Charcoal/Ash Scatter
Alcoves
Boulders
Niches
Pools
Stalagmitic Columns
Boundaries
Walls
Walkways
Flowstone
Stream
Breakdown
Floors
Mud
Sandy loam

Fig. 2-31

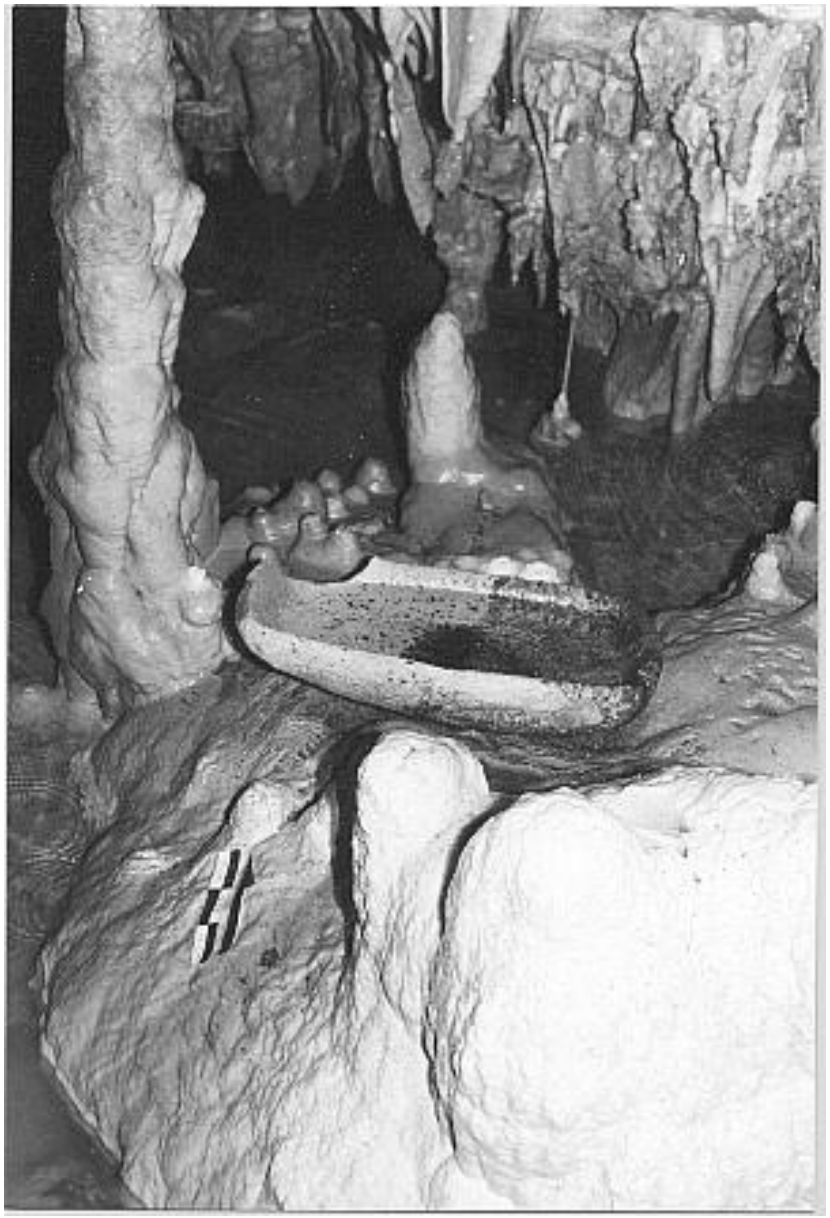


Fig. 2-32. Metate placed on stalagmite. Photograph taken during 1997 flooding.

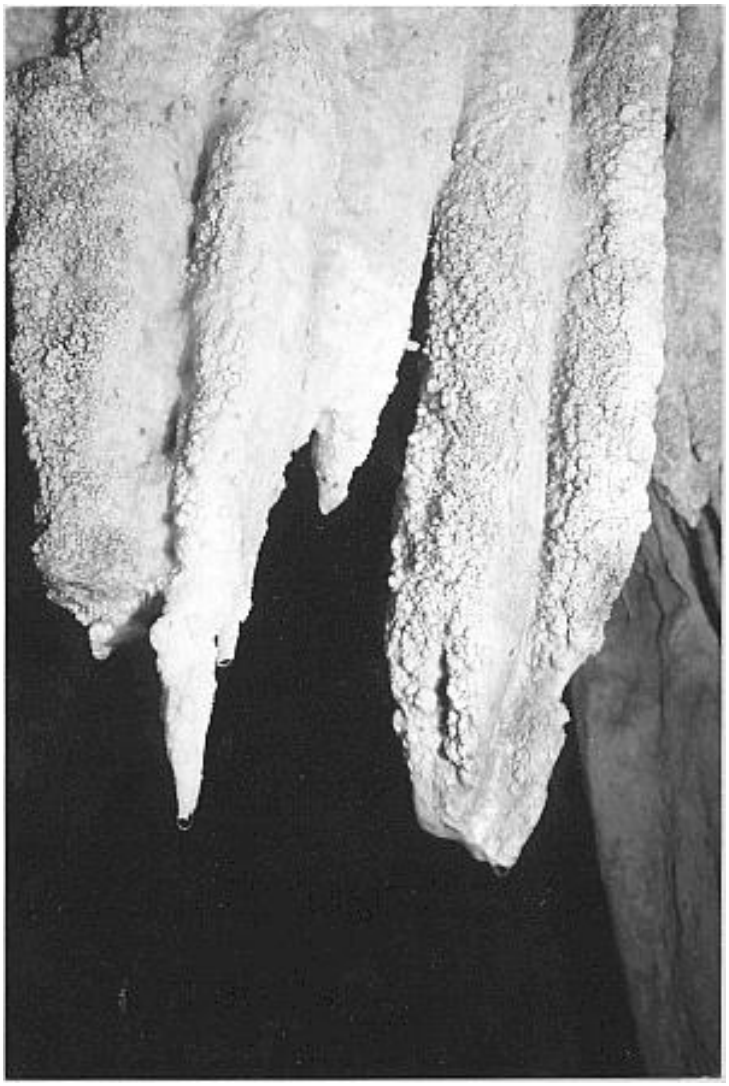


Fig. 2-33. Regrowth of stalactite formation at squeeze dividing areas of Angel's Room.

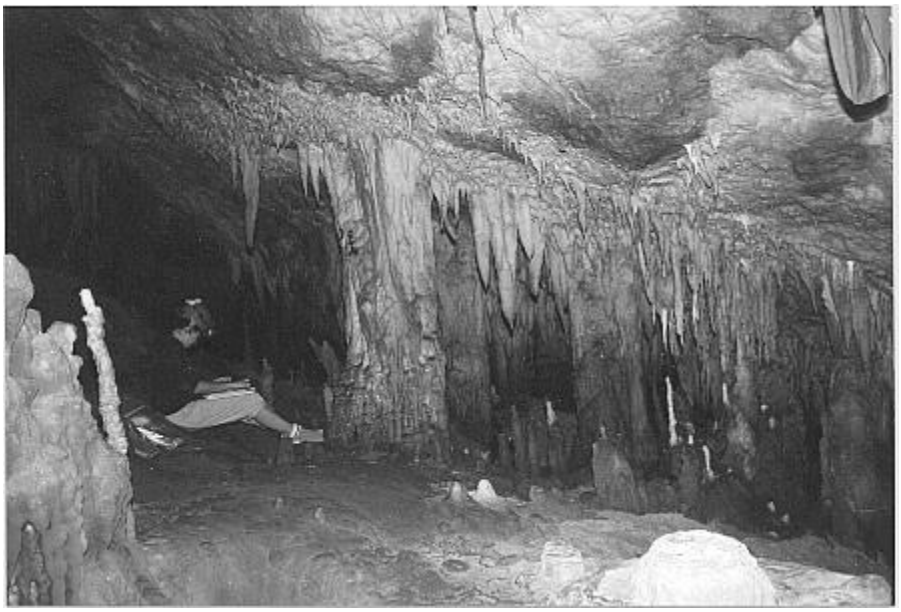


Fig. 2-34. Sherry Gibbs recording infant skeleton in northwest area of Angel's Room.

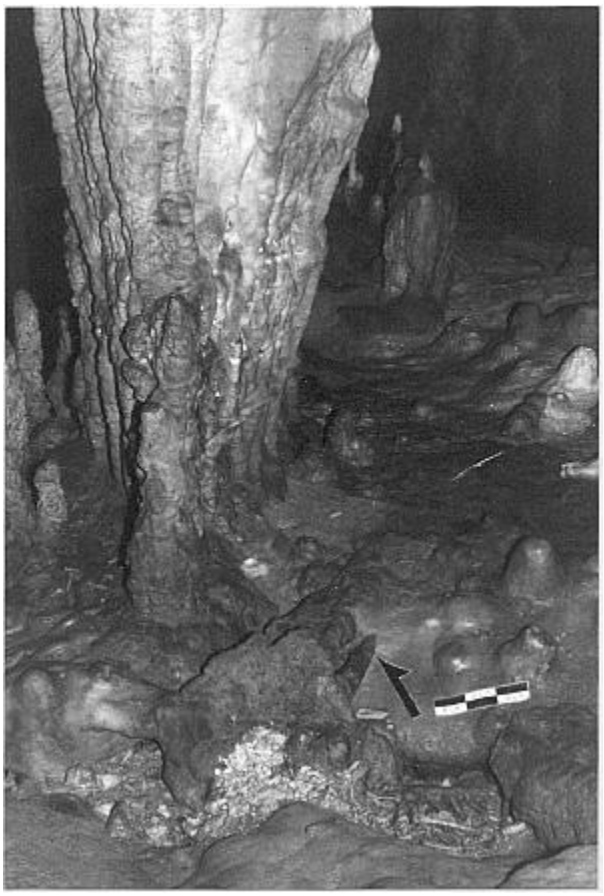


Fig. 2-35. Infant skeleton under stalacto-stalagmitc column, Angel's Room.

Fig. 2-36. Arrow shows location of Speleothem Bridge. Photograph taken facing south.

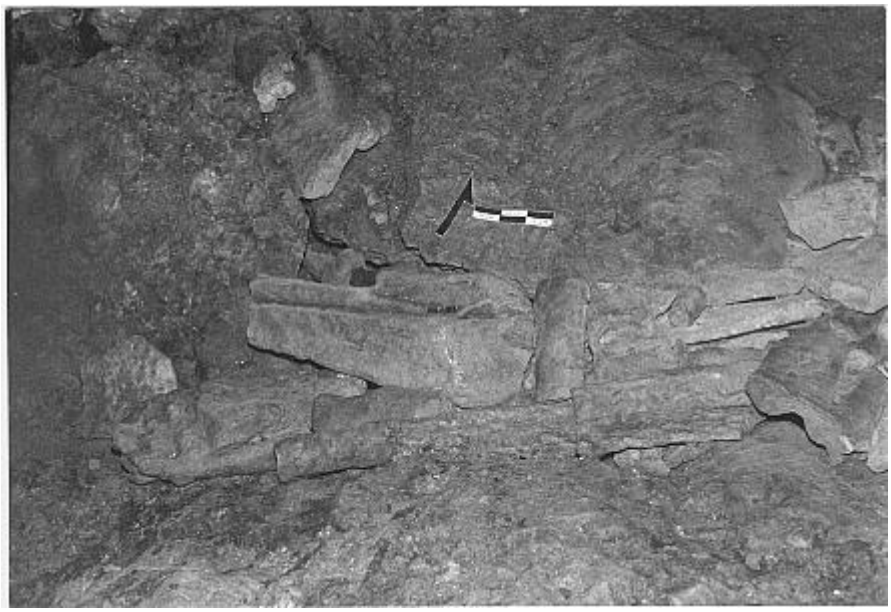


Fig. 2-37. Close-up of Speleothem Bridge facing north.

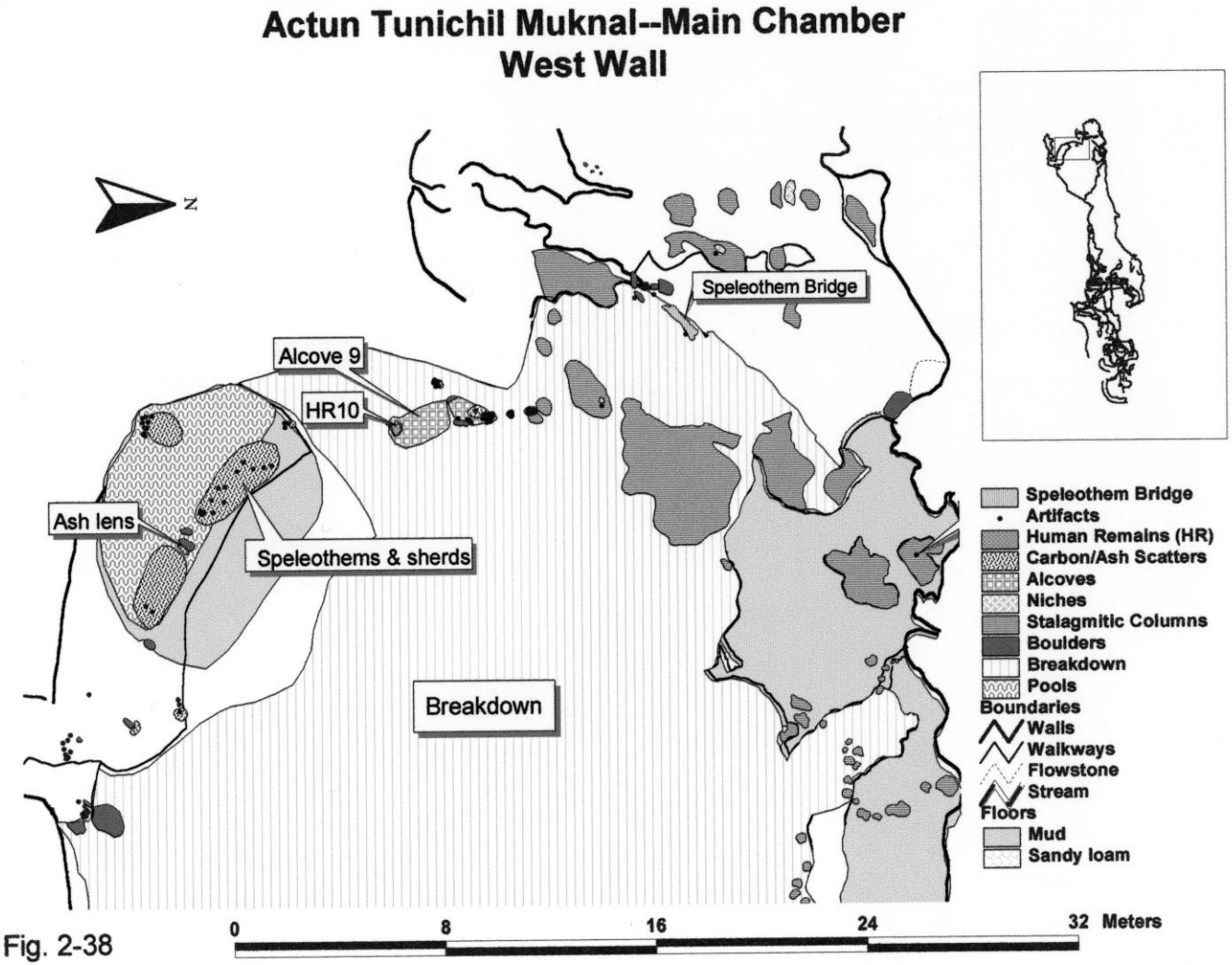

Actun Tunichil Muknal--Main Chamber
West Wall
N
Speleothem Bridge
Alcove 9
HR10
Ash lens
Speleothems & sherds
Breakdown
Speleothem Bridge
Artifacts
Human Remains (HR)
Carbon/Ash Scatters
Alcoves
Niches
Stalagmitic Columns
Boulders
Breakdown
Pools
Boundaries
Walls
Walkways
Flowstone
Stream
Floors
Mud
Sandy loam
0
8
16
24
32 Meters

Fig. 2-38

Fig. 2-39. Human remains (HR10) located between boulders in breakdown, West Wall.

Actun Tunichil Muknal--Main Chamber
Crystal Sepulcher

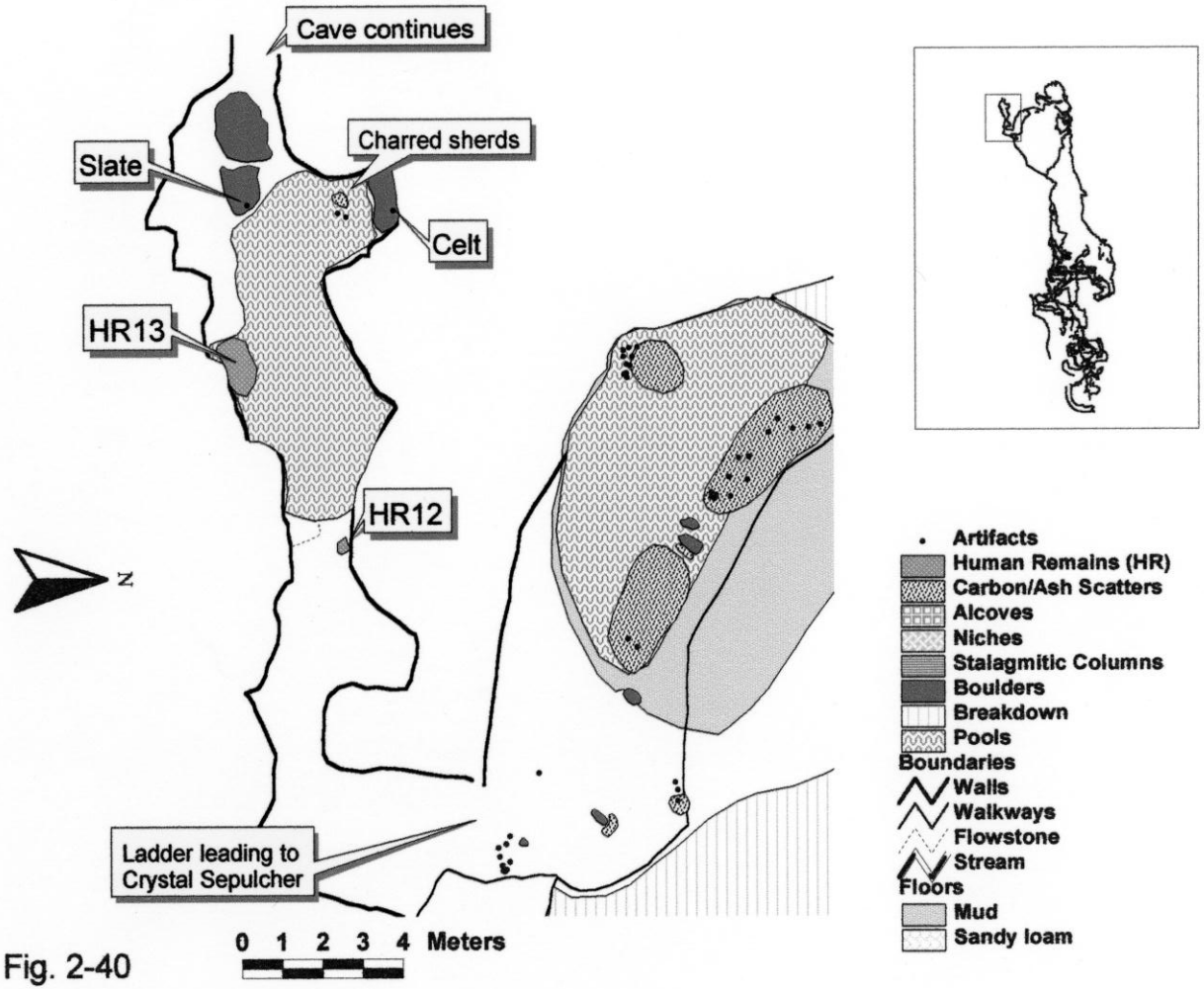


Fig. 2-40

Fig. 2-41. Ladder leading to Crystal Sepulcher. Christophe Helmke stands at top.

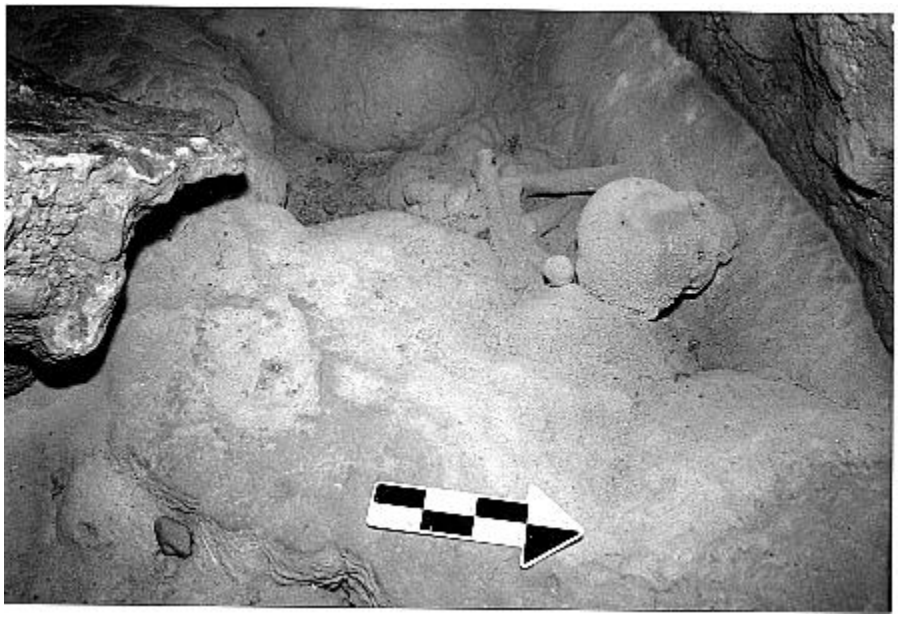


Fig. 2-42. Human remains (HR12) located in rimstone dam, Crystal Sepulcher.

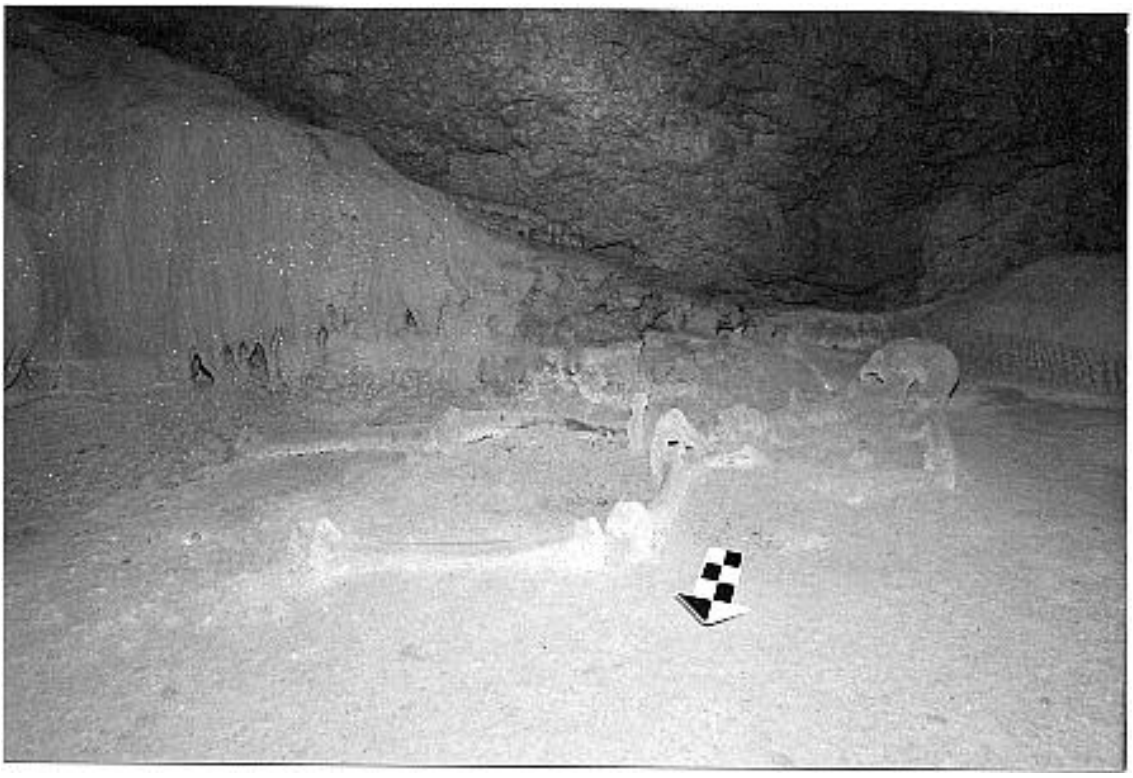


Fig. 2-43. Calcite covered skeleton (HR13) in supine position, Crystal Sepulcher.

Chapter 3

Methodology

Field Mapping

Mapping of the cave began in 1996 starting with the plotting of walls and major features. In 1997, the map was finished and artifacts recorded. Adjustments were made and artifacts added to the map in 1998. No electronic mapping devices were employed and all mapping was done using tape and compass due to the difficulty in accessibility of the chamber, as well as the wet, humid, conditions within the cave. To capture detail, a 1:60 scale was used. When completed, the paper map was almost 4m in length.

To record artifacts 1x1m grid system was drawn over the base map and each grid was assigned a number. Grid squares were located in the cave and artifacts were piece-plotted on grid maps. These were recorded on data sheets that were transferred to the base map. If an artifact was difficult to locate, it was triangulated for improved accuracy and measured onto the base map. Carbon scatters, ash lenses, ceramic sherd scatters, and human remains were recorded as polygonal areas rather than piece-plotted. The entire cave was represented using plan-view maps (two-dimensional top plans), and all analyses conducted were two-dimensional. This worked well for the Main Chamber since there was only one small area of vertical spatial overlap. Because the original map was not available for digitizing, a photocopied facsimile was constructed from 8.5x11in. copies.

Edge distortion tended to occur and an attempt was made to correct for this by carefully refitting undistorted portions.

Recording of Artifacts

All artifacts were recorded in situ to avoid breakage and cause minimal disturbance to the chamber. A few artifacts were removed from the chamber and replaced after having been drawn or photographed. No artifacts were permanently removed with the exception of two faunal bones, a ceramic dog whistle, an obsidian prismatic blade, a shell bead, and a single body sherd. Three speleothems were collected from cultural deposits in the Main Chamber and six charcoal samples were taken.

Field numbers were assigned to each artifact in situ. The field coding began with AT (for Actun Tunichil Muknal), followed by the year (97), the identification of the grid square in which the artifact was located, and a unique artifact number that progressed sequentially. If the artifact was broken, an additional letter was assigned to each fragment. For instance, the first artifact was numbered AT97-D117-001. The second artifact was found in two pieces. Its numbers were AT97-C121-002a and AT97-C121-002b. In situ refitting was undertaken by searching the immediate area for similar fragments. Usually, fragments were located within 1-2 meters of each other although in one instance the foot of a ceramic vessel was found 5m from the rest of the sherds. Only ceramic sherds 10cm or larger in length were included in the study. Several scatters of small sherds were noted and recorded, but individual sherds in these scatters were not assigned identification numbers.

Classification System

Cave features were categorized for analysis. The following categories were created based on my own observations as well as observations from previous cave reports (Andrews 1970; Brady 1989; Graham, McNatt, and Gutchen 1980; Reents-Budet 1980). They included: 1) alcoves, 2) walls and walkways, 3) boulders, 4) breakdown, 5) niches, 6) pools, and 7) stalagmitic or stalacto-stalagmitic columns (see Appenix A for category definitions).

Artifacts were also categorized and grouped by class based primarily upon the raw material from which the artifact was composed. Broad classes of artifacts include: 1) ceramics (reconstructable), 2) single ceramic sherds (non-reconstructable), 3)groundstone, 4) chipped stone (lithics), 5) faunal remains, 6) monument (limestone), 7) speleothems, 8) slate, and 9) unknown. These groups were further sub-classed for analyses.

The ceramic class divided into the following sub-classes based on form: 1) jars, 2) bowls, 3) dishes, 4) vases, 5) shoe pots (shoe-shaped vessels), and 6) whistles. (see Appendix B for list and number designations of artifact classes and sub-classes.) Definitions of ceramic vessel forms were those used at Seibal by Sabloff (1975:22-27). Shoe pots are almost always restricted to caves deposits in Belize, and are also referred to as "shoe-shaped vessels." (For a thorough discussion of their history and meaning see Brady 1992). Whistles refer to figurines that may have also functioned as musical instruments.

The category of "single sherds" was created to accommodate ceramic sherd fragments that could not be matched during "in situ" refitting. These sherds are

"orphans" in the sense that they do not appear to belong to any larger reconstructable vessel. This suggests that they were either brought into the cave as offerings in and of themselves, belong with vessels that were not located, or belong with vessels completely covered by flowstone.

The class of chipped stone (lithics) contained three sub-classes: 1) obsidian, 2) quartzite, and 3) pyrite. Groundstone was categorized separately and contains three subclasses: 1) manos, 2) metates, and 3) celts. The monument class contains one artifact, the stela-like limestone slab located at the entrance to the Boot Hill area. The class of faunal remains was divided into subclasses of: 1) shell, 2) bone [bat, jaguar, and unknown], and 3) faunal teeth.

Speleothems are formally defined as "any secondary mineral deposit that is formed in a cave by the action of water" (Gary, McAfee, and Wolf 1972:679). This is a very broad definition that would include all stalactitic, stalagmitic, or calcium carbonate formations. However, for purposes of this study, "speleothems" refer only to broken pieces. Only speleothems found in cultural contexts were recorded at Actun Tunichil Muknal. Speleothems were assumed to be cultural deposits only under the condition that it was impossible for their placement to have occurred naturally. Using this criterion, it is quite possible that the number of speleothems recognized as cultural material was underestimated. Sub-classes of this category included a carved speleothem bead and a carved object.

Like speleothems, slate is a naturally occurring material found in the Main Chamber. Consequently, only slate stones found in vessel interiors or in contexts that precluded their natural occurrence were recorded as cultural artifacts.

The category of unknown artifacts was created for objects that were unidentifiable due to the heavy flowstone buildup covering their surfaces. From observing the overall shape of the deposits, it is probable that the unknown artifacts are ceramic vessels. In four instances, flowstone was inadvertantly knocked away from these deposits by the crew. On each occasion the flowstone breakage revealed that these objects were in fact ceramics. This would be expected due to probability since the ceramic artifact class represented the vast majority of the entire assemblage.

The Use of Geographical Information Systems (GIS)

Due to the quantity of data to be analyzed and the large size of the analytical area, it became necessary to use a computer system that could handle large quantities of data as well as create visual displays. Although CAD or database management systems can organize data and produce images, they were not designed to create new data. What distinguishes GIS from other database management systems is its ability to conduct spatial searches and overlays that generate new information (Cowen 1988:1554-1556). GIS offers an advantage to other systems in that it provides an easily manipulated database, a means of visual display, and is a powerful tool for the analysis of spatially referenced data.

System Design

The system design called for four layers of point, line, and polygon *coverages* in the initial digitizing phase of creating the GIS. Two layers represented cave features and

two represented artifacts. Both line and polygon coverages were used for cave features and artifacts (including human remains) were represented by points and polygons.

A line coverage was created to represent boundaries and linear features. Each feature type was given a unique identification number. They included: 1) walls (exterior walls of the Main Chamber, 2) walkways (interior walls and floorlines delineating pathways), 3) rimstone dams, 4) the stream passage that runs through the tunnel system.

Polygon coverages represented all other cave features. Each category was given a unique identification number to facilitate future splitting of the coverage. Using a single coverage to digitize as many polygons as possible was advantageous because it saved time in appending and transforming coverages. The coverages were: 1) alcoves, 2) boulders, 3) breakdown, 4) pools, 5) niches, 6) stalagmitic/stalacto-stalagmitic columns, and 7) floors (sandy loam or mud deposits). The "floors" coverage was used for illustration and display but has not been included in analyses.

Artifacts were divided into point and polygon coverages. Artifacts were re-numbered and issued a new unique 8-digit identification number in the point coverage (See Appendix B). The first 2 digits of this number represented the class and sub-class of the artifact followed by a 4-digit sequential number. The final 2 digits of the identification number indicated how many fragments were present from a single artifact. The number 01 was given to the largest or most centrally located artifact fragment. For instance, if the artifact was a jar broken into 2 pieces, its number would read: 11000101, 11000102.

A polygon coverage was used in instances where it was impossible or impractical to number artifacts individually or quantify features. Polygon coverages included: 1) ash

lenses, 2) carbon scatters, 3) human remains, 4) sherd scatters, and 5) the Speleothem Bridge. Sherd scatters, consisting of concentrations of small sherds under 10cm, were not used in this analysis but were noted for future research. The Speleothem Bridge a feature that consisted of at least 48 speleothems was recorded as a single feature in an effort to prevent the skewing of the speleothem artifact counts. The Speleothem Bridge seemed to function as a single feature and was therefore recorded as such.

Attached to the artifact point coverage are attribute tables that function as a database for analyses. In this table, the computer generated a consecutive identification number system that augmented the unique identification number created by the operator (discussed above). Data fields added to this table included the minimum number of artifacts (MNA), and ceramic type/varieties.

The category of pools represented a methodological problem. Both the flood pools recorded in the 1997 flood and the gour pools between rimstone dams fall into the category. The problem was that rimstone dams were mapped and digitized as a line coverage and flood pools were recorded as polygons making it made it difficult to conduct analysis using standard GIS techniques. To solve this problem, each numbered artifact was evaluated on an individual basis and a presence/absence attribute table was created to facilitate analysis.

Creating Maps in GIS

Maps were digitized using PC Arc/Info. To prepare for digitizing, paper maps were color coded by feature class. The map was divided into 6 segments to fit the digitizing board. Between four and six tics were placed in each segment, corresponding

to the previously developed 1m grid system used for in situ recording. Once digitized, coverages were inspected, errors in digitizing were corrected, and polygon labels were examined for accuracy. Maps were then appended, edge matched and transformed in Arc/Info. Transformation was accomplished by using grid coordinates from the original grid system. Polygon coverages were split at this time to prevent overlapping polygons when building topology.

Editing

Editing of coverages was necessary in order to align them correctly due to an increasing RMS (root means squared) error. The RMS is a measure of tic registration accuracy during digitizing and coverage transformation. An error of .003 to .004 is considered generally acceptable. During digitizing the RMS error started out at .001 but over time increased to .009 as the paper map began to warp. The line coverage "boundaries" was the first to be digitized and carried an RMS error of .001. Because of this low error, the coverage was used as a template during editing in order to re-capture greater map accuracy.

Using ArcEdit, appended coverages were checked for node errors. Many nodes had to be corrected since small polygons in close proximity had a tendency to snap into the wrong node. A tiny edit distance of .09 was employed to correct this error. Once the coverages were edited, topology was built using Arc/Info. The built coverages were imported into ArcView 3.1 for analyses and data display, manipulations of attribute tables, and creation of data sets.

Data Sets

The tallying of artifacts was problematic due to ritual breakage. Should artifacts be counted as individual fragments or as whole objects? Did each individual fragment represent a discreet offering or was the offering the intact object? These questions were under consideration in the creation of data sets although answers to them are beyond the scope of this thesis. In an effort to begin to sort this out, multiple data sets were created. A technique borrowed from faunal analysis employs a "minimum number of individuals" or MNI to quantify data. This concept was applied to broken artifacts and will be referred to as the "minimum number of artifacts" or MNA. The aim of the MNA was to prevent unequal weighting of data when dealing with fragmented objects.

Data Set 1 was based on broad classes and divided into the eight major categories (Appendix C). This data set was designed for the preliminary analysis of artifact proximity to cave features and includes all 1408 artifact fragments. Data Set 2 divides the artifacts into 17 categories (Appendix D) but was not incorporated as part of the analyses in this paper. A list of the 1408 artifacts is included in Appendix E. The column labeled "Art" contains a computer generated identification number. The column labeled "Art id" is the unique identification number assigned to the artifact during digitizing. The column labeled "pools" is coded so that artifacts present in pools received a 1 and those were not received a 0.

Chapter 4

Artifact Analyses

Artifact Counts

A total of 1408 artifact fragments were assigned unique identification numbers in the Main Chamber (Appendix F). The majority (78%) of the assemblage consisted of ceramics, followed by unknown artifacts (9%), speleothems (8%), faunal remains (2%), groundstone (1%), chipped stone (.5%), slate (.4%), and the monument (.1%)(Appendix G). The unknown objects were located beneath flowstone deposits, but their shapes suggest that the majority of these unknown objects are ceramic vessels.

Of the ceramics, the majority are jars (64%), followed by bowls (11%), dishes (5%), shoe pots (3%), whistles (.8%), and vases (.2%). Orphaned body sherds ("single sherds") account for 17% of the ceramic assemblage. The dominance of the ceramic category is hardly surprising since, when smashed, ceramics tend to shatter into many fragments, thus weighting artifact counts. To adjust for this problem, based on in situ reconstructions, a minimum number of artifacts (MNA) were reported (Appendix H). The MNA counts did not include the "unknown" category, which eliminated 9% of the total data set. This reduced the total number of discreet objects to 718. Results were as follows: the majority of the assemblage were ceramics (77%) (this number includes the "single sherds" category), followed by speleothems (16%), faunal remains (4%), groundstone (2%), chipped stone (1%), slate (.7%) and the monument (.1%) (Appendix

I). Of the 551 discrete ceramic artifacts brought into the chamber, 54% were jars, 8% bowls, 3% dishes, 1% whistles, .9% shoepots, .4% vases and 32% were unidentifiable orphaned body sherds. The MNA data represents a more accurate assessment of the number of artifacts utilized within the chamber. Assuming that the speleothems were broken off stalagmites or stalactites within the chamber itself, that leaves a total of 602 artifacts were brought in from outside.

Although the MNA values do not change the class hierarchy between the two data sets, the percentages representing the MNA of non-ceramic artifacts are roughly doubled from those representing the entire assemblage. This produces a more representative value of the numbers of whole artifacts that were used in rituals and gives an idea of the categories of artifacts that were most or least often used. The following is a discussion of each artifact class.

Ceramic Chronology

Often in ritual caves, deposits are found on or near the surface. In this case stratigraphy cannot help to determine chronology. This was the case in the Main Chamber. Although two units were placed in muddy areas, no subsurface deposits were present below 2cm, suggesting that most of the chamber's artifacts are located on the surface or under flowstone. Unfortunately, no methodology has been developed for using flowstone deposits to represent time depth. Different amounts of flowstone deposit on artifact surfaces are not necessarily a function time but rather of water activity. Objects covered in thick calcite deposits tend to lie in gour pools between rimstone dams and are therefore subject to more calcite deposition than objects in other areas. It is likely that

recognizable surface artifacts represent a good random sample of the total assemblage and therefore a reasonable chronology.

Ceramics were cross-dated with Gifford's (1976) Barton Ramie collection under the supervision of Dr. Jaime Awe. This method of analysis directly addresses ceramic chronology based on form and surface treatments. Cross-dating is a well-established analytical method that has been employed throughout the Maya area at such sites as Altar de Sacrificios (Adams 1971), Seibal (Sabloff 1975), Becan (Ball 1977), Dzibilchaltun (Andrews 1962), and Petroglyph Cave (Reents-Budet 1980).

The entire ceramic assemblage fits into the Late or Terminal Classic Spanish Lookout complex (A.D. 700-950) (Appendix J). Although the presence of two Tohil Plumbate sherds suggests that the cave may have been used as late as the early Postclassic Period (Ball 1977:47), they provide the only evidence for use in that time period. This type is considered to be a marker for Ball's late Xcocom period at Becan, which may slightly overlap with Gifford's Terminal Classic dates.

Gordon Willey (1973:105-106) has suggested that for Belize Valley ceramics, a change in ceramic patterns occurred during the late half of the Spanish Lookout Phase, which begins at A.D. 830 and ends between A.D. 890-950. His observations regarding the changes in this phase were as follows: 1) ash tempered-wares disappear, 2) calcite tempered wares were reasserted, 3) polychrome painting is gone, and 4) there is very little decoration. Since Barton Ramie is in close proximity to Actun Tunichil Muknal, it would not be surprising to observe a similar pattern for the same time period.

In fact, many of the vessels from the Main Chamber were of similar form and type, consisting primarily of unslipped ware, along with highly polished red or black-

slipped monochromes. Ash-tempered ware, common in the Belize Valley, was completely missing from the assemblage and no painted vessels were located in the chamber. The entire ceramic assemblage was calcite tempered and few vessels exhibited decoration. This evidence, coupled with the presence of the two Tohil Plumbate sherds suggests that the chamber was occupied during the terminal part of the Spanish Lookout Phase. Based on this data, the Main Chamber may be dated from A.D. 830 to 950, which correlates with the dates postulated by Willey (1973:98) as the time that the shift occurred between the Spanish Lookout Phase to the Postclassic New Town phase. Willey's approximation was that the Spanish Lookout Phase ended somewhere between A.D. 890-950, and if the earlier estimation is correct, the Main Chamber could have been used during a very narrow time frame of about 60 years. Otherwise, using Willey's date of A.D. 950 as the end of the phase, the chamber would have been utilized for up to 120 years.

It is unclear as to whether the change from the Late Classic Spanish Lookout phase to the Postclassic New Town phase represented a continuous occupation or a new group moving in. Willey suggested that the social transformation characterized the by the New Town phase was a shift from a hierarchical to a non-hierarchical society. He drew the inference from the lack of construction of ceremonial architecture, the absence of fine craft goods, the humble quality of material remains as compared with earlier phases, and the lack of substantial domestic building. Populations declined during the New Town phase until A.D. 1300, at which point the Belize Valley was completely abandoned. The ceramic assemblage in the Main Chamber suggests that this remote area

of the cave was used during the critical transitional interface between the Late Classic and Postclassic periods.

Cave Assemblages

Collection of *Zuhuy Ha*

In his summary of Maya cave use, J. Eric Thompson suggested that among the Maya, the purpose of jars found in caves was for the collection of *zuhuy ha* or "virgin water" to be used in rituals (1959:124-127; in Mercer 1975:xv-xxii). In limited instances this may have been the case but evidence from the Main Chamber belies this interpretation. If Thompson was correct we would expect to find whole vessels set under dripping stalactites. Over time, these vessels could break from dampness or be inundated with flowstone, but an entire vessel should be present. Both the placement and condition of the vessels in the Main Chamber precluded water collection as their function. Only four vessels in the entire assemblage were intact and most were broken into sherds that were disassociated with dripping water. None of the intact vessels were placed under drips or filled with water after the 1997 storm, nor did they show signs of calcium carbonate deposits. Many vessels were located in niches and alcoves where drips did not occur. Some were found in inverted positions or upright with the bases smashed.

One artifact may have been used for water collection, but it was not a ceramic vessel. An almost complete metate located in the Angel's Room atop a stalagmitic formation (see Fig. 2-32) was placed directly below a drip that became active after the 1997 storm, causing the interior to fill with water. This could be considered somewhat

analogous to the *haltuns* or stone troughs used for water collection in caves in Yucatan (Bonor 1989:134; E. Thompson 1897:15; Mercer 1975:25-27).

Ritual Breakage

Over 99% of the artifacts within the chamber were broken and are assumed to be ritually smashed since this is documented behavior in ceremonial contexts. Barbara Tedlock (1982:65) reported that in Momostenango a ritual was begun with the breaking into pieces of a large unused cooking pot. The individual sherds were then used as incense burners. This observation is supported by archaeological evidence from Naj Tunich. Stone (1995:129) reported a broken polychrome vessel at the base of an altar that she believes was ritually smashed during a ceremony which included painting an inscription and burning fires. In the Main Chamber many sherds, particularly jar sherds, exhibited signs of interior charring. For example, charred jar sherds were noted in Alcove 3 in Boot Hill (see Fig. 2-5) and in the elevated niche in the Cathedral (see Fig. 2-27). Jar sherds located on the eastern side of the pathway of the Creek contained an ash lens that is also an indication of burning (see Fig. 2-4).

However, many more vessels showed no signs of burning indicating variation in their function. Both ceramics and other objects were broken and deposited on the floor, stacked, or cached. Also occurring in the chamber were many instances of single sherds that could not be refitted with whole vessels. I would argue that these objects were left in the chamber as offerings.

Some light may be shed on this practice by turning to the Popol Vuh, an ancient Maya pre-Columbian text of the Quiche Maya from Highland Guatemala. The text, often

referred to as the "Maya Bible," was transcribed from Maya hieroglyphic writing to the European alphabet probably in 1554 (D. Tedlock 1996:57). Although there are many translations, the most recent is Dennis Tedlock's original 1985 Quiche to English version. In the story, at the beginning of the history of mankind, the mythic Hero Twins conquer the evil Lords of the Underworld and are then able to establish a civilization of humans. Although the Twins threaten to kill the people of the Underworld, they decide to spare their lives but chastise them in the following manner:

> Very well. Now this is our word, we shall name it for you. All of you listen, you Xibalbans: because of this your day and your descendants will not be great. Moreover, the gifts you receive will no longer be great, but reduced to scabrous nodules of sap. There will be no cleanly blotted blood for you, just griddles, just gourds, just brittle things broken to pieces (D.Tedlock 1996:138).

Bearing these words in mind, it should come as no surprise that offerings left for underworld deities or that offerings left in the cave, a symbolic the Underworld domain, should be "broken to pieces." According to the Popol Vuh, offerings of copal incense ("scabrous nodules of sap"), should also be common in cave assemblages.

Refitting

An "in situ" refitting of artifacts was conducted by the project. Refitting rarely produced the entire object, even in instances in which a vessel was smashed and sherds from the vessel were stacked together. Brady (1989:86) noted that in refitting vessels at

Naj Tunich, some portion of the vessel was invariably missing. This evidence suggests that sherds were either deposited in other chambers, buried under the flowstone, or taken away for future use.

A total of 278 body sherds that did not refit with any vessel within the immediate area were recorded. The most striking example is two sherds of a Tohil Plumbate jar (identified by Joseph Ball 1998, personal communication). Although this type is common at Becan (Ball 1977:47), it is extremely rare in the Belize Valley. Because this is such a distinctive type as compared to the rest of the chamber's ceramic assemblage, it would have been easily recognized during refitting. While it is possible that these sherds refit with vessels completely obscured by flowstone or others which were not located, it is equally possible that they were brought in as offerings in and of themselves. The fact that we were unable to refit such a large number of single sherds adds to the evidence that this may be the case.

Since this refitting pattern was so pervasive not only in the Main Chamber, but also at the cave of Naj Tunich, it is a reasonable hypothesis that single sherds were used in two ways. Some were intentionally removed from the cave as evidenced by sherds missing from reconstructable vessels, and some brought into the cave as offerings. This is supported by evidence from the site of Santa Rita Corozal. Chase and Chase (1988:72) noted that effigy censers occurred in two different contexts at the site. They were smashed and left in situ and were reconstructable or smashed and discarded over a large area.

Artifact Specialization

In the cave beneath the Pyramid of the Sun at Teotihuacan, Rene Millon (1981:234), reported that three pottery forms seemed to be particular to cave ritual. This observation is intriguing and presents an interesting question as to whether a special assemblage of cave artifacts, and in particular, ceramic artifacts exist. Although much of the cave assemblage may have had a utilitarian function, evidence points to the fact that there may be some forms or decorative motifs that are specific to cave ritual use.

Most of the ceramic assemblage from the Main Chamber is composed of unslipped jars identical to those found in household assemblages. However, some more unusual ceramic types are also present. For example, the Main Chamber contained at least two and possibly five (if one includes orphaned sherds) shoe-shaped vessels (shoe-pots). Brady (1992:7) noted that they were part of ritual assemblages based on his work in lowland Maya caves. At the time the article was written, there were 70 known shoe-pots in the Maya lowlands 52 of which were found in caves.

Additionally, working at the Cueva del Sangre at Dos Pilas, Brady (personal communication, 2000) located a vessel that he believed to have been specially commissioned for a cave ceremony. A broken tripod bowl was found lying in an inverted position under which was the proximal end of a broken human tibia. The scene on the vessel depicted a spear piercing the left leg of a man at approximately the point where the accompanying bone was broken. This led Brady to conclude that the scene represented the taking of a captive who was later sacrificed. The vessel commemorated the event and his bone was used in a ceremony. Brady's work represents a step towards demonstrating that a special a ceramic assemblage may have been associated with ritual cave use.

Evidence from the Main Chamber supports this notion. Four large almost identical bowls with an unusual motif were found in the chamber. In form and size, these vessels resemble the Late Classic Garbutt Creek Red: Garbutt Creek Variety bowls identified by Gifford (1976: 230-235, Fig. 140). However, an unusual bichrome interior decoration was noted on the sherds giving the interior slip the appearance of tree bark (Figure 4-1). Three of the vessels were located in the Boot Hill area and an additional example, which was largely intact, was found at the base of the breakdown along the West Wall (Figure 4-2). Another example of these bowls was found inside the nearby Twin Caves on a reconnaissance exploration.

The suggestion that the variety may be specific to caves is based solely on negative evidence, and alternatively, the decoration may turn out to be a local stylistic variant. However, regardless of whether they are a specific to caves, the bowls represent a new variety. This variant has not been reported by Gifford (1976:231) although he does mention two small rim sherds that "appear" to have black pigment applied to the slip. In a personal communication, Joseph Ball (1999) also denied having ever encountered this bichrome slip decoration. To date the variety has not been reported by other archaeologists and did not show up in test excavations at the nearby site of Cahal Witz Na (Jennifer Erhet and James Conlon personal communication, 2000).

The bowls have been classified as members of the Garbutt Creek ceramic group and their suggested designation is Garbutt Creek Red: Tunichil Variety. They are flat bottomed with incurved rims and diameters ranging from 20-36cm. Since a large part of vessel #12076201-03 was intact, a base diameter of 9.8cms. and a height of 16.5cms. was obtained. Rim thicknesses ranged between 8–13mm and body thickness between 4-

8mms. Their pastes are brown and one vessel exhibited dark gray to black coring. They are tempered with fine calcite as well as hematite nodules that are generally small (<1mm), but occasionally large (5mm). The interior slip extends over the edge of the rim. The interior of the bowl is slipped throughout with an orange to orange-red slip (we were not able to take Munsell readings in the artificial light), that exhibits crazing. On top of the base slip is a black slip that appeared to be brushed on. The black slip forms short horizontal and diagonal lines that occasionally criss-cross, giving the interior of the vessel the "bark-like" appearance. A thin wash covers the exterior of the bowls and #12076201-03 was highly polished. This vessel exhibited heavy exterior and light interior charring indicating that it may have been used as an incensario.

Speleothems

Function and Meaning

Speleothem breakage, caching, and removal has been well documented in caves, although it has only been given sporadic attention by archaeologists (Andrews 1970; Awe et al. 1997; Brady 1999; Bonor and Martinez 1995; MacLeod and Puleston 1978; McNatt 1996; Pendergast 1970; Reents-Budet 1980; Rissolo 1998). Speleothems have functioned as altars, idols, *haltuns*, incensarios, raw material for construction, venues for rock art carvings, and offerings in and of themselves (Brady et al 1997; Moyes 2000). Recently, Brady has reported on the distribution and context of speleothems throughout the Maya area in both caves and surface sites (Brady et al. 1997), but to date, no formal analysis has been undertaken examine specific meanings or how that meaning may be altered by context. Brady concluded that speleothems carry sacred meaning whether they are

modified of unmodified, and relates their presence in ritual contexts to the Polynesian concept of *mana* or spiritual power (Brady et al. 1997:740).

The Yucatec term for speleothems is *xix ha tunich* or "drip-water stone" (Barrera Vasquez et al. 1980:946). This lexical evidence suggests that the Maya, were cognizant, at least empirically, of the process of speleothem formation. Water found in caves, called *zuhuy ha* or "virgin water", was considered sacred and used in ritual throughout Mesoamerica during prehispanic times (A. J. O. Anderson 1982:82; Duran 1971:131; Sahagun 1981:141; E. Thompson 1959:124-127.) In a personal communication with Barbara Tedlock (2000), she suggested that the correct spelling is *suhuy,* which translates as "pure" as opposed to "virgin." In Yucatec (Barrera Vásquez et. al. (1980:741) *suhuy haa'* is defined as water springing from a hole (my translation). According to Tedlock, in practice this becomes water that is caught, such as rainwater or dew, or that which comes from a spring. She reports that water drawn for rituals is not taken from the banks or edges of the source since water found in these areas is thought to be polluted. In one example, her informant stood on a stone so that she could reach into the middle of the pool to avoid drawing water from the edge of the spring. The concept is also present in central Mexico. It was noted by Aramoni (1990 in Heyden n.d.), that in Tzinacapan, water coming from caves in the area is believed to be pure because it originates in Talocan (the underworld).

It would be expected that stone created from "pure" water would be imbued with "special" meaning as Brady suggests. It is also possible that their meaning is related to transformation or transition as well. The cognitive association with transformation instantiated in the process of the creation of stone from dripping water, particularly

sacred water from caves, may be a major contributing factor in understanding the meaning of these objects.

Speleothem Use in the Main Chamber

In the Main Chamber, speleothems served a variety of functions such as construction material for the Speleothem Bridge, raw material for worked artifacts, hearths, and as offerings. Of the 1408 recorded artifacts located in the chamber, 116 (8%) were speleothems. In terms of the MNA, speleothems accounted for 116 (16%) of the 718 artifact total, making them the second largest represented artifact class. When artifacts were divided into 252 discreet clusters (See Chapter 5), 59 or 23% contained speleothems. Up to 10 occurred within a single cluster. A map of speleothem distribution is shown in Figure 4-3.

The most common speleothem usage was in conjunction with other artifact offerings. To name a few examples, on the balcony of the Boot Hill area, speleothems are associated with an artifact cluster containing a mano fragment and sherds. In the Burial Chamber, nine speleothems are located in a niche containing bat bone, obsidian flakes and sherds. Another three are located in a niche on the south side of the platform with a number of vessel sherds and a jaguar pelvis (see Fig. 2-21). In the Ransom Chamber, two are placed together along the east wall leading to Alcove 7, and three were associated with the adult skeleton HR 8. Along the West Wall, eight speleothems are located in the muddy flat area associated with sherds and burning (see Fig. 2-38).

Construction Material

The Speleothem Bridge is located in the deepest area of the Main Chamber where the Angel's Room adjoins the West Wall (see Chapter 2, Figs. 2-36, 2-38). At least 48 broken speleothems (these were not included with the speleothem artifact counts), were placed in a crevice between boulders at the edge of a large area of breakdown. It is referred to it as a "bridge" because it must be stepped across to gain access to the easiest and indeed only route over the breakdown. Although the feature is placed in a crevice in the floor, it has not utilitarian function since the crevice only measures 30 cm wide and provides no real obstacle.

Ethnographic evidence sheds some light on the meaning of this feature. In his account of the Mixe of Oaxaca, Frank Lipp (1991:48) reports that there are two deities that inhabit caves, the Devil who lives in the Underworld and 'Ene who lives in the abode of Poh 'Ene. There is a crossroads in the cave leading to one entity or the other. The Devil is thought to extract the soul of a supplicant whereas 'Ene only demands sacrificial fowl. If a person wishes to acquire wealth a deal can be struck with 'Ene who doles out money in the form of pottery sherds that transform into cash on the outside. In order to reach Poh 'Ene, one must cross a bridge in the form of a large serpent (Ibid.).

In what he thought to be a problematic account, LaFarge (1947:124) reports a similar belief among the Maya of Santa Eulalia. An informant of Miss Bertha P. Dutton gives an account of a cave New Year's ceremony that he has supposedly witnessed. In the ceremony, a chicken is sacrificed and the blood spilled onto the fire of incensarios. The reason given for this practice is that it enabled the souls of the dead to pass between the good and bad worlds. If the soul fell off the bridge during this journey it was lost.

Since LaFarge had never heard of this belief, he doubted its veracity. However, the Mixe myth adds to its credibility. Also, both beliefs resonate with the Popul Vuh since both sets of twins must choose the correct path at the crossroads in Xibalba. The Speleothem Bridge is located in the deepest and most remote area of the Main Chamber and may represent this underworld crossroad.

Ornaments

In two instances speleothems were used as raw material to create ornaments. The first is a bead in the shape of a quatrefoil or four-pedaled flower, found cached in a crevice in a remote area of breakdown near the West Wall (Fig. 4-4a). Carved speleothems ornaments are rather rare. Two beads were found at Petroglyph Cave in Belize (Reents-Budet and MacLeod 1997:67) and in their comprehensive article on speleothems, Brady et al. (1997:737) were only able to produce only one example of an ornament, a bead from the site of Chichicaste in northeastern Honduras.

The speleothem bead from the Main Chamber may be carved to represent a model of the Underworld. In a recent ethnographic study of underworld symbolism, Timothy Knab (2000:62) reported a similar iconographic feature that while working in San Martín Zinacapan in Sierra de Puebla, Mexico. Knab's informant described the Underworld as, "..a land of darkness ..*Talocan* (the name in Nahuat for the Underworld) is a great flower of darkness." She then drew a model in the sand of a large square flower. Note the resemblance to the drawing of the speleothem bead (see Fig. 4-4b-c). The model divided the Underworld into four quadrants. The first petal was in the north, which was described as "The Cave of the Winds, *Ejecatalan* or *Ejecatan*, and the Land of the Dead,

Miquitalan or *Mictali*." This was followed by the east, described as *Apan* or "the sea." The third was the south, called "Land of Heat, *Atotonican*," and last she drew the west, "House of the Women, the *Cihuauhchan* in *Tonallan*." To complete the diagram, she drew a circle in the center of the petals that was called, "..the true heart of *Talocan*, the *Talocan Melaw*."

The second carved speleothem object is more problematic. It was located along the south wall of the Burial Chamber on a small flat altar-like feature. Found with the speleothem was a fragment of polished pyrite, a sherd, and some small pieces of charcoal (Fig. 4-5). The object is small, highly polished, and cylindrical. A piece is broken off and the remainder measures 1.3cm in diameter and 1.6cm in height.

A similar object was found at Petroglyph Cave. Four intact examples were located in Burial Chamber I, Cache Area III, and were found in association with a smashed pyrite mirror (Reents-Budet and MacLeod 1997:43). The authors suggested that, for lack of a better description, the artifact may be a fractured labret, which is an ornament that would have been worn on the lower lip. However, as Reents-Budet expressed in a current personal communication (2000), this is somewhat doubtful since the ornament is specific to central Mexico and unknown in the Maya area. She has more recently suggested that these objects may be parts of pyrite mirrors, a notion that is bolstered by the fact findings from both caves were associated with pyrite mirror fragments.

The Three-Stone-Hearth

Speleothems were also used within the chamber in the construction of hearths. In the Passage area at the western edge of the Beach, a concentration of charcoal is surrounded in a circular fashion by two speleothems, a large sherd and a rock (see Fig. 2-13). Hearths may have frequently carried significance far beyond their simple function as fire pits. This is suggested by the very importance of fire within Maya ritual. Cook (1986:139) noted that the Quiche frequently refer to rituals as "burnings" and Bunzel (1952:431) reported that Maya altars are called "burning places."

Hearths may also become expressions of cosmological ideas. Recent work by Friedel et al. (1993 68-93) has suggested hearths are salient features in Maya cosmology, particularly the three-stone-hearth in the 4 Ahau 8 Kumk'u creation event of 3114 B.C. More recently, Taube (1998:430) drew an analogy between Maya household architecture sacred architecture. He argued that temples were configured as "god houses" whose roofs were supported by four posts and whose center was the 3-Stone Hearth that represents both a place of creation and the axis mundi that connects the sky, earth, and underworld. Taube proposed that this hearth symbolism was replicated in radial stairway pyramids, cache vessels, censors, and three-legged altars. He associates a cluster of iconographic elements with three-stone-hearth: centrality, jaguars, fire, and water (1998:431-440).

Taube´s cosmological model for the concept of the temple as god houses may apply to cave space as well. Caves are widely accepted as functioning as the houses of deities, particularly rain deities (J. E. Thompson 1970:267-268; Guiteras-Holmes 1961:153,281; Holland 1963:93; Nash 1970:141; Toor 1947:473; Reina 1966:181-182),

and ancestral spirits (LaFarge 1947:127-8; Nash 1970:19, 45; Vogt 1970:6; J. E. Thompson 1970:314, 316). Andrea Stone (1995:35-36) argued that caves were thought to be the house of gods based on linguistic evidence in which the Maya term for cave in many areas translates as "stone house." This agrees well with Las Casas who noted centuries ago that the Maya word for temple was also used for cave (cited in J. E. Thompson 1959:122). Given this analogy one would expect a three-stone-hearth feature to occupy the center of a cave just as in a house or temple.

A cluster of three speleothems was found in the Burial Chamber area. Based on the presence of the iconographic elements delineated by Taube, the cluster represents a three-stone-hearth. The cluster is particularly notable due to its odd configuration (Fig. 4-6). Note that all three speleothems were modified to resemble hearthstones. The tapering ends were removed and a rounded shape was achieved. The three speleothems were stacked one on top of the other two. It is the only instance within the Main Chamber that this configuration occurs. This particular type of cluster is noted by Taube in ancient Maya epigraphic representations of the three-stone-hearth (1998:433; see Fig. 4-6).

Each of Taube's iconographic elements is associated with the feature, the most important of which is the centrality. Not only is the cluster central to the smaller chamber in which it is located, but also central to the entire Main Chamber (Fig. 4-7). There is a high degree of confidence that the stones are in their original context because they have been firmly cemented to the floor with calcite.

According to Taube´s model one would also expect to find a jaguar element associated with the hearth. A detail map of the immediate area illustrates the provenience

of two jaguar bones, a pelvis and a metatarsal, located in the Burial Chamber near the speleothem cluster (Fig. 4-8). Evidence of burning would also be expected in relationship to the three-stone-hearth symbolism. Although large areas of charcoal scatter are found along the walls, any carbonized material located among the rimstone dams in the center of the chamber would have been either washed away or covered with flowstone. There is however some remaining evidence of burning. The speleothem on the top of the stack exhibits charring. Given the central location of the feature, its configuration, and the associated artifacts, it can be said with a high degree of confidence that the cluster of three speleothems is a representation of the three-stone-hearth of Maya creation.

Accounts of the Maya creation myths come from a number of ethnohistoric and ethnographic sources as well as ancient hieroglyphic texts. The most thorough treatment of the creation is from the Popol Vuh, a Quichean hieroglyphic text translated into Spanish orthography in the 16th century (Tedlock 1996). Although the book can be traced through its colonial heritage, the creation myth is of more ancient origin since the characters appear in ancient iconography going back to the Preclassic Period (See Smith 1984 for examples of Izapa iconography).

In the Popol Vuh, the Maya creation leading to the populating of the world by humans occurred in a series of attempts and failures. In the beginning the world dark because there was no sun and the cosmos consisted of a primordial sea. In this dark primordial time, gods of the earth and sky created a vision of the emergence of the earth from water and it's population by plants, animals, and people. Based primarily on the Tablet of the Cross texts from Palenque, Freidel et al. (1993:68-93) argued that in Maya

mythology the creation of the world was initiated by the Maize God at the center of the cosmos. At the beginning of creation, the sky is "lying down." on the primordial sea. First Father (the Maize God or One Hunahpu) begins by setting the three-stone hearth, at a place called "Lying-down-Sky," (Ibid.:75), thus centering the universe. First Father "Enters the Sky," by raising the world tree from the plate of sacrifice, an image illustrated on the Palenque Tablet of the Cross (Ibid.:72). By entering the sky, First Father creates the "…Raised-up-Sky-Place, the Eight House Partitions" (Ibid.:71). This action separates the earth from the sky and establishes the eight cardinal and inter-cardinal directions of the cosmos.

The presence of the three-stone-hearth feature in the Main Chamber suggests a ritual that involved the re-enactment of the Maya creation myth. The wet, dark cave would have provided an analogous environmental counterpart to the state of the cosmos at the beginning of creation when the sky was "lying down," resting on the primordial sea. I would argue that the use of speleothems as primordial hearthstones was hardly accidental. Their association with pure water, transformation, and power embues the objects with special significance appropriate to a ritual creation event.

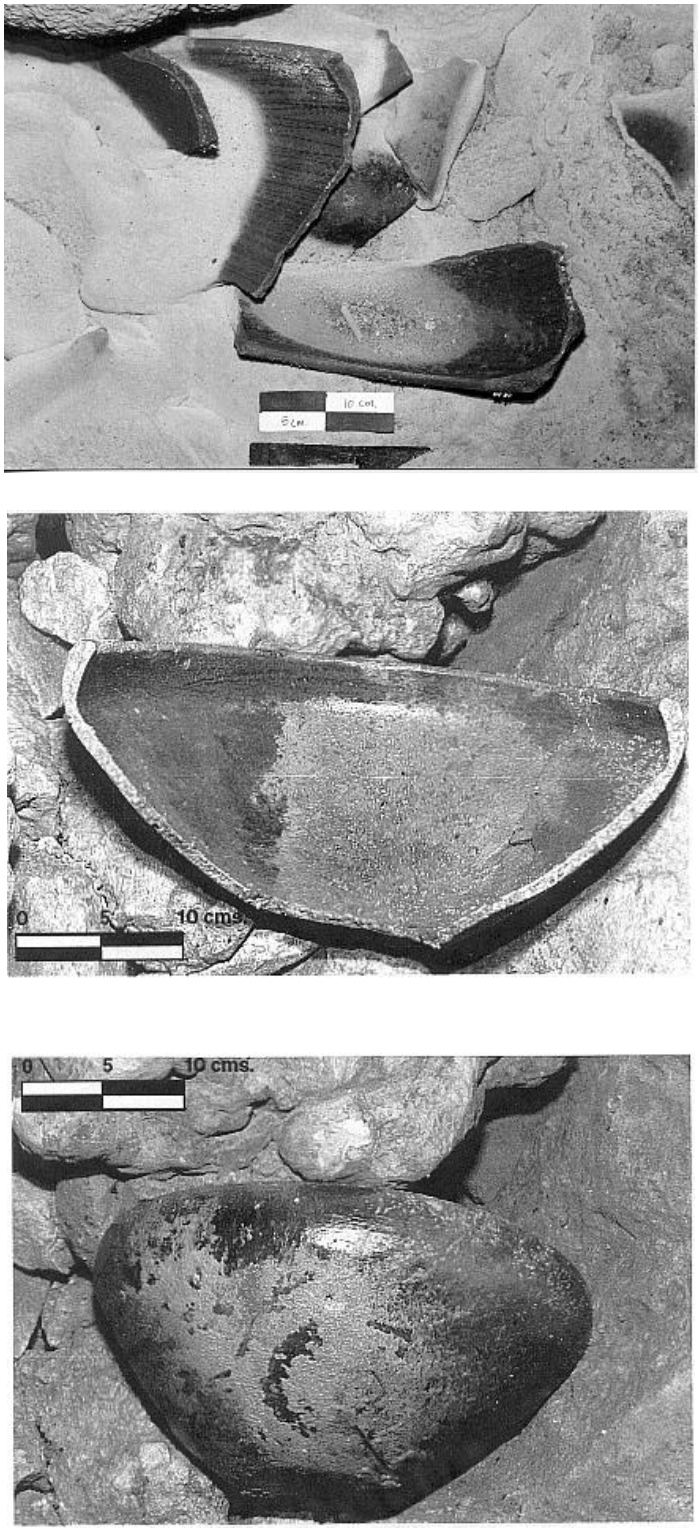


Figure 4-1. Vaca Falls Red: Tunichil Variety bowls. Top is vessel #12012101-03 located in Boot Hill area. Middle and bottom are vessel #12076201-03 located in West Wall area. The black horizontal and diagonal lines are best illustrated in top photo. (Photographs by author)

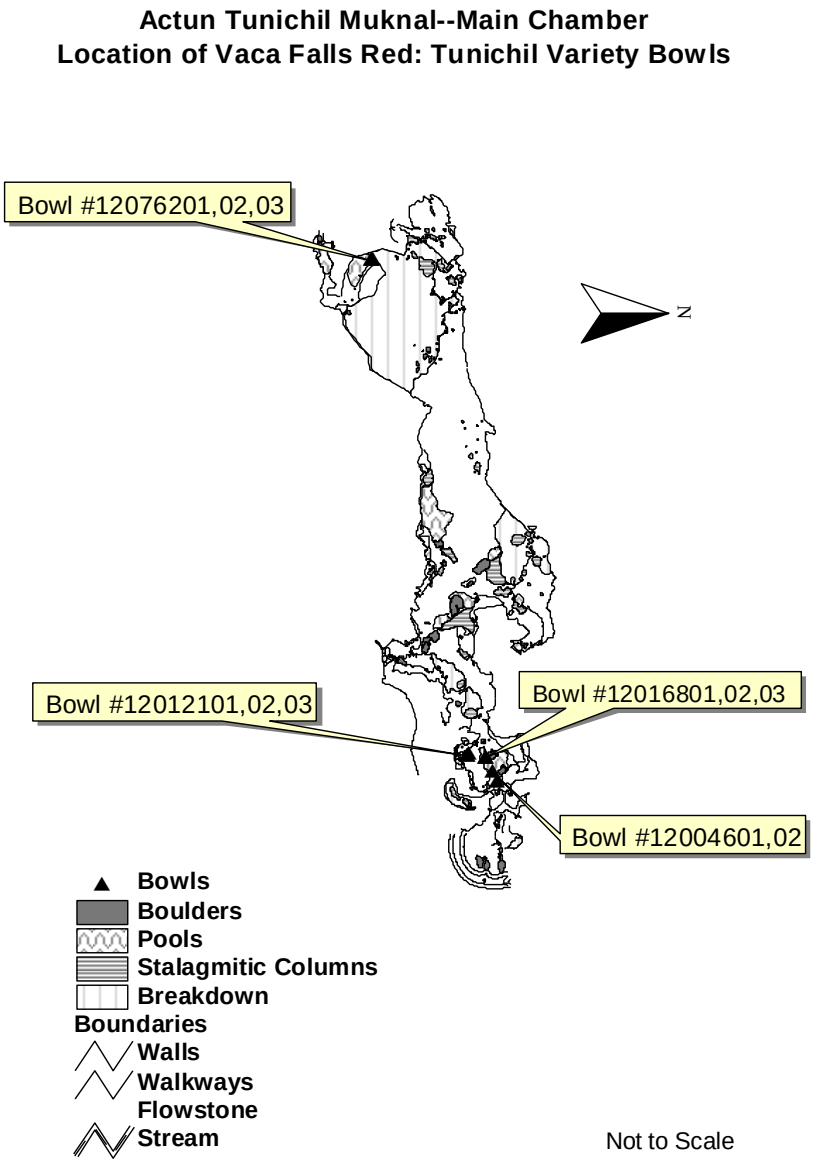


Figure 4-2. Spatial distribution of the four Vaca Falls Red: Tunichil Variety bowls.

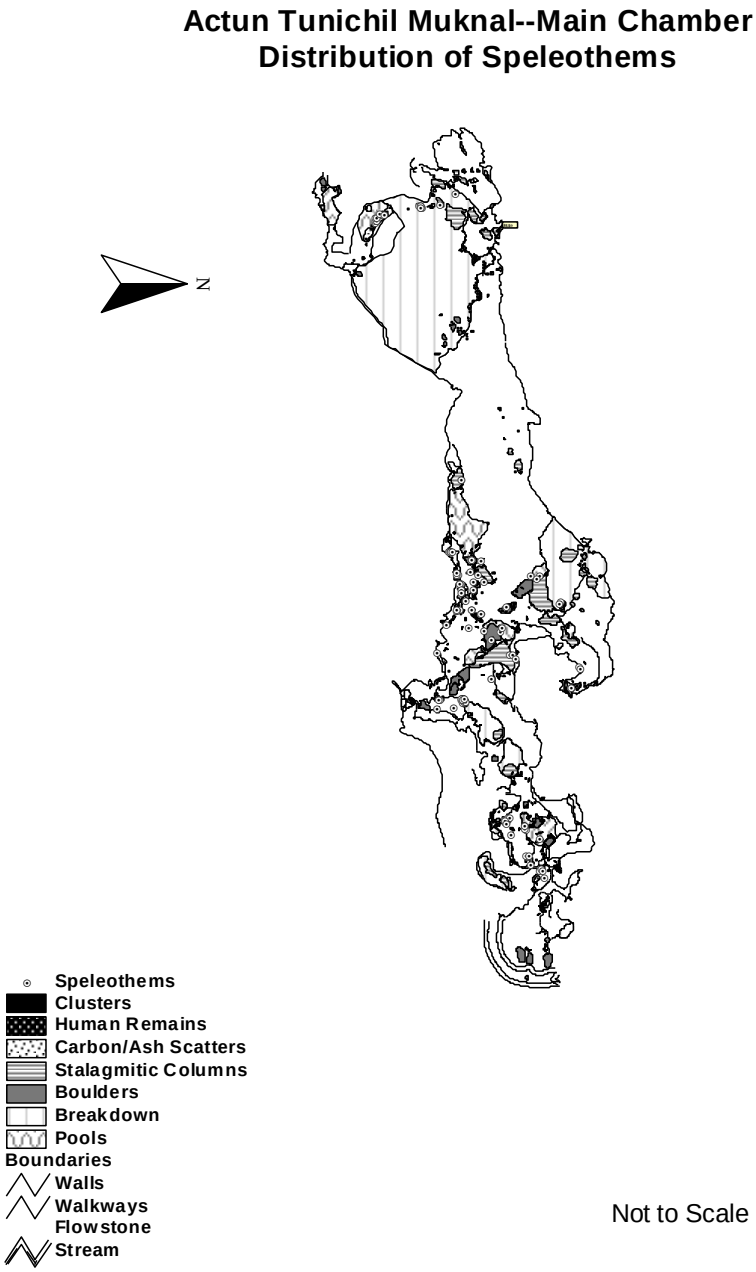
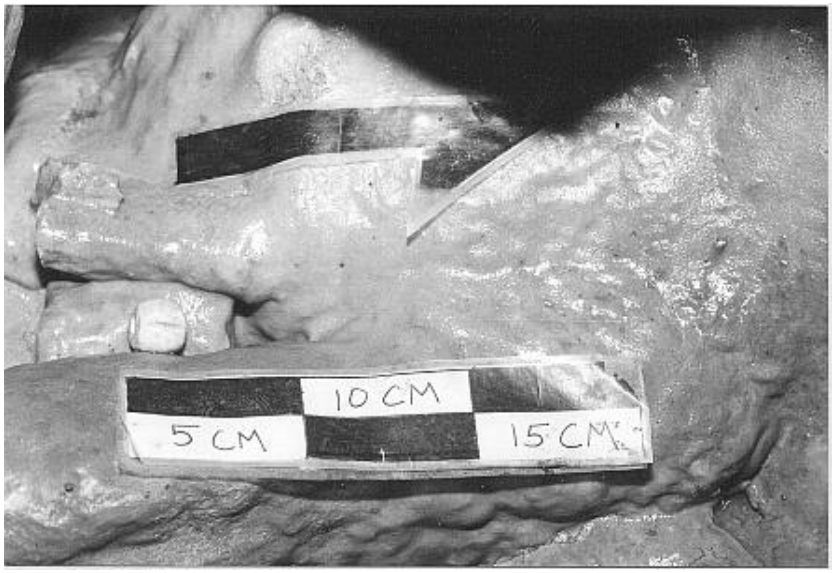
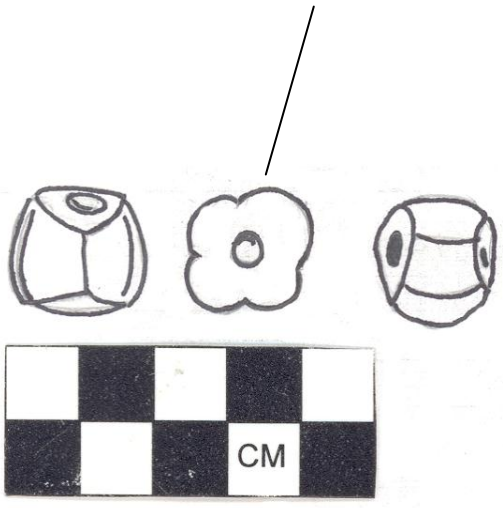


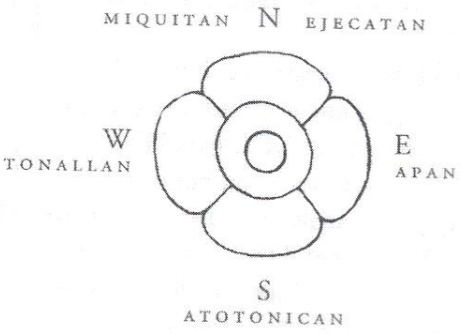
Figure 4-3. Spatial distribution of speleothems in Main Chamber.



a)



b)



c)

Figure 4-4. a) Speleothem bead found in small crevice located in West Wall area.
b) Drawing by author of speleothem bead.
c) Diagram of Talocan (the Underworld) (Knab 2000:62).

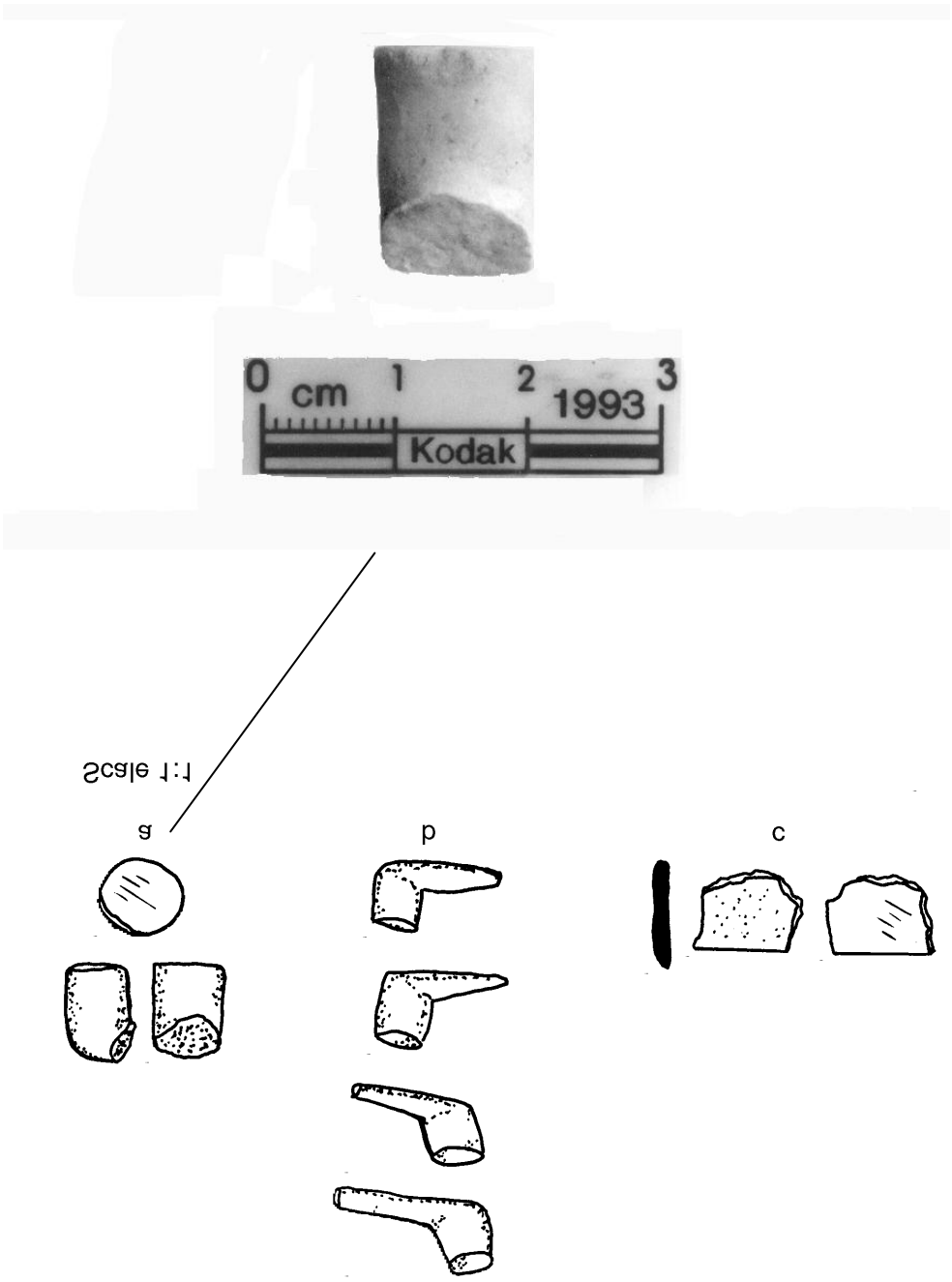


Figure 4-5. a) photograph and drawings of speleofact from the Main Chamber, Actun Tunichil Muknal.
b) drawings of 4 "labrets" from Petroglyph Cave
c) pyrite tessera from Main Chamber, Actun Tunichil Muknal

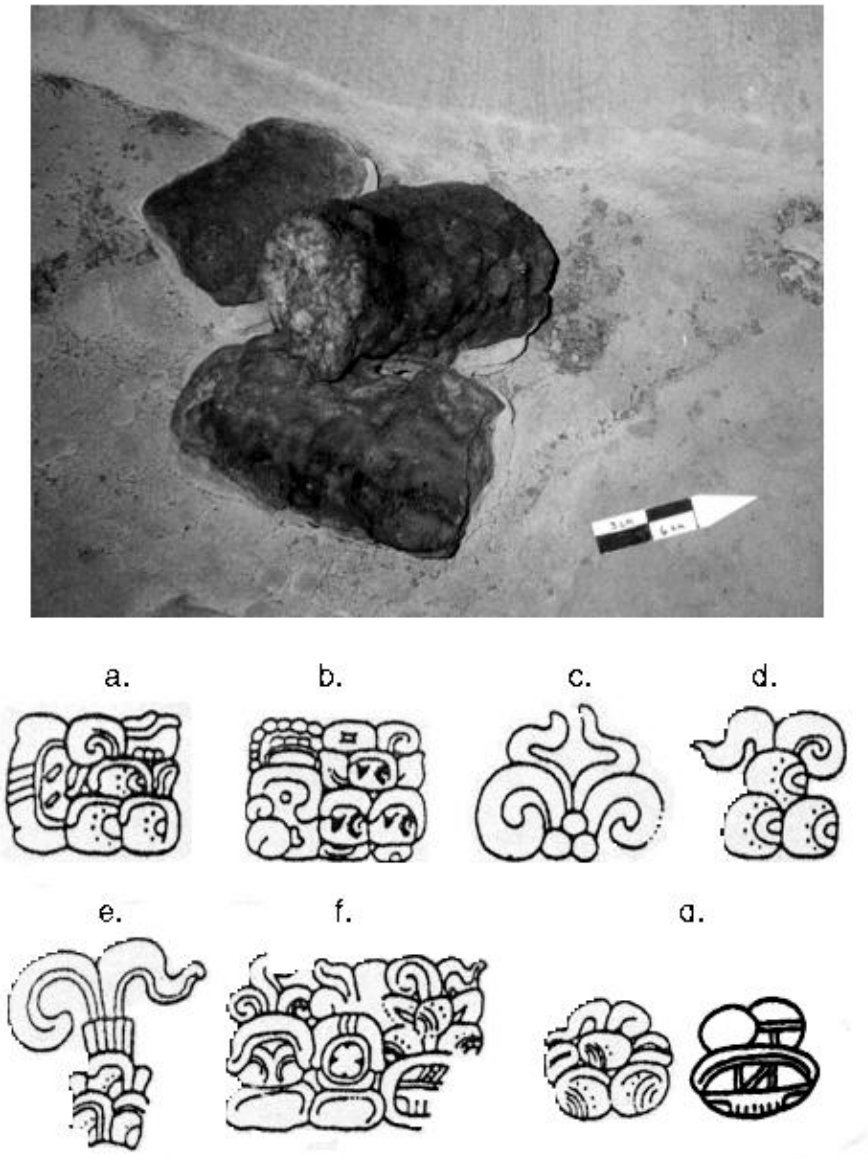


Figure 4-6. Top-Photograph of the 3 speleothem cluster located in the Burial Chamber of the Main Chamber of Actun Tunichil Muknal.
Bottom- Drawings of epigraphic depictions of the three-stone-hearth assembled by Taube (1998:433):
a)the green hearthstone place, Quirigua; b) the Seibal emblem glyph, Tablet 4 of hieroglyphic stairway, Seibal; c) three smoking hearthstones, Monument 74, Tonina; d) one of a series of smoking hearthstones on headdress of ruler, detail of recently excavated stela, Tonina; e) three stones with burning wood, Naranjo Stela 30; f) smoking sky hearthstones with glyphs for Tikal Paddlers, Stela 16, Copan; g) smoking hearthstones with sky ahau glyph, Stela 1, Salinas de los Nueve Cerros (Taube 1998:433).

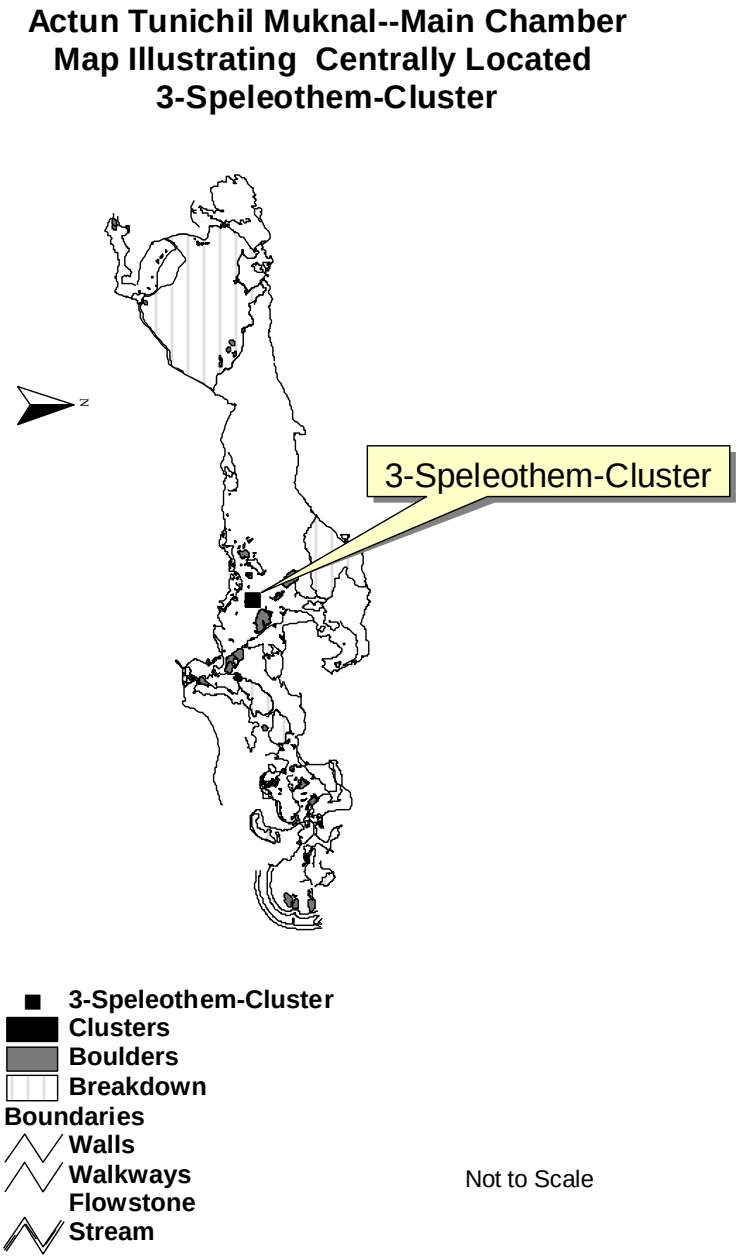


Figure 4-7. Map illustrating location of three-speleothem-cluster. It is centrally located not only in relation to the Burial Chamber but to the Main Chamber itself.

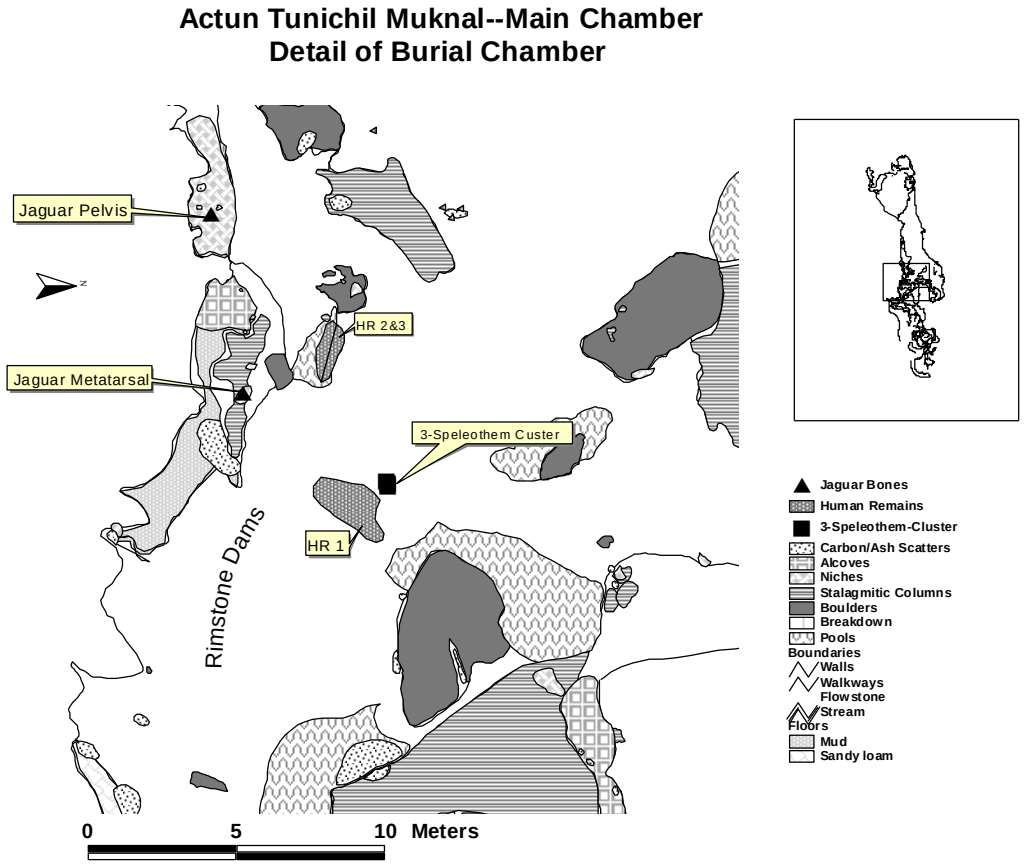


Figure 4-8. Small-scale map detail of the Burial Chamber illustrating the most central area of the cave. Note the two jaguar bones located within 5m of the three-speleothem-cluster.

Chapter 5

Quantitative Analyses and Results

Preliminary Analysis

Computer analysis was conducted using GIS for the purpose of determining if individual artifacts were placed in proximity to specific morphological features within the cave, and if so, which if any feature categories were favored over others. This was accomplished by creating coverages for each feature category. To generate a proximity measure, entities contained within each feature class were surrounded with polygonal buffer zones of various sizes. Resulting buffer zones formed polygons dividing that which was inside from that which was outside the specified buffer distance from each feature. The artifact coverage was overlaid with feature coverages to determine the number of artifacts within each buffer zone for each feature class. This produced a global measure within each class of the number of artifacts present within specific proximities.

Using Arc View 3.1, buffer areas of .25m, .5m, 1m and 1.5m were used to surround components of the line and polygon feature coverages. Although buffer zones were expected to overlap to some extent, by using variable buffer sizes, it was possible to separate results for each feature category. Although the feature categories were determined by observed placement of artifacts in relation to morphological features at ATM as well as other cave sites, the question remained as to whether these categories

were salient in relation to the behavior patterns of the ancient Maya. Buffers were used as an analytical tool to determine the salience of feature categories and to demonstrate the existence or nonexistence of pattern in artifact placement in relation to morphological features within the cave.

Each buffer increment was applied to the following feature classes: 1) walls and walkways, 2) boulders, and 3) stalagmitic/stalacto-stalagmitic columns. The feature classes of niches, alcoves, and breakdown, were evaluated by querying the database to find artifacts contained within these features. Pools were evaluated on apresence/absence basis.

The analysis was done using Data Set 1, the artifact point coverage of 1408 fragments. All artifacts received an equal weight of one and results are presented in percentages. This data was published in 1997 (Moyes and Awe 1998), but because artifacts were added to the data set and some refinements were made to the technique, a new data is presented in this study.

The computer generated the following results reported in percentages (Appendix K). When adding up percentages of artifact proximity to cave features, no buffer category totaled less than 100% due to category overlap. For example, an artifact could sit adjacent to both a boulder and a wall and thus be counted twice. In this preliminary stage, it was preferable not to bias data by arbitrarily assigning an artifact to one or the other.

The feature category of pools is the most problematic since much of the cave floor consists of rimstone dam or intermittent flood pools, causing a great deal of overlap of other feature categories. By considering the pools separately, 102% of the data is

represented by all other feature categories at the .50m buffer size, considerably reducing the overlap. Since this is the closest result to 100%, the data from the .50m buffer level is the best representation of the preliminary analysis. The following are the results in descending order: 1) pools (51%), 2) walls and walkways (28%), 3) boulders (27%), 4) stalagmitic/stalacto-stalagmitic columns (20%), 5) niches (13%), 6) breakdown (8%), and 7) alcoves (5%). All results are listed in Appendix L.

Summary of Preliminary Results

There were two major problems with these preliminary results. First, artifact breakage caused unequal weighting of the data and second, there was the difficulty in determining an ideal buffer size. An examination of the artifact distribution revealed that artifacts tended to be clustered. In many areas, such as small niches and rimstone dam pools, clusters were well bounded. In less bounded spaces, clusters were sometimes more difficult to define. In assessing human behavior, these clusters of objects deposited in close proximity to each other become a better unit of measurement than single artifact fragments since they most likely represent intentional groupings. Ideally, buffers should encompass those clusters. In order to address these problems, artifacts were clustered by combining statistical techniques with GIS technology.

Cluster Analysis

K-means Clustering

Clustering was based on pure locational analysis using the *K-means* cluster analysis program developed by Kintigh and Ammerman (1982). This method was

employed because it is a simple non-hierarchical program that can be applied to two-dimensional spatial coordinates of a set of points. Its application in this context is to determine if specific artifact classes can be formed into a set of groups based on their pure spatial location. These groups, should they exhibit robust patterning, may then be related to specific morphological features in the cave. In this research context, the approach is superior to point pattern methods such as the nearest neighbor analysis. Point pattern methods are generally concerned with the evaluation of the degree to which the individual members of a single artifact class have a tendency to be distributed randomly across a space, homogeneously, or clumped together with reference only to members of that class (Bailey and Gatrell 1995:75). These methods are powerful and they are based on the assumption that the spatial relationship of the members of that single class of artifacts vis-à-vis one another is *intrinsically* more important than the degree of spatial proximity of those artifacts to members of a different artifact class.

In contrast, pure locational clustering is not specifically concerned with a single artifact class, but instead the degree to which members of different artifact classes are found in close spatial proximity. The content of these clusters can then be evaluated to gain insights into past behaviors. This approach has the advantage of not weighing a priori any specific artifact class more than another. Instead, the method seeks to define "natural" groupings of objects across a space. While it is necessary to acknowledge that these methods often impose a structure on a data set, experimental studies have shown that *K-means* clustering generally provides excellent recovery of known data structure, especially when patterning is strong within the data (Aldenderfer and Blashfield 1984:48-49).

The number of clusters to be generated by the *K-means* program is determined by the user. The *K-means* algorithm allocates each point to one of a specified number of clusters and attempts to minimize the global goodness-of-fit measures by using an SSE (sum squared error). This is the distance from each point to the centroid of the cluster. Some programs allow the operator to view plot files of the SSE data in order to determine which number of clusters used produced the best goodness-of-fit configuration, but these programs can only handle small data sets. In order to handle the large ATM data set, it was necessary to run the program in SPSS. Unfortunately, SPSS does not generate SSE plots, and although SSE's were numerically generated, they were produced by using a linear function, which was ill-suited for the ATM spatial data.

New methodology was developed to determine the ideal number clusters used for the *K-means* analysis. Although one option was to estimate the number based on perusal of the data, this was rejected for two reasons. First, it would have introduced bias to the data and defeated the purpose of numerical clustering. Secondly, not all of the points were well clustered and decisions on the number of clusters present in these areas would have been difficult if not arbitrary. Instead the aid of another computer program the LDEN (local density analysis) was enlisted.

Local Density Analysis

The LDEN, or local density analysis, proposed by Johnson (1976) is a global measure designed to compute densities of artifact classes within a fixed radius of each point. Using Data Set 1, which included all 1408 artifact fragments and *x,y* spatial coordinates generated by the GIS program, a LDEN was conducted on the data. The

LDEN was iterated beginning at .10m, and then increasing to .25m, and increasing in .25m increments to 3m. The program was directed to produce a plot file of the results. The plot file that showed the highest local density coefficients of the spatial data occurred at the .25m radii. Using ArcView, a .25m buffer was created around each of the 1408 artifact points, and overlapping buffers were dissolved by the program resulting in 252 polygons (Fig. 5-1).

Test of Best Fit

The *K-means* analysis was then initiated using the spatial data (*x*,*y* coordinates) from Data Set 1 and directed to generate 252 clusters. Before importing this data into ArcView for further analysis, this cluster number was tested for best fit against higher and lower numbered configurations using the coefficient of variation (CV). The CV is defined as the ratio of the standard deviation to the mean:

$$CV = \frac{s}{X}$$

It is used to compare variables with unequal means by comparing the relative variability of a frequency distribution. Relatively less dispersed variables have lower coefficients of variation.

K-means clusters were created for eight cluster configurations using the Data Set 1 spatial coordinates. The cluster configuration numbers chosen were: 240, 250, 251, 252, 253, 254, 255, and 264. Seven numbered clusters from each configuration generated by the *K-means* were chosen at random for analysis. They were cluster numbers 9, 23, 78, 158, 175, and 176. The CV for the *x*,*y* coordinates for cluster numbers of each cluster configuration were added together and compared (Appendix M). The results of this test

showed that cluster configuration 252 had the lowest combined CV (.026554), demonstrating less dispersal in the variables, therefore producing the best goodness-of-fit. (Appendix N).

Creating a Cluster Coverage in GIS

Using the 252 *K-means* cluster configuration, a cluster attribute table was produced in ArcView. Each of the 1408 artifacts was assigned a cluster number. Numbers of artifacts in each cluster were highlighted and polygons were created using highlighted artifact points as nodes. This graphic was converted to a shapefile and imported into Arc Info. Topology was built in Arc Info and the new built coverage was re-introduced into ArcView.

The advantage of the new cluster coverage was that the clusters were smaller and more clearly defined than those generated from GIS buffers and each cluster had its own unique shape. Figure 5-2 illustrates shape and size differences between the two cluster coverages. The advantage of the *K-means* clusters is that they provided a more accurate unit of analysis allowed for a better spatial resolution. The cluster coverage also reduced the data by combining artifact fragments into single units and eliminating the problem of unequal weighting in artifact counts.

Spatial Analyses of Clusters

Proximity of Artifact Clusters to Cave Features

Using the newly generated *K-mean* clustering results, tests were performed to determine the proximity of clusters to cave features. These tests were run on the same

features used in the preliminary analysis. Using ArcView, buffer areas of .10m, .25m, .5m, 1m and 1.5m surrounded components of the line and polygon feature coverages. Smaller buffers were used in this analysis since it was not necessary to increase buffers to incorporate artifact clusters. Each buffer increment was applied to the following feature classes: 1) walls and walkways, 2) boulders, and 3) stalagmitic/stalacto-stalagmitic columns. Walls and walkways were evaluated by directing the computer to locate clusters within the distance of the line coverage. The feature classes of niches, alcoves, and breakdown, were evaluated by asking for clusters that intersected these features. Pools were evaluated on presence/absence basis and were manually selected. Some clusters contained artifacts points located withinin pools and with those that were not. In these cases, the cluster was considered to be in a pool.

Results

Using the 252 *K-means* clusters created in GIS, the following results were generated (Appendix O). Buffer zones were generated for .10m, .25m, .50m .75m and 1m buffer levels. At the .25m buffer level, 154% of the data was represented. The results were as follows: 1) pools (60%), 2) walls & walkways (28%), 3) boulders (23%), 4) stalagmitic/stalacto-stalagmitic columns (17%), 5) niches (12%), 6) alcoves (7%) and 7) breakdown (7%). If the pools category, discussed earlier as covering a significant area of the floor space and overlapping many other categories is considered separately, the remaining categories account for 94% of the artifacts. This indicates that there is reduction in category overlap at this level, suggesting that this buffer level is the best representation of the data since it is the closest to 100%. When ranked hierarchically,

categories remain in the same order at all calculated buffer zones (Appendix 0), although the percentages vary due to category overlap.

Frequency Index of *K-means* Clusters Based on Area

A further question was whether the differences in spatial areas of morphological features effected the results of the above data. To address this issue, a frequency index was created to compare expected values to actual values of the frequency of *K-means* clusters in proximity to cave features. Because some feature categories cover much more surface area than others, it would be expected that more artifact clusters should occur in larger spatial areas and fewer cases in or near features with smaller summed areas. The index was created to correct for the difference in area size.

Areas of cave features represented by polygons were derived using ArcView tables. Features represented by line coverages or those features requiring buffers for analysis such as walls and walkways, boulders, and stalagmitic/stalacto-stalagmitic columns, were represented by graphics and converted to shapefiles. Using Arc/Info, topology was built for these shapefiles converting them to polygon coverages in order to derive their areas. The pools category was represented by both line and polygon coverages and the graphic was produced by digitizing a polygon graphic in ArcView and converting it to a coverage as described above. The sums of the areas of feature categories, produced by ArcView, were used for analysis and are listed in Appendix P.

Expected values were calculated by dividing the total number of *K-means* clusters (n=252) into the total area of the Main Chamber (4,540m^2). Given an even distribution, one cluster would be expected every .055506608 square meters. This number was then

divided into the sum of the areas of cave feature categories in order to create an expected value for each feature category. For the categories of boulders, stalagmitic/stalacto-stalagmitic columns, and walls and walkways, areas for .10m, .25m, .50m, .75m, and 1m buffers were tabulated (Appendix P).

Actual values of the proximity of *K-means* clusters to cave feature categories had been previously derived using ArcView. To calculate the frequency index, expected values were divided into the actual values. Values exceeding 1 indicated that there were more actual than expected clusters whereas values below 1 indicated more expected than actual clusters (See Appendix P).

Results

Values exceeded 1 for all feature categories at all buffer levels with the exception of the breakdown category. This indicates that all other feature categories were statistically relevant. The numerical index may be thought of as the number of artifact occurrences within a feature category beyond or below the expected density. In order for these numbers to be meaningful it is best to view them in ranked order so that comparisons can be drawn between categories:

	Area	Frequency Index
1. Niches	14.95	22.8960
2. Alcoves	64.24	5.5971
3. Boulders	186.69	5.0058
4. Stalagmitic/stalacto-stalagmitic formations	354.46	2.1903
5. Walls and Walkways	540.88	2.3316
6. Pools	1853.30	1.4776
7. Breakdown	1071.70	0.3026

In this density model, the highest artifact densities are in the smallest spaces. The largest area, the breakdown category, showed a minimal artifact deposition density well

below 1. The feature categories of niches, alcoves, and boulders show elevated densities. Although artifact scatter was less dense in the case of stalagmitic/stalacto-stalagmitic formations, walls and walkways, and pools, results were still significant.

Discussion

The first conclusion that can be drawn from these results is that artifacts arrived at their current locations by intentional placement. This data is supported by the observation that many artifacts were cached in niches or placed in stacks. Although the categories of cave features were imposed on the data, at the .25m buffer size (minus the pools category), all of the data were accounted for with only 2% overlap. This suggests that the categories may in fact represent an emic reality rather than a strictly heuristic tool. The following is a discussion of the categories of pools, stalacto-stalagmitic columns, boulders, and niches and alcoves. The category of walls and walkways will be discussed at length in the next chapter. Twenty eight percent of the artifact clusters were placed adjacent to walls and walkways and not all walls and walkways were utilized. As argued in Chapter 6, this artifact deposition pattern designated a "linear scatter," correlates with ritual pathways reported in ethnographic and ethnohistoric texts.

Pools

As Vernon Scarborough (1992) argued, water and its management may have been the single most important resource in the development and maintenance of Maya society. Therefore, it comes as no surprise that the most prominent feature category of artifact deposition frequency was pools, which are areas of intermittently standing water.

Despite the fact that density measures were low in this category due to its large spatial area, it was an important observation that 51% of the artifacts in the cave were placed on the cave floor in gour pools. Of the 1408 total artifacts recorded, 38% were jar forms, and of these jars, 40% were placed in pools.

The salience of this category can be further demonstrated by examining the placement of human remains in the Main Chamber. Ten skeletons from the population of thirteen were placed in pools. Their association with water suggests a connection to rain or water deities, particularly since seven of the ten are sub-adults. According to ethnographic and ethnohistoric data, children were the sacrifice *par excellence* in rain related rituals. This is well documented throughout Mesoamerica both in central Mexico (Sahagun 1981 1-2,5,42-44,192; Nicholson 1976: Table 4; Heyden 1981:19-20; Brundage 1985:54-56), and the Guatemalan highlands (Fuentes y Guzman 1932:336). In Yucatan, the drowning of children in the Cenote of Sacrifice at Chichen Itza was documented both ethnohistorically (Tozzer 1941:44n), and archaeologically (Hooton 1940). The practice was not limited to the Cenote at Chichen Itza but seems to have been widespread (Scholes and Roys 1938:615). Both caves and cenotes are considered *che'n* in Maya thought and are therefore cognitively related (Vogt and Stuart n.d.).

As Brady (1989) has noted, caves are closely associated with rain and fertility, the two most important concerns of agricultural people. Throughout Mesoamerica, rain deities are thought to dwell in caves, particularly the Maya *Cha*c, the Zapotec *Cocijo*, and the Central Mexican *Tlaloc* (Miller and Taube 1993:184). However, not all rain deities are male. Male gods are often related to falling rain are often distinguished from female deities that are the patrons of standing water (Ibid.). Although male deities may have

been propitiated caves, it is unwise to assume that all cave offerings are intended as gifts for rain gods. Objects placed in pools in the Main Chamber may have been intended for more than one deity or may have invoked specific events.

In Maya myth the world is established in a series of creations. A great flood destroyed the previous creation to prepare for the current creation. It is a female deity who is responsible for this destructive and creative process that Taube (1988a:143-150) has associated with the 4 Ahau 8 Kumk'u creation event. She is illustrated in the Dresden Codex p.74 (Fig. 5-3) as an old woman who hangs in the sky pouring water from an inverted water jar. Taube identified her as Goddess O, the Moon Goddess, named in the codex as *Chac Chel*.

Taube draws on evidence from both ethnohistorical sources and the Maya codices to illustrate the relationship between the flood and year renewal rites. He argued that the flood event embodied a chaotic destructive force preceding creation. The flood provided a direct contrast between chaos and order that preceded the establishment of the four corners of the world and the erecting of the world tree in the establishment of the cosmos.

Not only was the flood vital in the establishment of the original cosmos, but it remained an integral part of the re-creation of the world in ritual. For instance, ethnographically, the ancient goddess may still be witnessed today presiding over the renewal of the cosmos. In the renewal ceremonies held at Easter in Santiago Atitlan, studied by Allen Christenson (1998:176), a *Monumento,* representing the first mountain of creation and the rebirth of the earth, is symbolically erected using scaffolding. Overseeing the building of the *Monumento* and therefore the creation of the world is a representative of Maria Castellana, who Christenson identifies as the creatrix, a divinity

that appears in nearly all Atiteco creation myths (Ibid.: 87). The moon is one of her principal symbols and her representative is an old woman. During the *Monumento's* construction, she waves a censer of incense to create a cloud of smoke (dark rain cloud) that is understood to be issuing from the mountain as if it were a sacred cave (Ibid.: 95).

Tarn and Prechtel (1986:176) point out that besides Maria Castellana, there are a number of Marias and that Maria in all her forms represents standing water. Maria Castellana is associated with the moon, which is thought to hold rainwater. During rainy season, the moon, envisioned as a vessel, turns up sideways until the water spills out (Ibid.). This could well explain the prevalence of ollas found in Maya caves.

This image agrees well with the central Mexican myth in which the wife of Tlaloc, Chalchiuhtlicue, goddess of standing water, presides over the great flood of the previous creation (Taube 1993:34). Additionally, according to Serna (1953:306), clouds that held rain were called the Cihuateteo or "Divine Women." These women descended to the Earth to bring water to make plants grow and were the deified women who died in childbirth (Ibid.).

Although many of the offerings, in the Main Chamber may have been intended for rain gods to insure proper amounts of rainfall, it is also likely that fertility rites such as earth and/or calendrical renewal ceremonies associated with water or the flood of creation, could have taken place. Ethnographic and iconographic evidence indicates that caves were in fact a venue for new year rituals. For instance, Tozzer (in LaFarge 1947:122) discussed a new year rite among the Lacandon. In the ritual, two turkeys were sacrificed and their blood mixed with copal and burned. A bit of the blood was reserved

and placed in two small gourds. One was taken to the cave Yalan Na' where it was put beside a pool of water. If the offering went well, the water took the gourd away, cleaned and returned it.

In Santa Eulalia, divination by prayer makers is conducted in a cave during the *uayeb*, a liminal five-day period at the end of the Maya calendar year (LaFarge 1947:128). The divination is an annual prophecy for the community given by the "Old Father and Old Mother." According to Christenson, near Santiago Atitlan, a light appears inside the cave of *Paq'alib'al* at New Year's (1998:86). Among the Mixe (Lipp 1991:48), on New Year's Eve, a red, a yellow, and a blue light appear in the mountains to indicate the location of buried treasure and on the following day, sacrificial rites and a feast are held within a cave on Granary Mountain. Likewise in Mitla, Oaxaca, Charles Leslie (1960:77,95) reported that on New Year's Eve, the Zapotecs go to a cave to make requests of the "the devil-who-gave-wealth."

In a personal communication, Taube (2000) has suggested that in the Dresden Codex on pages 27 and 28, the U-shaped devices upon which the year-bearer possums stand are caves (Fig.5-4). Taube (1988a:194) also points out that on Naranjo Altar 1, adjacent to a 3 *Uayeb* date is a bone device shaped in the form of a quincunx, a well-known symbol for a cave (Fig. 5-5). The *Uayeb* is a 5-day period at the end of the 360 day year. It precedes the first day of the new year and is considered an inauspicious liminal period. In a personal communication to Taube (1988a:194), Stephen Houston tentatively suggested that on the *Uayeb* glyph, the U-shaped superfix attached to the T548 tun sign, is a skeletal maw representing a cave entrance to the Underworld. If he is

correct, this evidence would count as strong evidence that *Uayeb* events are directly associated with caves.

Stalacto-stalagmitic Columns

Artifacts surrounding stalacto-stalagmitic or stalagmitic formations comprise 17% of the assemblage at the .25m buffer level and have a density of 2.1903, or over twice the expected value. We know very little about the modern, much less ancient, meaning of these features. The most notable example of the use of a stalacto-stalagmitic column was at Balankanche (Andrews 1970), a cave in Yucatan. Not only was the column utilized by the ancient Maya but was also employed in a modern ceremony held for the purpose of protecting the archaeologists working at the site. The *h'men* (shaman) chose the large column located in the first chamber of the cave as the venue for a *ch'a'chaak* ceremony. He stated that the large column was the "Throne of the Balam" (1970:11). It functioned as an altar for the ceremony and offerings were placed around the base of the column. What is interesting is that the ancient Maya must also have considered this feature important since the largest group of effigy censors found in the cave (Group 1) was found around this column. Andrews (1970:9) noted that there were a total of six foci of ancient artifact deposits, and that all were associated with either bodies of water or "striking stalagmitic formations."

Stalacto-stalagmitic columns are the focus of ancient rituals in other caves as well. In Petroglyph Cave in Belize, MacLeod and Reents-Budet (1997:5,36-43) reported that Burial Chamber I contained some of the most spectacular natural drip stone formations in the cave. In this area, they found the remains of at least seven adults and

eight infants, pottery, bone needles, obsidian blades, shells carved to resemble human skulls, snake skeletons and a slate-backed iron pyrite mirror (Ibid. 5). Cache Area I was located between stalacto-stalagmitic columns and flowstone. Cached in niches in the formations were pottery, shell and bone artifacts, 2 perforated dog teeth, and 3 snake skeletons (MacLeod and Reents-Budet 1997:39-40; Reents-Budet 1980:19). Also, in Burial Chamber II, a metate was cached on top of a large stalagmite (Reents-Budet 1980:18).

Reents and MacLeod (1997:37) noted the "tree-like" appearance of these features. It is tempting to draw comparisons between world trees found in Maya mythology at the four corners and center of the cosmos (Reilly in Weaver 1993:64; Reilly 1994:87; J. E. Thompson 1970) with "tree-like" calcite formations. This is particularly intriguing since the roots of the tree were thought be in the Underworld.

Among the modern Maya, cognitive associations of calcite formations are with stone, water, and trees. The Yucatec term for speleothems is *xix ha tunich* or "drip-water stone" (Barrera Vasquez et al. 1980:946) suggesting a transformative property indicative of the "growth of the stone." This helps explain why, on a recent trip to Oaxaca, while visiting the caves of San Sebastián the local guide described stalacto-stalagmitic columns as "growing like trees up from the ground."

Boulders

The feature category of boulders is of particular interest not only because 23% of the clusters fall on or within .25m of boulders, but also that the density of clusters around

these features is high as compared with other categories. The category includes a range of freestanding rocks ranging from volleyball size to those weighing several tons.

These features have been typically overlooked as sacred objects perhaps since rocks are considered worthless to the modern westerner. However, stone takes on a more important role in the religious life of other cultures. Mircea Eliade (1959:155-156) characterized the cross-cultural religious significance of stone as demonstrating power, hardness, and permanence. He stated, "..the existence of the stone reveals to man the nature of an *absolute existence*, beyond time, invulnerable to becoming," in other words, immortality.

Ethnographic and ethnohistoric accounts indicated that rocks were important ritual objects to the Maya. For instance, Tozzer (1941:78) recounts an 1805 report by a Yucatecan Jesuit, D. Domingo Rodriquez in which, there was a list of ritual objects that had been destroyed by the church. Besides 5000 idols, 27 printed texts, and 197 vases, there were "13 great stones which served as altars" and "22 small stones of various forms."

Maya altars are often associated with stone. Friedel, Schele, and Parker (1993) have drawn a parallel between perishable table altars used by modern h'men and ancient stone table altars. Their understanding is that all altars represent the Maya cosmic center or axis mundi. Other ethnographic accounts suggest that stones serve as benches or seats for deities. Bassie-Sweet (1996:93-95), points out that in the Dresden codex Chac is seated on benches, and that in the cave setting, modified ledges or flat stones are often called the "bench" of the deity.

While David Friedel (Friedel, Schele, and Parker 1993:179) was excavating at Yaxuna, local villagers became deeply concerned over the removal of some carved stones from the site. Friedel did not understand the nature of the problem and tried to convince them that sometimes artifacts had to be removed for analysis. Ultimately the stones remained and Friedel concluded, "...I now know why the matter loomed so large: such stones are likely *k'an che',* seats of the supernaturals."

Many stone altars have been reported in caves. Sosa (1985:414) reported that he was taken to a cave, which, according to his *h'men* informant, was the home of *yum báalum,* a dwarf-like protector of the community. The form of the cave entrance was described as "the snake's mouth," and the rock ledges and formations at the entrance as "his bench."

Tozzer (1907:87) reported that the Lacandon place carved stones called "idols" at the base of insensarios and Soustelle (1961:59) indicated that the stones were taken from sacred caves. Robert Bruce (1975:80), also working among the Lacandon, stated that these stones are the most sacred of all ritual objects and are referred to *k'anché k'uh*, which is translated as "the seat of the god" or "the holy seat." They function as a place on which the god may sit in the fire of the burning incense during ceremonies. The stones were originally taken from some shrine related to the god in question and considered to be one of his possessions.

LaFarge (1947:128) found stone altars in a cave near Santa Eulalia. He described the altars as "...a flat ledge in the rock, known as *mesas*, although, in fact, they are no sense tables." This suggests that rock altars in caves are analogous to but not morphologically identical to *mesas* used by ritual specialists in other venues.

In a modern ceremony at Balankanche, witnessed by Andrews (1970:11), offerings were left on top of rocks in the "Water Chamber." It was on this same group of rocks that Andrews found the most extensive group of ancient offerings in the cave suggesting that the ancient Maya recognized these features as salient ritual venues.

Located in highland Guatemala at Espuipulas is Cave 2, a man-made cave situated along the Rio Chacalapa less than 1 km south of the basilica erected to the cult of the Black Christ. Throughout the cave, the floor is littered with stones (Brady and Veni 1992:155). Brady reports that stones have been stacked to form low, crude altars.

Outside of the Maya area in Sierra de Puebla, Mexico, Knab (2000:31) described a local cave near San Martín Zinacapan. At arriving at the entrance of the cave, Knab spots "an enormous rock that had obviously fallen long ago from the ceiling of the cave." This, according to Knab was the "earth altar."

In the Main Chamber, artifact placement on top of or within .25 m of boulders suggests that freestanding stones were used as altars or benches for the deities as the ethnographic literature and iconography suggests. Although rocks in caves are not morphologically similar to altars used in surface contexts, they apparently serve as analogs to these features.

Niches and Alcoves

Niches and alcoves are topologically related since both are restricted spaces. The difference between the two involves the human interaction with space. For this study, niches by definition are too small to enter whereas alcoves are large enough to allow access. Both niches and alcoves are located in every utilized area of the Main Chamber.

Of the 43 niches and alcoves, only 5 were associated with the gour pools that covered much of the chamber floor. This indicates that these two categories of artifact deposition functioned independently of placement in pools and suggests that this may represent different ritual behaviors.

Forty-nine of the 252 clusters were located in niches or alcoves. Thirty clusters were found in niches and 19 in alcoves. In combination, 20% of the total number of artifact clusters were represented by these categories. Cluster densities for both categories were very high, and niches exhibited the greatest density of any category at 22.896 times the expected value.

Contained within niches and alcoves in the Main Chamber were fragments of pottery jars, bowls, dishes, shoe-shaped vessels, manos and metate fragments, animal bones, obsidian and quartzite flakes, speleothems, and human remains. What remains unclear is why some objects were placed in restricted spaces whereas the majority of artifacts were scattered across the floor or deposited adjacent to walls and walkways.

Brady (1989:402) observed that in the tunnel system at Naj Tunich there was a preference for restricted spaces in spatial utilization patterns. Activity areas had a tendency to be located against cave walls, not in the center of passages. He suggested that these patterns of deposition represented private rituals restricted to one or two individuals. However, Brady's examples may be a manifestation of two separate behavioral patterns. In the case of alcoves that may be entered by one or few people, the pattern may well represent private rituals as Brady proposes and may also suggest a more esoteric component of a larger ritual. Alternatively, artifacts located in niches and overhangs along walls in the tunnel system, could be the results of deposition along ritual

routes or pathways. The placement of artifacts in niches, defined as smaller spaces for this study, may have a different and possibly more specific meaning.

The deposits found in small, enclosed spaces such as niches resemble caches found in ritual contexts at surface sites in form, although they may or may not have a similar function. Caches as defined by William Coe (1959:77) refer to subsurface hidden offerings of "one or more objects found together, but apart from burials, whose grouping and situation point to intentional interment as an offering." Coe stressed that these offerings were intentionally hidden, and suggested that caching constitutes a major offertory pattern among the Maya (Coe 1965:462). According to Coe's criteria, caches may be distinguished from storage items by their ritual content, location, and purpose.

The major difference between caches located on the surface and those found in caves is that at surface sites they are most often discovered in the fill of structures or in association with monuments, and archaeologists usually attribute them to dedicatory or termination rituals (Ibid.) Since caves are exclusively ritual spaces, cached offerings are likely to represent a variety of rituals, which may or may not include dedication and termination.

Breakdown

Although the breakdown category does not prove statistically significant in this analysis, a few comments are worthwhile. In this particular case, a qualitative assessment may be more representative than the quantitative data. It is not the number of items in the area that is instructive, but nature of the deposits, special properties of the objects, or qualities associated with the space itself. Breakdown is characterized by large boulders

and is difficult to negotiate. These areas are much drier than the rest of the cave and pooling of water was not noticed in these areas after the 1997 storm.

Only 112 artifacts organized into 17 clusters were located in the Breakdown category areas. Although their density is small compared to the large spatial area of the category, it does contain two of the 13 of the human skeletons, HR 9 and HR 10. Both individuals were positioned between large boulders. Of the human remains in the cave, only three individuals were not placed in pools and two of the three were located in the Breakdown area. What seems to be the case is that the significance of deposition in the dry areas contrasts with those placed in pools. Clearly wet areas were more heavily utilized, but the drier breakdown areas may have been preferred for specific rituals or in special circumstances.

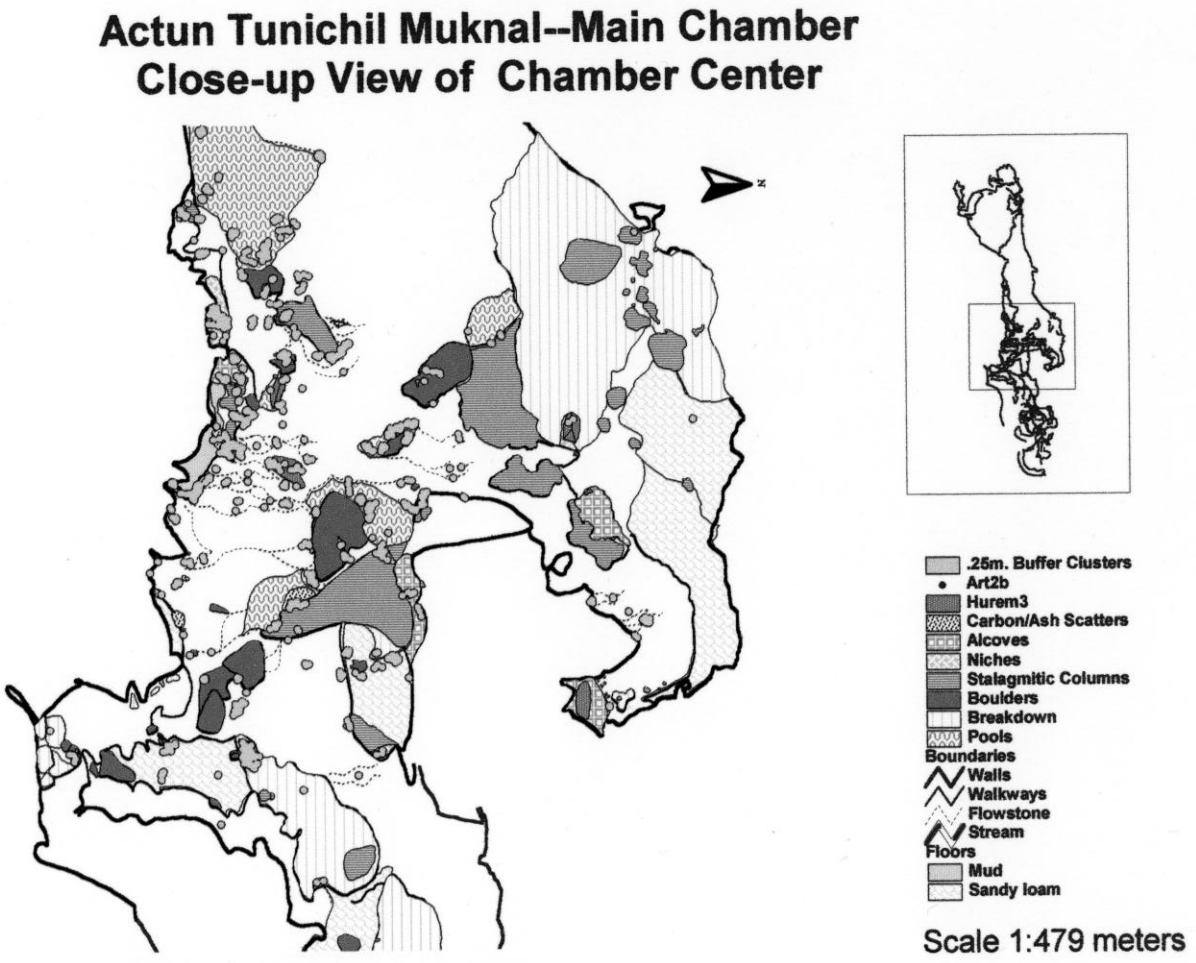


Fig. 5-1. Close-up view of the central portion of Main Chamber showing clusters produced by .25m. buffers.

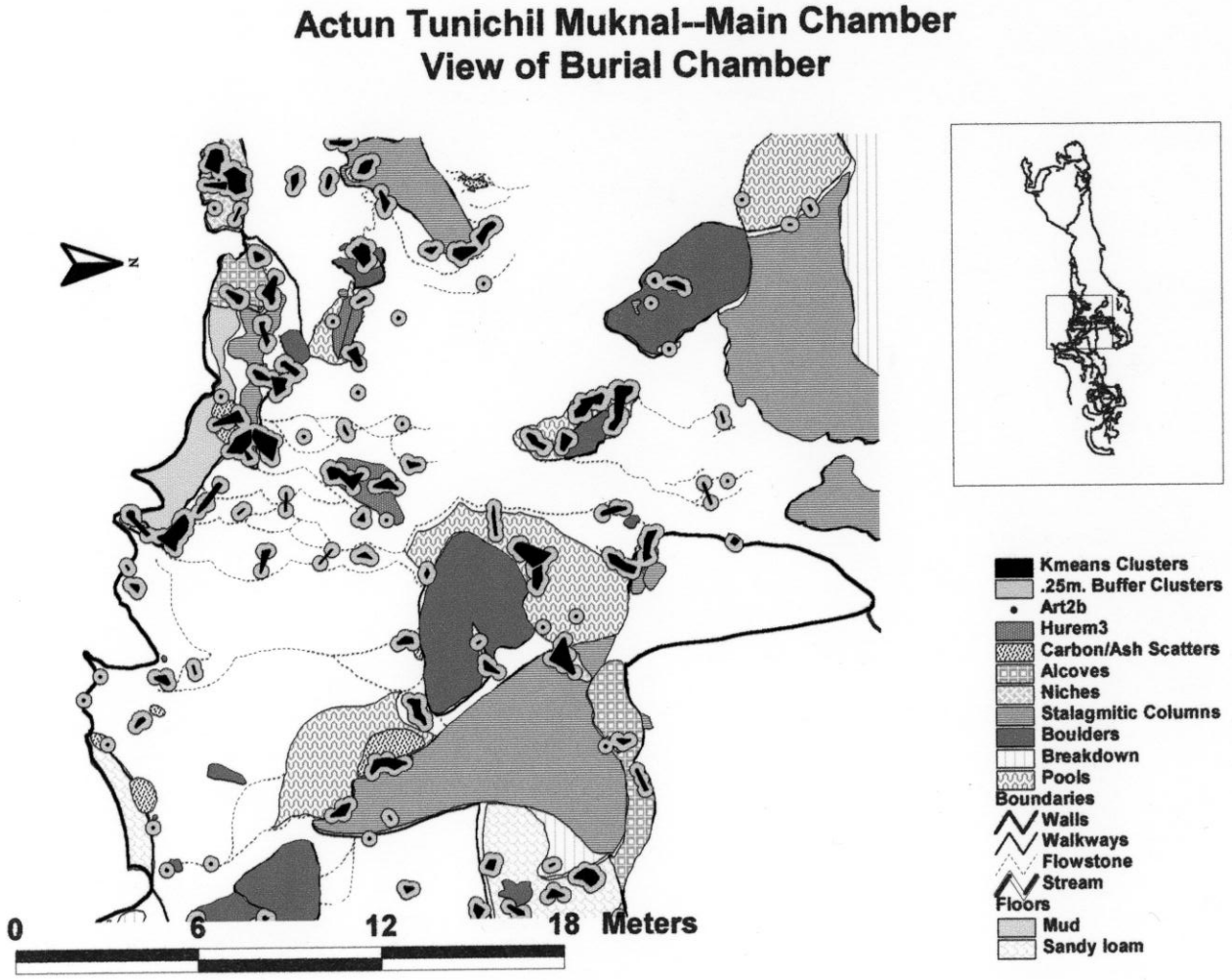


Fig. 5-2. Close-up view of Burial Chamber illustrating differences between GIS generated buffers and clusters created using GIS and K-means analysis.

Figure 5-3. Page 74 of the Dresden Codex illustrating the great flood. Goddess O hangs in the sky holding an inverted jar spilling water.

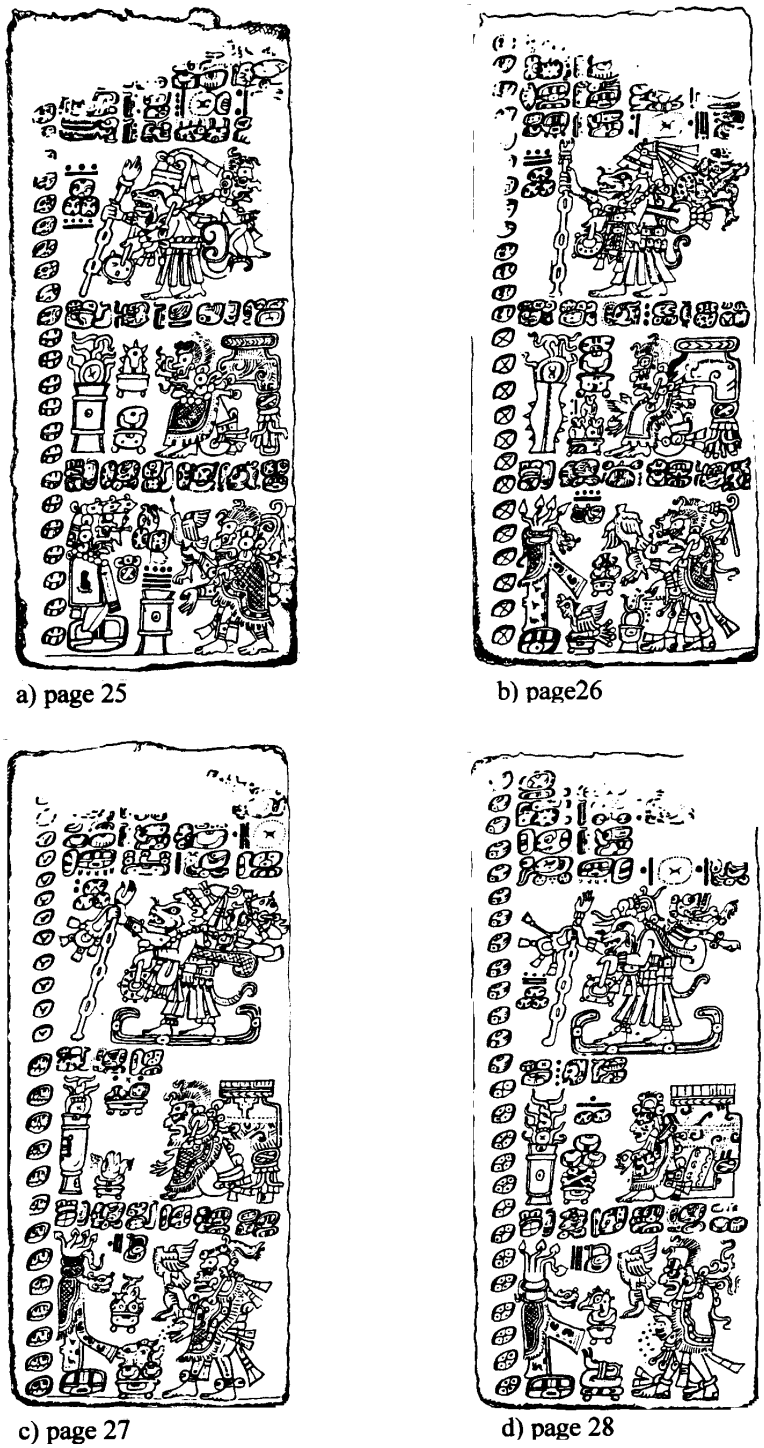


Figure 5-4. New Year pages of the Dresden Codex.
a) the year *Ben* b) the year *Eznab* c) the year *Akbal* d) the year *Lamat*

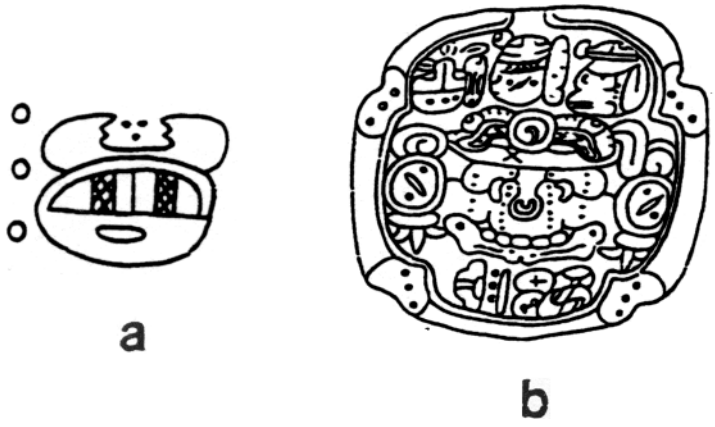


Figure 5-5. Naranjo Altar 1 shows (a) 3 *Uayeb* date adjacent to (b) a bone quincunx symbolizing a cave. (in Taube 1988a:468, following Graham 1978, II: Plate 104).

Chapter 6

Qualitative Analysis and Ethnographic Models

Cluster Patterns

In viewing the 252 artifact clusters, three patterns of artifact deposition could be identified: 1) concentrated clusters, 2) linear distributions, 3) isolated clusters located in peripheral areas (Fig. 6-1). Concentrations of clusters occurred in the eastern and middle sections of the Main Chamber in the areas of the Burial Chamber and Boot Hill. Closely spaced clusters suggest intense usage in these areas. The Burial Chamber was the area of highest artifact concentration evidenced not only by the largest number of artifacts but also by the most variation in artifact classes. Although the spatial area of the Burial Chamber comprised only 10% of the cave's total area, out of the 1408 artifacts fragments located in the Main Chamber, 557 (40%) were located in this room. Of the total number of 252 clusters, 60 (24%) were found in this area. This data may be compared with Boot Hill which also accounts for 10% of the overall spatial area. In the Boot Hill area there were 289 (20%) of the artifacts, and 41 (16%) of the clusters.

Linear Distributions

Linear distributions were defined as multiple clusters of artifacts that followed the outline of walls or walkways (Moyes and Awe 1999). Four linear scatters were identified

in the Main Chamber, each associated with one of the cardinal directions. The first was the eastern scatter, which commenced in the Creek area, just above the river at the beginning of the ascent leading to the Boot Hill area (Fig. 6-2). The artifact scatter followed the only negotiable path leading to the squeeze at the entrance to Boot Hill. Jar sherds, dish sherds, metate fragments, speleothems, and an obsidian blade found inside of a broken jar were located along the path. Concentrations of charcoal were located on the floor and inside of jar sherds.

The next two scatters were located in the middle section of the Main Chamber (Fig. 6-3). The northern scatter commenced just inside of the Ransom Chamber, and ran along the south wall of the northernmost area of the Main Chamber. The artifact scatter consisted of jar sherds and speleothems, and at the terminus of the scatter was Alcove 7, which contained a human skeleton (HR 7).

The southern scatter ran along the southernmost wall of the Burial Chamber. The scatter commenced near a group of large boulders, which functioned as a partition between the Burial Chamber and the Passage. It led to an area in the center of the chamber exhibiting dense artifact distribution and the remains of three individuals (HR 1, 2, and 3). Heavy charcoal concentrations were found along this wall and the artifact assemblage consisted mainly of jar sherds, a speleothem, and a faunal bone.

The final and most explicit example was the western scatter (Fig. 6-4). This artifact distribution ran along the westernmost wall of the cave over a large area of breakdown. The northern terminus began in the Angels's Room near HR 11, and the southern terminus ended at the entrance to the Crystal Sepulcher. An internment (HR 10) was located in the breakdown in the middle of the scatter. Charcoal and ash lenses were

abundant in the area approaching the Crystal Sepulcher. Artifacts found along this route consisted mostly of jar sherds and broken speleothems, but also contained a number of special finds including a broken shoe pot, a carved speleothem bead, a large bowl, and a dish. Also located along this pathway was the Speleothem Bridge, which had to be stepped over to gain access to the route when moving from the northern to the southern areas of the cave. In reverse, coming from the south, it had to be crossed to reach the northern areas. The artifact distribution across the breakdown delineated the easiest and *only* route across the area of roof fall.

Isolated Clusters

Isolated clusters are the third category of cluster patterning. They are located in peripheral areas such as along the outermost walls of the Main Chamber, or at the termini of crawl spaces or alcoves. Seven clusters of this type were located (Fig. 6-5). Each cluster consists of a single artifact, of which, three were smashed and four were almost completely intact.

Miller (1989) noted the most dramatic example, as the artifacts located farthest from the cave entrance (see Fig. 2-2). A small subsidiary tunnel, accessed through the Crystal Sepulcher, originates at west end of the Main Chamber and eventually rejoins the river. This tunnel was almost devoid of artifacts, but contained the sherds from three jars and a small cluster of speleothems. At the terminus, where the passage rejoins the main tunnel system, a single jar sherd containing a charcoal scatter, isolated cluster (I1), was placed on a clay mound (Michael Mirro 1998, personal communication).

Isolated cluster 2 (I2) was located in the northwest part of the Main Chamber in a small room adjacent to the Angel's Room. It is a largely intact metate placed within a group of stalagmites (see Fig. 2-32). The third isolated cluster (I3) was found in the area of breakdown that separates the Cathedral area from the West Wall. It is located high above the floor of the Main Chamber, and consists of approximately 75% of an unslipped jar broken into three fragments. The sherds contain a scatter of charcoal and ash. In an area of breakdown east of the Cathedral, located high above the Main Chamber floor (approximately 6m), is isolated cluster 4 (I4). The artifact is a single intact shoe-shaped vessel placed within a group of stalagmites (see Fig. 2-29). Located in a flat sandy area 13.5m east of I4 near the northernmost wall of the cave is isolated cluster 5 (I5), a hollow bone tube. The tube was created from a faunal long bone, and measures 8.1cm in length and 1.5cm in width. One end is smoothed and the other is fractured. Isolated cluster 6 (I6) was located in the Boot Hill area along the southernmost wall of the cave. The artifact is a red-slipped bowl (Vaca Falls red type) situated on a shelf high above the floor of the chamber near the cave ceiling. The last example is isolated cluster 7 (I7), located in the area of the Creek. The artifact is half of a wide-necked unslipped jar placed against the cave wall at the entrance to a small alcove containing no other artifacts.

Although some isolated clusters were located in areas of high elevation, others were not. This pattern of deposition seems to indicate that the remote placement of these artifacts near the outermost areas of the cave is the key factor in their placement. In cases where artifacts are placed at high elevations, it is coincidental with the fact that the cave walls curve upwards along peripheries. The pattern of these peripherally placed artifacts does not suggest that intense ritual activity occurred in these areas.

Models of Mesoamerican Spatial Cognition Cluster Distributions

The Quincuncial Model

Mircea Eliade recognized that cross-culturally, the world is perceived as having a center, or navel, from which extends four horizons projected in the four cardinal directions and referred to this square constructed from a central point as an "imago mundi" (Eliade 1959:42-45). According to Eliade, this paradigmatic cosmological model becomes, "the archetype of every creative human gesture, whatever its plane of reference may be" (ibid.). Therefore, it should not be surprising to encounter this spatial model throughout Mesoamerica. Evidence for its presence among the pre-Columbian Maya can be found in the Codex Madrid, in the layout of tombs at Rio Azul (Adams and Robichaux 1992:412), and in site construction typified by the twin pyramid complexes at Tikal (Ashmore 1991:201).

Ethnographers report that the earth is thought of as a four-sided horizontal flat plane (Gossen 1974:34; Holland 1964; Redfield and Villa Rojas 1962:114; Vogt 1976:13). In one of the most well recognized models (Fig. 6-6), Gossen (1974:34) illustrated that the sun was thought to move in a vertical circular pattern around the plane. Its rising and setting on summer and winter solstices delineated the four corners of the plane and its zenith and nadir marked the center of the square earth model.

Much of our ethnographic knowledge of Maya spatial cognition comes from the work of William Hanks (1984, 1990) who spent time among the Maya in Yucatan. He recognized that the directional principle was the cognitive spatial model at the heart of all ceremonies performed by shaman (1984:136) and has noted that among the contemporary

Maya, the quincuncial model is the basic spatial model used in ritual (1990:390-391).

Hanks (1990:299), dichotomized between the sacred and profane use of directionality by differentiating between cardinal "directions" and cardinal "places." Cardinal "directions" constitute "an abstract coordinate system, presumably fixed by features of the natural environment (terrestrial and celestial), relative to which any actor can orient himself or any other object," whereas cardinal "places" serve to totalize spatial zones (Fig. 6-7). Cardinal "places" used in ritual discourse, may be thought of as representing "mini-universes." They are conceptualized as a centroid surrounded by a four-sided polygonal structure whose sides are created by joining the four intercardinal points. Hanks considers this spatial model to be the elementary schemata upon which more complex forms may be built (Ibid.:380).

This concept, described as a "frame" by Mary Douglas (1966:63-64), divides reality, both temporally and spatially, between that which is within the frame and that which is outside of it. In Hanks' model, the frame is used to represent a totalized space conforming to any scale, ranging from a household altar to an entire community. The nature of the quincuncial frame is mereotopological in that there is a part/whole relationship between a specific frame and the larger spatial universe in which it exists. Although the earth itself is described in terms of the frame, in practical usage a frame represents a "mini-cosmos" at a smaller scale such as the community, milpa, household, or altar. Therefore, the frame may be nested within progressively larger social spaces in the way that a Chinese box may open into another and another.

Hanks' work is instrumental in providing an understanding of the purpose of the frame. Through shamanic discourse, by invoking the cardinal directions, spirits are

brought down from their celestial realms in a procedure referred to as "binding the altar" (1990:336-337). At the culmination of ceremonies, they are sent back to their spiritual abodes and the altar is said to be "untied." Hanks points out that "binding of the altar" is best thought of as creating a secure place. In his own words:

> The altar is secured in the sense that spirits are bound to absolute locations around it, at once protecting the shaman from attack by any marauding spirits in the area and also preventing the lowered spirits themselves from wandering around. Even fully beneficent spirits can cause damage when loosed…(1990:337).

The above attests to the fact that this procedure creates a zone of spiritual safety for the actors involved in order to manipulate powerful and often ambiguous beings (Ibid.:337). Hanks summarily states that "without its perimeter, a place has no unity and is potentially dangerous" (Ibid.:349).

The frame may operate at the community level on a large spatial scale and having the same protective quality. Barbara Tedlock (1982:82) reports that at Los Cipréses in highland Guatemala the priest-shaman makes a four-part pilgrimage to the mountains surrounding the town. This ritual circuit is referred to as either the "sewing and the planting" or the "stabilization" of the community. The latter is a metaphor for the firm placing of a table on its four legs so that it will not wobble or tip over in times of natural of other disasters (Ibid.).

At the village of Chan Kom in Yucatan, during the *loh*, a curing ceremony (meaning "redeem" or "free"), the participants traverse a ritual circuit to each of the four entrances of the village, and at each point bury crosses, obsidian, and salt in the road to prevent evil winds. Afterward, they proceed to the cenote and throw in 13 wooden crosses so that "the winds would not come out of it again" (Redfield and Villa Rojas 1962:176). John Sosa (1985:343,451,452) also working in Yucatan described the occurrence of the similar *loh kàah* ritual in the town of Yalcoba, but adds that it is a nighttime ceremony to propitiate the cave dwelling deity *Yum Baláam* who protects the populace from evil winds causing disease. This guardian possesses four aspects that correspond to the corners of a quadrilateral structure. During curing ceremonies, one priest/shaman walks a ritual circuit encompassing the community, leaving offerings at the corners, which he describes as "tying the edge," while another remains at the centrally located church (Ibid.:343-344). Afterwards, he walks back around in the opposite direction so that humans inside are protected (1985:362-363).

At Zinacantan, Vogt (1998:24-26) describes a house dedication ceremony designed to protect the souls of the inhabitants from the Earth Lord and from demons. A shaman leads a procession counterclockwise to each of the inside four corners of the house. Offerings are deposited at the corners (intercardinal points), at the centers of the four walls (cardinal points) and in the center of the floor, which according to Bardick, are the most susceptible places for demons to enter (Bardrick 1970 in Vogt 1998:26). Vogt also reports that when someone dies, the corpse is laid out with the head placed toward the setting sun and the area is "fenced off" within the house by household articles (1998:27) no doubt to prevent the spirit from wandering.

Hanks (1990:345) reports that in the "fixed earth" ceremony, a household rite designed to drive away a malignant spirit, the yard is spatially bound or "locked in" by traversing its perimeter and "putting in" guardian spirits by showing them their "boundary stones." A similar pattern of perimeter definition occurs in ceremonies for the laying out of milpa. The perimeter is always cut first, prayers for protection from snakes are proffered, and offerings left at the five cardinal points (Hanks 1990:362-364).

It is likely that the four linear scatters established inside of the Main Chamber represent ritual pathways described by ethnographers. Viewed collectively the pathways correspond quite literally to the four cardinal directions (Fig. 6-8). However, for this to correlate with the Maya frame representing the layout of the cosmos, a central feature would be expected. The three-speleothem cluster representing the three-stone hearth of Maya creation completes the fifth central element of the quincuncial frame (see Chapter 4 for a detailed description of the feature). Not only is the cluster central to the smaller chamber in which it is located, but also to the entire Main Chamber. When the spatial configuration in the cave is juxtaposed with Hanks' model, the similarity to the Maya ideal is quite apparent (Moyes 1998; Moyes and Awe 1998, 1999; Fig. 6-9).

Alternative Spatial Models

Although the quincuncial frame is an important and often utilized model in Mesoamerican cognitive structure, other models also exist. For example, Taube (1988a:163-168) presents evidence from ethnohistoric texts for a circular world model. Early colonial dictionaries, the Chilam Balam of Chumayel, and the Chilam Balam of Kaua make reference to, or show maps of a circular earth. Taube also points out that in

prehispanic Central Mexico, the circular earth could be characterized by a round flat mirror or round calendar stone (1988a:166). A round globular turtle could also represent the circular earth as evidenced by the late Postclassic stone tortoise altar figures discovered at Mayapan or in the Classic Period depictions of the Maize God raising from a cleft in a turtle carapace found in Maya iconography (1988a:167). Taube (1988b) has suggested that turtles also represent time/space models signifying the 20-year *katun* cycles in Postclassic Yucatan.

In both contemporary and colonial representations of the circular world, a cross or axis divides the circle into quadrants (Taube 1988a:168). This may be an ancient concept since an Esperanza phase bowl depicting turtles with crosses on their backs was found in Tomb A-VI at Kaminaljuyu (Kidder, Jennings, and Shook 1946:185). Additionally, pecked designs illustrating two concentric circles divided into quadrants by crossed lines were found at both Teotihuacan (Aveni et al. 1978; Aveni 2000) and Uaxactun (Smith 1950: 21-22, fig.15a). It has been suggested that these are time/space models that correlate calendrical cycles with astronomical events (Aveni 2000; Broda 2000).

More than one spatial model may operate simultaneously. For instance, in rituals of foundation both the circular and quadrilateral worlds were referenced. In his study of ethnohistoric documents, Angel García-Zambrano (1994) has pointed out that to establish communities, rituals of foundation were conducted throughout Mesoamerica by the Zapotecs, Mayas, Mixtecs, Tarascans and Otomis. The purpose of foundation rituals was to establish or reestablish territorial boundaries. According to García-Zambrano (1994:220), the outward meaning of the ceremonies was to erect a "mini-cosmos"

through ritual. It was represented as an abstract time/space model of the universe of a square within a circle. The circle represented time and the square space.

This complex of rituals began with the identification of five mountains. Four were considered the periphery of the community and the fifth along with its water hole became the center. From the central mountain, a group beat the boundaries of the new community carrying ropes constructed of boughs and grasses that enclosed the space, establishing borders along community perimeters. Although the visual referents for the demarcation of the boundaries formed a square with the four cardinal mountains, according to García-Zambrano (1994:219), the procession followed a circular pattern. This pattern of movement agrees well with Gossen's model of the cosmos in which ritual circuits are depicted as moving in an oval pattern (1974:34; see Fig. 6-6).

Following the beating of the boundaries, the group moved to the top of the central mountain where two additional ceremonies occurred. A smaller circle of boughs was constructed mirroring the larger circle used to mark the peripheries (Alva Ixtilxochitl 1975:220). This was set on fire to make sacred the center and promote the transit of the sun through the sky. Following this event arrows were shot into the four cardinal directions. The ritual enactment incorporates both quincuncial and circular patterns. The resulting spatial pattern was modeled by García-Zambrano as a set of squares encompassed by a circle (1994:220; Fig. 6-10). This agrees well with Hanks' (1990:350) observation that among the Yucatec Maya there is interplay between round and quadrilateral space in cosmological models. Hanks' informant provided a drawing of a cross section of his conceptual universe, which illustrated the earth as a quadrilateral flat plane inside of a sphere (Hanks 1990.:305; Fig. 7.3). William Holland (1964:14-15)

working in San Andrés Larrainzar, described a similar model in which the sky is thought of as a cup over the flat earth. Were these circular sky/flat earth models viewed from above in two dimensions, they would look like a square earth contained within a circle, strongly resembling the model of foundation rituals reported by García-Zambrano.

For archaeologists, the most important thing about cognitive spatial models is not as much how the universe was conceived, but how that conceptualization affected behavior. Although Hanks' model of "cardinal places" emphasizes the intercardinal points as the corners of the spatial frame, García-Zambrano emphasizes the square earth in his model. However, in terms of behavior they are in agreement, since in foundation rituals, the "arrowing" or ritual marking of the cardinal directions is directed to the intercardinal points (see Figure 6-10).

As a part of foundation rituals, stone markers and/or stelae were set along borders to provide permanent boundary designations. These provided an enduring visual representation of the community boundaries to warn trespassers that intruders would not be tolerated (García-Zambrano 1994:219). Hanks (1990:356) reported a similar type of boundary marking in the modern community of Oxkutzcab. Several major boundaries separate the community from its neighbors and are marked with stone mounds. The markers are thought to have been placed in the woods by foreigners, wealthy men, or the town and may also include the property lines of wealthy ranch owners. They define the permanent limits beyond which one cannot go in choosing land for milpa and if anyone crosses these markers he is denounced.

This same marking of boundaries is present in Zinacantecan *K'in Krus* rites or waterhole ceremonies reported by Vogt (1976:111-115; 1969:690-695). These renewal

rites encircle the culturally utilized parts of the local environment associated with particular lineage groups in order to compensate the Earth Lord for the use natural resources (Vogt 1976:114). Ritual stations are determined by features of the natural landscape such caves, waterholes, and rocks, as well as house cross shrines of local officials. Offerings are given to the Earth Lord at stations constrained by geographical landmarks. As Vogt has suggested (1969:391), the definition of territorial geographic space is an important feature of Maya spatial cognition.

In viewing the positions of the seven isolated clusters in the Main Chamber (see Fig. 6-5), their placement does not correspond to the quincuncial model which is so often used in Maya ritual. Their positions along the outside walls of the chamber (I2, I3, I4, I5, I6) and in areas where further access is terminated (I1,I7), suggests that these artifacts are boundary markers. Their location along the natural perimeters of the Main Chamber appears to enclose the frame created by linear scatters creating a configuration similar to that reported for foundation rituals. A comparison between illustrations of the cluster patterns found in the Main Chamber and García-Zambrano's spatial model illustrates the similarities between the use of space in both instances (Fig. 6-11). It is likely that the placement of artifacts along peripheral boundaries within the cave interior represents the delineation of social space and are analogous to the beating of the boundaries in foundation rites or *K'in Krus* renewal rituals. Although stone markers were used to reify boundaries in foundation rituals, artifact deposits appear to have been substituted to permanently mark cave perimeters.

Summary

Ethnographic and ethnohistoric research suggests that although models of the spatial aspects of ritual behavior are commonly based on a quincuncial template, rites of foundation may utilize a more complex geographic configuration. In the cave, artifact cluster patterns closely resemble models of foundation rituals in which a larger time/space/sky configuration encircles the quincuncial frame. The larger configuration is defined in the cave by artifact deposits located in isolated areas and identified as boundary markers. Among the modern Maya concern with ritually delineated boundaries can be demonstrated and comparative ethnographic data from these contexts suggests that their establishment within the cave may have been an important means of ritually defining a social universe.

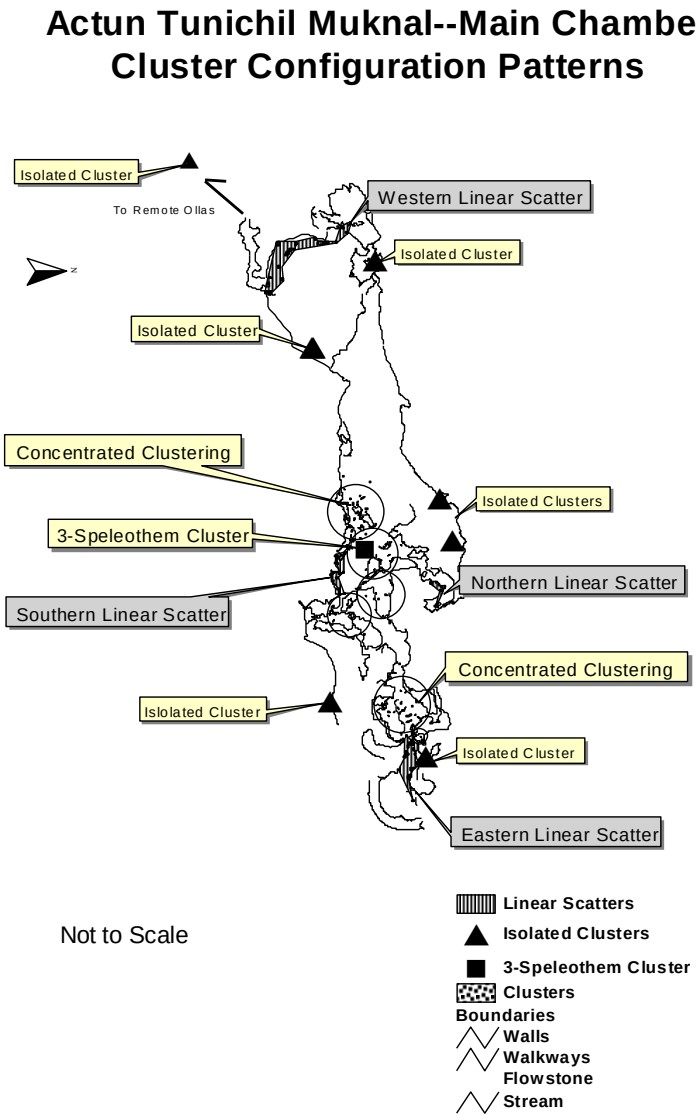


Figure 6-1. Map of Main Chamber illustrating cluster concentrations, linear scatters, and isolated clusters. Cluster concentrations are circled.

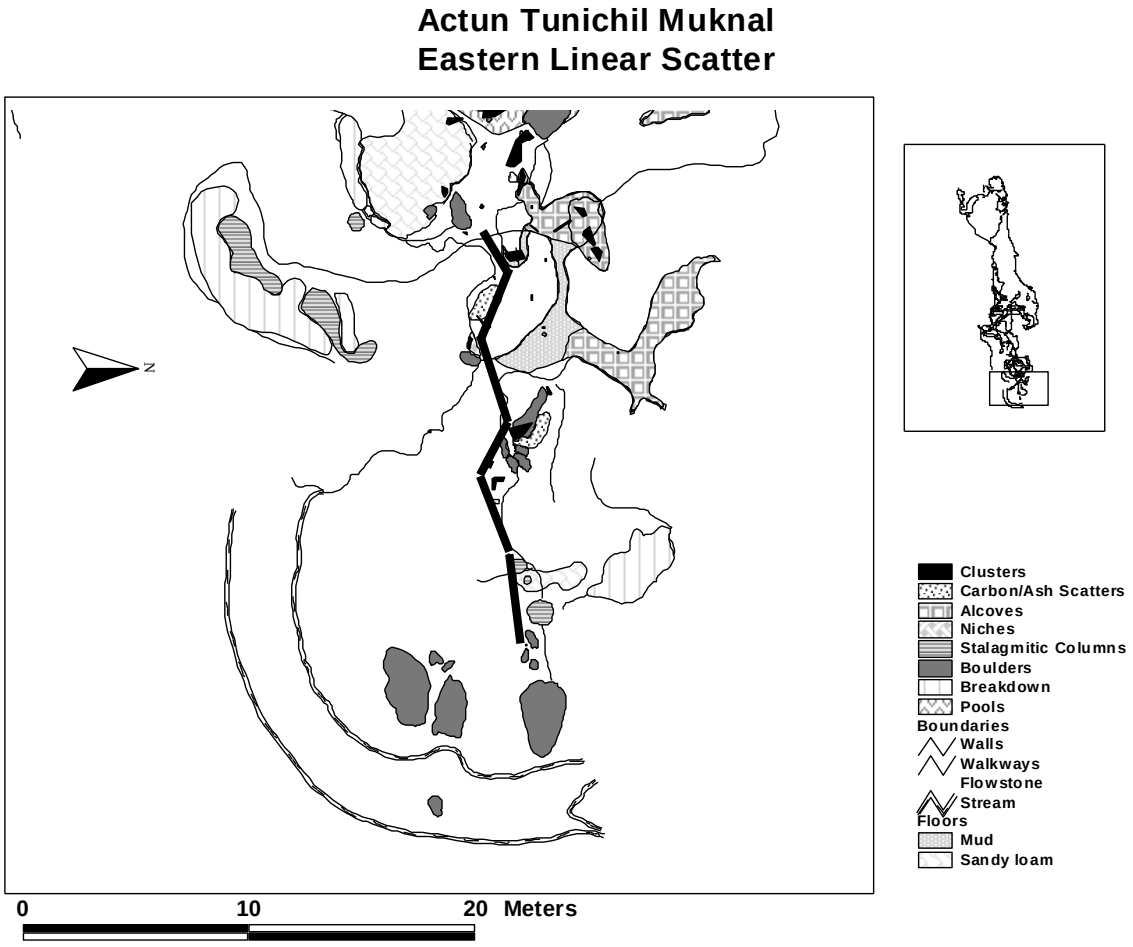


Figure 6-2. Map of Eastern Linear Scatter in the Creek area. Black line illustrates path of scatter.

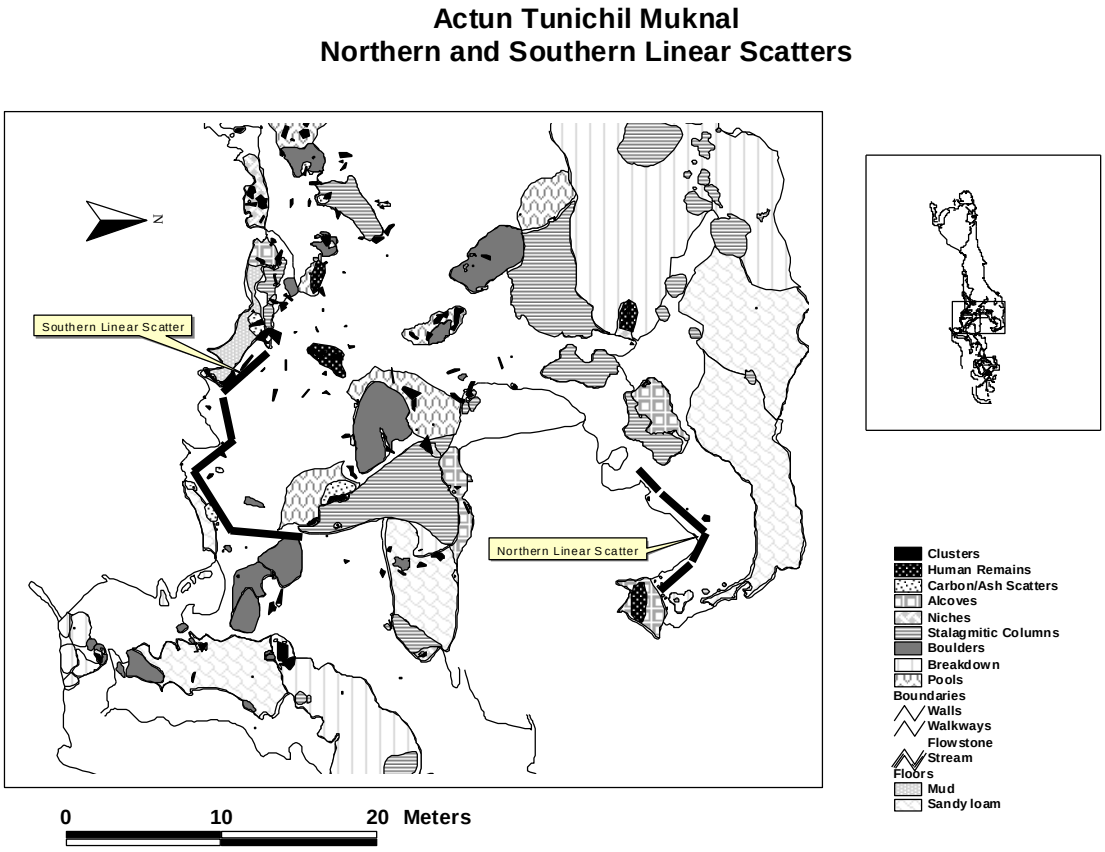


Figure 6-3. Map of Northern and Southern Scatters. Black line indicates path of scatter.

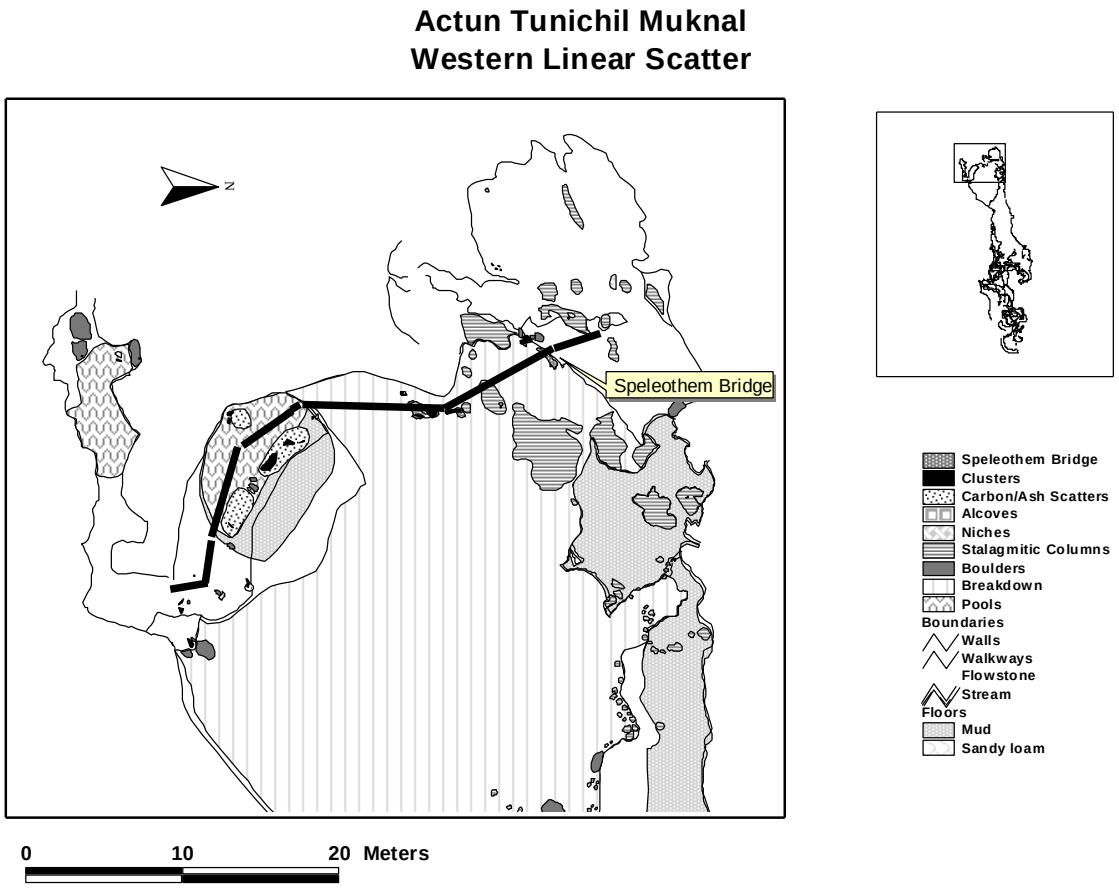
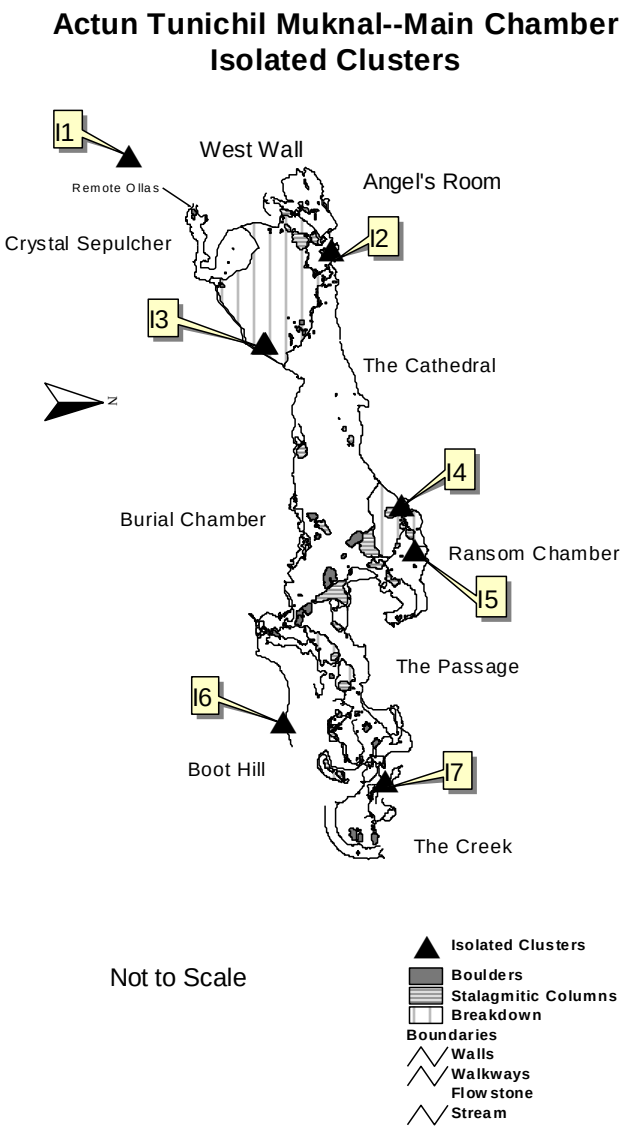


Figure 6-4. Map of Western Linear Scatter. Black line indicates path of scatter.



6-5. Map of the Main Chamber illustrating the seven isolated clusters.

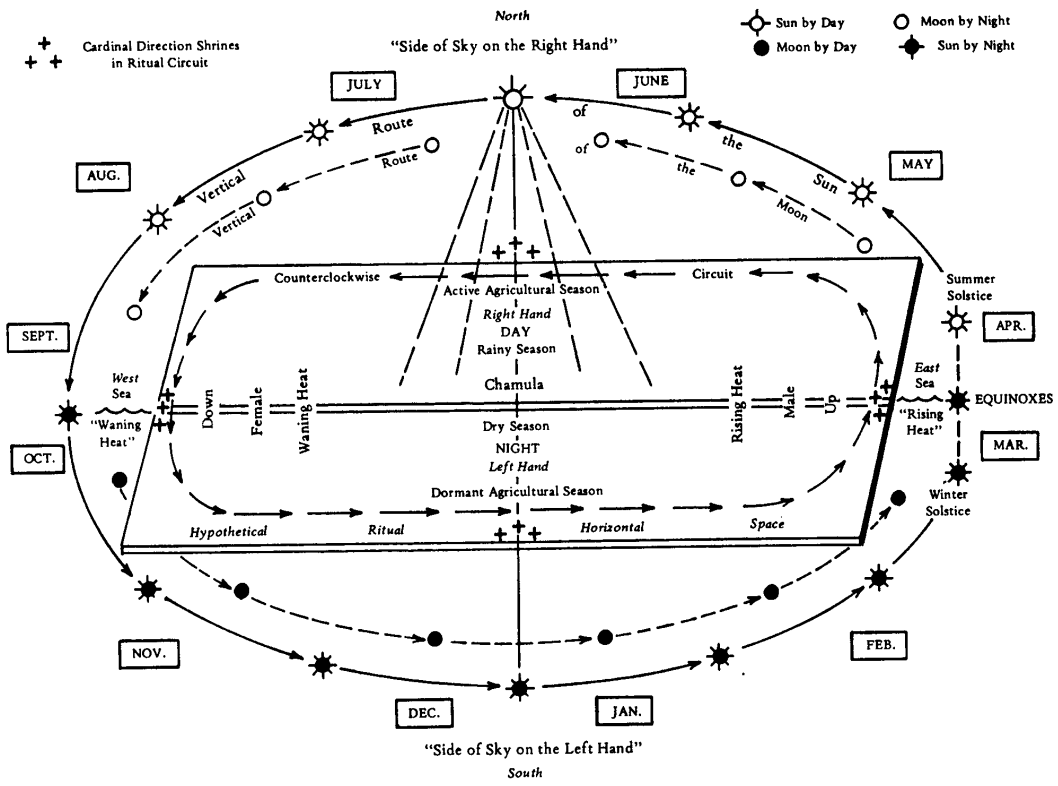


Figure 6-6. Gossen's (1974:34) model of the Maya cosmos illustrates the concept of a rectangular earth with sun revolving around the flat earth plane.

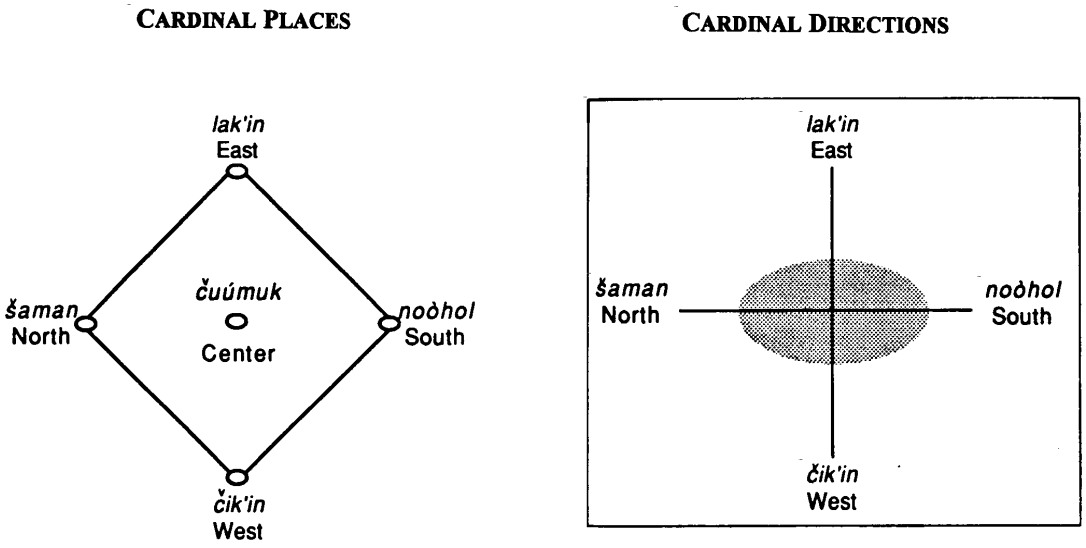


Figure 6-7. Hanks differentiates between profane "cardinal directions" and "cardinal places" which delineate the quincuncial frame used in ritual (Hanks 1990:300,301).

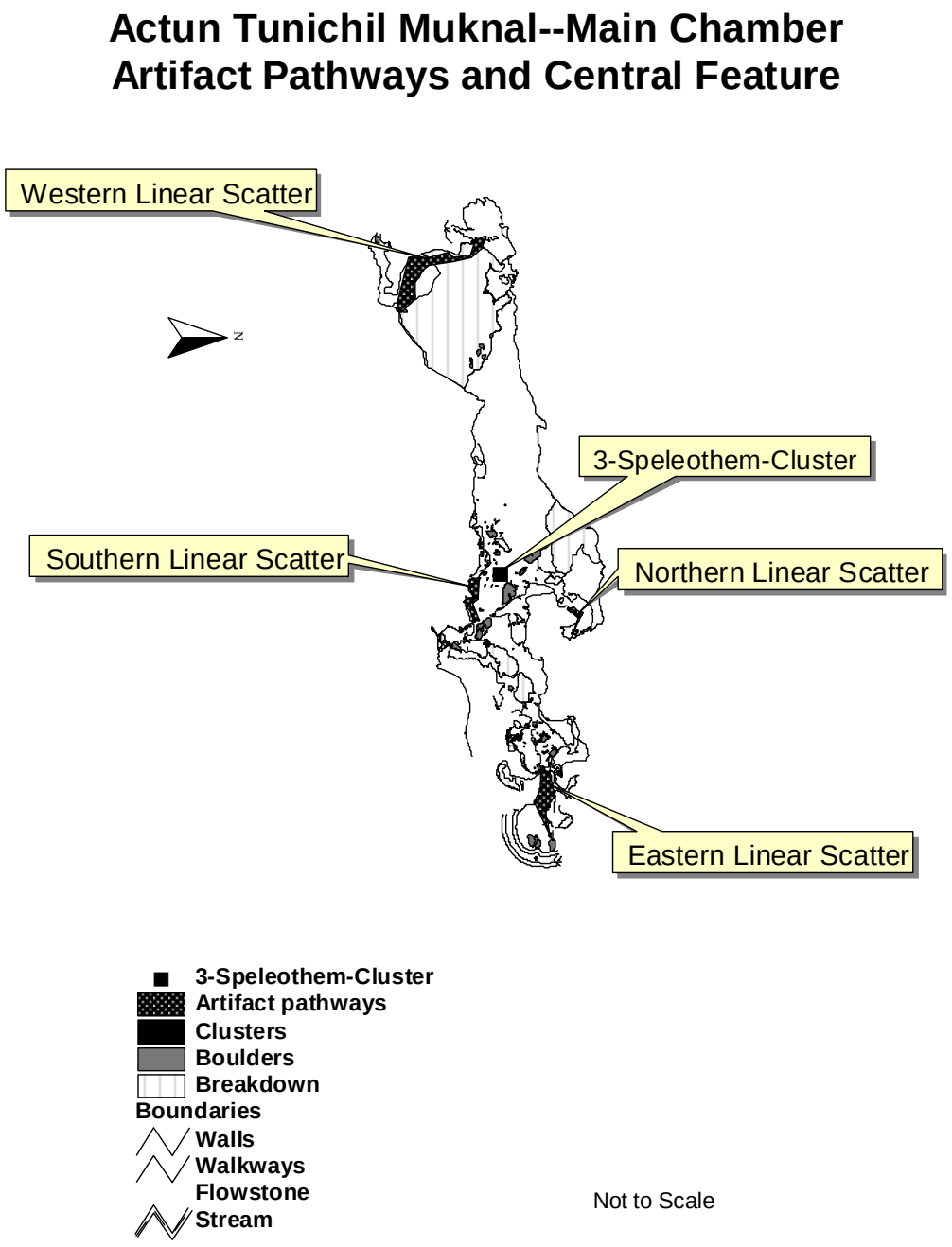


Figure 6-8. Map of the Main Chamber illustrating artifact pathways corresponding to the four cardinal directions and central three-speleothem cluster.

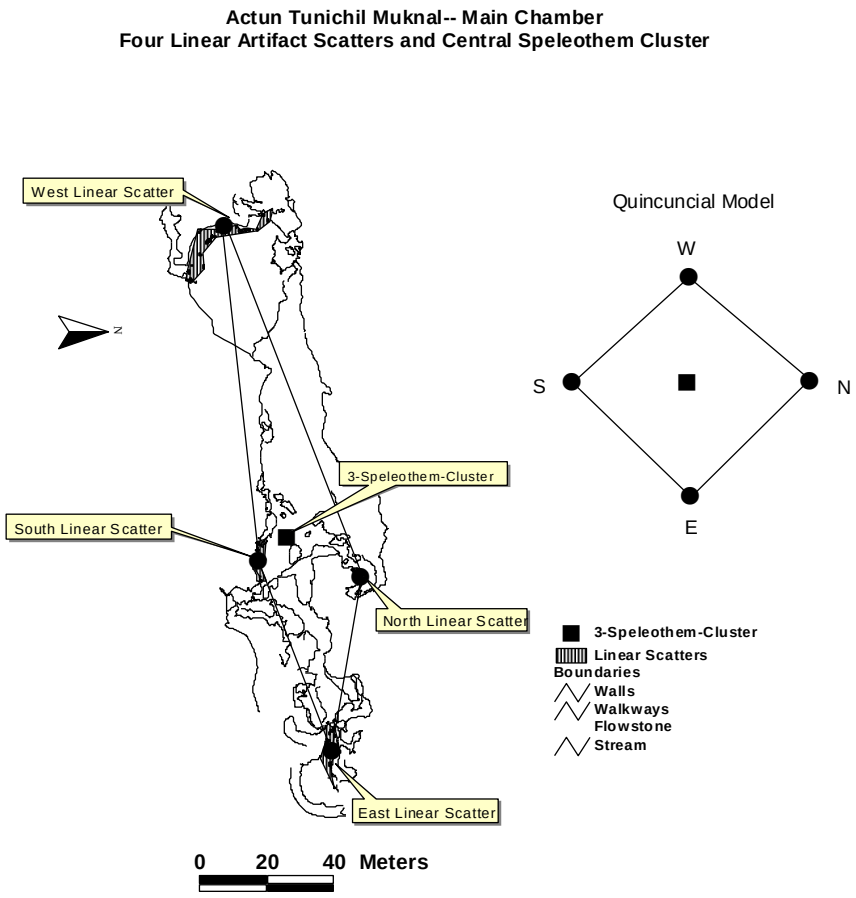


Figure 6-9. Map of the Main Chamber illustrating the spatial layout of clusters juxtaposed with Hanks' quincuncial model of cardinal "places" (after Hanks 1990: 301, fig. 7.2; Moyes and Awe 1998, 1999).

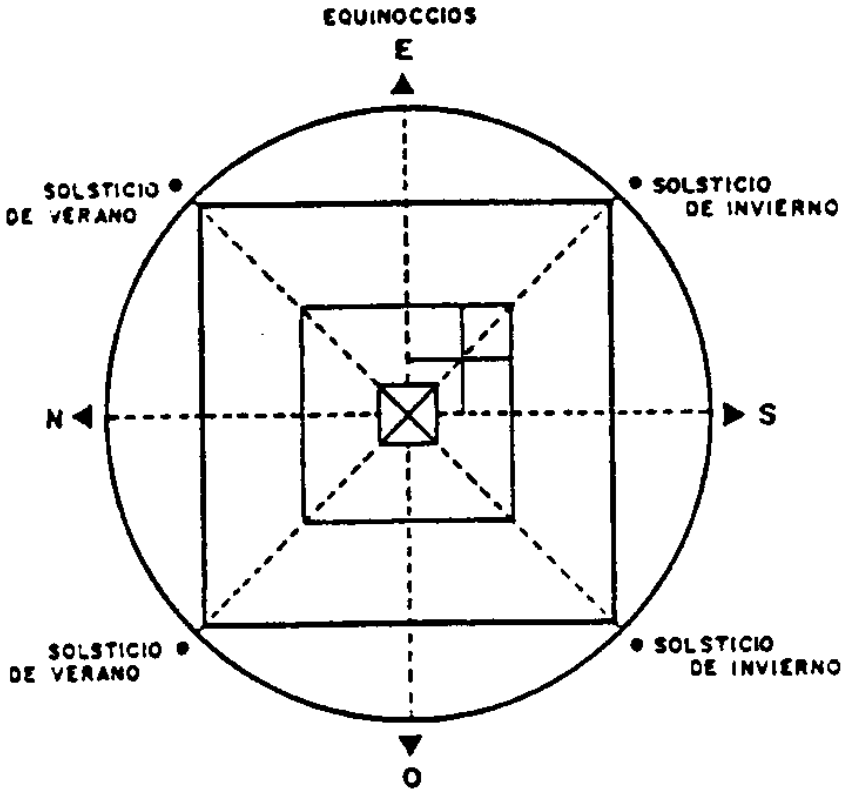


Figure 6-10. Graphic of spatial pattern of foundation rituals by García-Zambrano (1994:220).

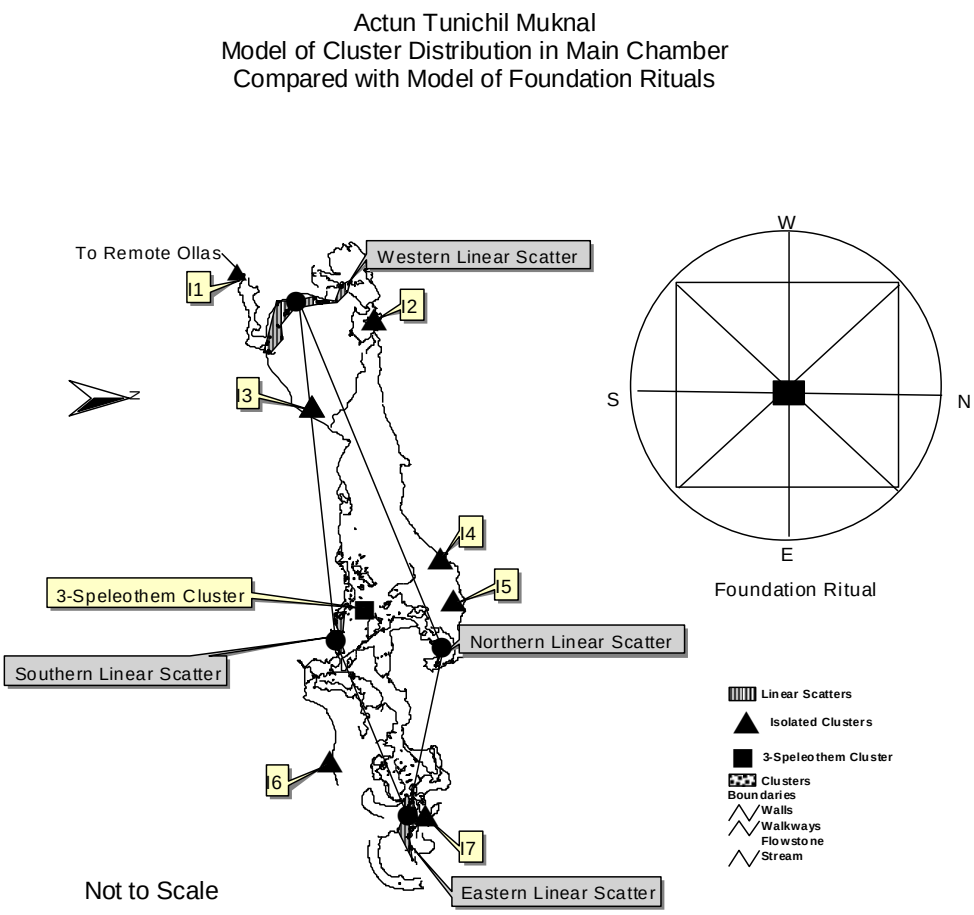


Figure 6-11. Map of the Main Chamber illustrating ritual pathways, the three-speloethem cluster, and boundary markers beside García-Zambrano's illustration of a spatial model of rituals of foundation (after García-Zambrano 1994:220, fig.3).

Chapter 7

Conclusion

This paper demonstrated the utility of a GIS as a tool for the graphic display and analysis of piece plotted artifacts in a ritual setting and reinforced the importance of visualization in assessing artifact assemblages. Several lines of inquiry were developed in this intense investigation of a single area. Methods used in the study included the evaluation of artifact content, the assessment of stylistic or unique features of artifacts, the spatial proximity of artifacts to one another, the spatial relationships of artifacts to morphological features of the cave, and determination of specific artifact deposition patterns. Findings provided the information necessary to link ethnographic, ethnohistoric, and iconographic data with the artifact record. This led to a better understanding of the rituals conducted within ancient Maya caves.

The extent of variability in the ritual use of caves is one of the pressing questions facing Mesoamerican cave research. It is unclear as to whether all caves were used for similar purposes, whether specific caves were reserved for specific rituals, and if local or regional variation in ritual usage occurred. Methodology to address these questions is still in its developmental stages. This study has provided both quantifiable data and models from which to make comparisons.

In the quantitative analysis, artifacts were divided into classes and counts were determined for each category. In situ refitting of broken objects provided a good estimate of the number of individual artifacts imported into the chamber. The use of quantitative methods to assess artifact classes established a database for future studies as comparative material becomes available.

A qualitative assessment of artifacts that evaluated their the context and provenience was instructive as to their meaning. For instance, the configuration and placement of the three-speleothem-cluster at the center of the Main Chamber suggested that the feature represented the three-stone-hearth of the Maya creation event.

Using artifact points, a cluster coverage was generated by combining a *K-means* clustering program with GIS technology. This created new units of analyses to evaluate the distance of artifacts to morphological features of the cave. Clusters represented the data better than points. They are likely to represent unique events and they solved the problem of unequal weighting of the data due to artifact breakage.

The analysis suggested that the features represented salient emic categories and that artifact deposition within the cave produced some patterns analogous to those found at surface sites. Also instructive was the importance of artifact deposition patterns that were not immediately intuitive to the western mind but appearred in quantitative analyses, such as the significant number of objects located near boulders.

The data generated by the analysis was compared with ethnographic and ethnohistoric reports. Using these sources, a hypothesis was developed which posits that rituals conducted in the cave may have been to propitiate or honor deities associated with

rain or standing water. It is likely that at least some of these rituals referenced the mythical flood of the Maya creation event.

The ability to view the artifact deposition pattern of the entire site on a single screen was instrumental in distinguishing and categorizing global spatial patterns as demonstrated in Chapter 6. Three patterns were identified: concentrated clusters, linear distributions, and isolated clusters located in peripheral areas. By comparing linear distributions and isolated clusters to models of modern Maya rituals and ethnohistoric rituals of foundation common throughout Mesoamerica, it was possible to determine the way that the space in the cave's interior was conceptualized. Similar to rituals conducted in surface contexts, socialized space was established within the cave creating a well-defined and safe environment. As Hanks (1990) suggested, the delineation of space is an important and salient feature in all Maya ritual. This study has demonstrates that ritual performances conducted in caves are no exception.

Appendix A
Definitions of Cave Features

Alcove- a recessed or partially enclosed area, accessible for human entry, opening onto a room, passageway or tunnel. Alcoves may be at floor levels, sub-floor levels, or elevated. An alcove may not open onto another alcove, therefore it must be partitioned on three sides.

Boulder-"…a detached rock mass larger than a cobble, having a diameter greater than 256mm (10inches or about the size of a volleyball)…" (Gary, McAfee, and Wolf 1972:86). It is somewhat rounded or otherwise distinctively shaped by abrasion in the course of transport; the largest rock fragment recognized by sedimentologists.

small- diameter=256-512 mm (10-20 inches)
medium- diameter= 512-1024mm (20-40 inches)
large- diameter= 1024-2048 mm (40-80 inches)
very large- diameter= 2048-4096mm (80-160 inches) or larger

Breakdown- the debris accumulated from the process of collapse of the ceiling or walls of a cave (Gary, MacAffee, and Wolf 1972:112).

Gour pools- pool created by a rimstone dam (Gary, MacAffee, and Wolf 1972:304).

Monument- a structure erected by human agency culturally modified, erected by human agency, whose function is thought to commemorate an event or define ritual space.

Niche- are very small alcoves that do not permit human entry. In the cave, they are usually recesses walls or spaces under rock overhangs.

Pools- for purposes of this study, "pools" refer to areas in the cave where standing water was observed during flooding. These include gour pools.

Rimstone- in a cave, a thin crust-like deposit of calcite that forms a ring around an overflowing basin or pool of water (Gary, MacAffee, and Wolf 1972:610).

Rimstone dam- a formation of rimstone that forms a pool or basin (Gary, MacAffee, and Wolf 1972:610).

Squeeze- in a cave, a passage that is trasversable only with difficulty (Gary, MacAffee, and Wolf 1972:686).

Stalactite- "a conical or cylindrical speleothem that is developed and hangs from the roof of a cave. It is deposited by dripping water and is usually composed of calcium carbonate but may also be formed of metallic carbonates" (Gary, McAfee, and Wolf 1972:687)

Stalagmite- "..a conical speleothem that has developed upwards from the floor of a cave by the action of dripping water. It is usually composed of calcium carbonate but may also be formed of metallic carbonates" (Gary, McAfee, and Wolf 1972:687-688).

Stalagmitic Column- a large stalagmite or group of stalagmites that have fused, usually over 1m in height.

Stalacto-stalagmitic Column- is a similar columnar deposit to a stalagmitic column, formed by the union of a stalagmite with its complementary stalactite (Gary, McAfee, and Wolf 1972:687-688).

Walls- for purposes of this study, cave walls refer to the exterior-most boundaries of the cave, or vertical structures that create interior partitioning. These may include large stalacto-stalagmitic columns or areas of breakdown.

Walkways- are areas of mud, sandy loam or other deposits that delineate a passable route.

Appendix B
Artifact Class and Sub-class Divisions
Unique Identification Numbers Used in Digitizing Point Coverage

CLASS	SUB-CLASS	UNIQUE ID (1^{ST} 2 DIGITS)
1. Ceramics		10000000
	Jars	11000000
	Bowls	12000000
	Dishes	13000000
	Whistles (figurines)	14000000
	Shoe pots	15000000
	Pedestal Vases	16000000
2. Single Sherds		20000000
	Jars	21000000
	Bowls	22000000
	Dishes	23000000
	Whistles (figurines)	24000000
	Shoe pots	25000000
	Pedestal Vases	26000000
3. Groundstone		30000000
	Manos	31000000
	Metates	32000000
	Celts	33000000
4. Chipped stone		40000000
	Obsidian	41000000
	Quartzite	42000000
	Pyrite	43000000
5. Faunal remains		50000000
	Shell	51000000
	Bone	52000000
	Teeth	53000000
6. Monument		60000000

7. Speleothems		70000000
	Bead	71000000
	Speleofact	72000000
8. Slate		80000000
	located inside vessel	81000000
9. Unknown		90000000

Appendix C
Data Set 1
Based on Broad Artifact Classes

CLASS	NUMBER
Ceramics	1
Groundstone	2
Chipped stone	3
Faunal	4
Monument	5
Speleothems	6
Slate	7
Unknown	8

Appendix D
Data Set 2

CLASS	NUMBER
Jars	1
Bowls	2
Dishes	3
Shoe pots	4
Vases	5
Whistles	6
Grinding stones	7
Celts	8
Obsidian	9
Quartzite	10
Pyrite	11
Ornaments	12
Faunal remains	13
Monument	14
Slate	15
Unknown	16
Speleothems	17

Appendix E—Data Sets

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
2	11000201	1	0	1	1	1230	11002704	4	0	1	1
3	11000202	2	0	1	1	1228	11002901	1	1	1	1
8	11000301	1	0	1	1	1340	11002902	2	0	1	1
10	11000302	2	0	1	1	1341	11003301	1	0	1	1
9	11000303	3	0	1	1	1342	11003302	2	0	1	1
12	11000304	4	0	1	1	1343	11003303	3	0	1	1
11	11000305	5	0	1	1	1344	11003304	4	0	1	1
4	11000401	1	0	1	1	1345	11003305	5	0	1	1
5	11000402	2	0	1	1	1351	11003306	6	0	1	1
6	11000403	3	0	1	1	1355	11003401	1	0	1	1
32	11000701	1	0	1	1	1356	11003402	2	0	1	1
29	11000702	2	0	1	1	1357	11003403	3	0	1	1
31	11000703	3	0	1	1	1346	11003501	1	0	1	1
30	11000704	4	0	1	1	1347	11003502	2	0	1	1
28	11000705	5	0	1	1	1348	11003503	3	0	1	1
27	11000706	6	0	1	1	1349	11003504	4	0	1	1
1329	11000801	1	0	1	1	1350	11003505	5	0	1	1
1328	11000802	2	0	1	1	1236	11003506	6	0	1	1
1327	11000803	3	0	1	1	1352	11003507	7	0	1	1
1326	11000804	4	0	1	1	1353	11003508	8	0	1	1
1324	11001501	1	0	1	1	1354	11003509	9	0	1	1
1323	11001502	2	0	1	1	1237	11003601	1	0	1	1
1322	11001503	3	0	1	1	1238	11003602	2	0	1	1
1321	11001504	4	0	1	1	1239	11003603	3	0	1	1
14	11001701	1	0	1	1	1240	11003604	4	0	1	1
1330	11001801	1	0	1	1	1241	11003605	5	0	1	1
1335	11002301	1	0	1	1	41	11004401	1	0	1	1
1336	11002302	2	0	1	1	42	11004402	2	0	1	1
19	11002303	3	0	1	1	43	11004403	3	0	1	1
20	11002304	4	0	1	1	44	11004404	4	0	1	1
21	11002305	5	0	1	1	45	11004405	5	0	1	1
22	11002306	6	0	1	1	46	11004406	6	0	1	1
23	11002307	7	0	1	1	47	11004501	1	0	1	1
24	11002308	8	0	1	1	48	11004502	2	0	1	1
18	11002309	9	0	1	1	51	11004701	1	0	1	1
25	11002310	10	0	1	1	52	11004801	1	1	1	1
26	11002311	11	0	1	1	62	11005801	1	0	1	1
1232	11002701	1	0	1	1	63	11005802	2	0	1	1
1233	11002702	2	0	1	1	64	11005803	3	0	1	1
1234	11002703	3	0	1	1	65	11005804	4	0	1	1

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
65	11005804	4	0	1	1	190	11015202	2	0	1	1
66	11005805	5	0	1	1	191	11015203	3	0	1	1
67	11005806	6	0	1	1	192	11015204	4	0	1	1
68	11005807	7	0	1	1	193	11015205	5	0	1	1
69	11005808	8	0	1	1	202	11015501	1	1	1	1
70	11005809	9	0	1	1	203	11015502	2	1	1	1
97	11008101	1	0	1	1	204	11015503	3	1	1	1
94	11008301	1	1	1	1	205	11015504	4	1	1	1
95	11008302	2	1	1	1	206	11015505	5	1	1	1
96	11008303	3	1	1	1	207	11015506	6	1	1	1
99	11008401	1	1	1	1	213	11015601	1	1	1	1
102	11008501	1	1	1	1	215	11015801	1	1	1	1
103	11008502	2	1	1	1	211	11015901	1	1	1	1
104	11008503	3	1	1	1	225	11016401	1	0	1	1
105	11008801	1	1	1	1	226	11016402	2	0	1	1
112	11009201	1	0	1	1	227	11016403	3	0	1	1
113	11009202	2	0	1	1	216	11016501	1	0	1	1
108	11009301	1	1	1	1	217	11016502	2	0	1	1
109	11009302	2	1	1	1	218	11016503	3	0	1	1
110	11009303	3	1	1	1	219	11016504	4	0	1	1
111	11009304	4	1	1	1	220	11016505	5	0	1	1
114	11010501	1	0	1	1	221	11016506	6	0	1	1
115	11010502	2	0	1	1	222	11016507	7	0	1	1
116	11010503	3	0	1	1	223	11016508	8	0	1	1
141	11011401	1	1	1	1	224	11016509	9	0	1	1
142	11011402	2	1	1	1	229	11016701	1	0	1	1
139	11011501	1	1	1	1	244	11016901	1	0	1	1
140	11011502	2	1	1	1	240	11017101	1	0	1	1
143	11011701	1	1	1	1	238	11017201	1	0	1	1
144	11011702	2	1	1	1	239	11017202	2	0	1	1
145	11011703	3	1	1	1	250	11018301	1	0	1	1
146	11012201	1	1	1	1	252	11018501	1	0	1	1
147	11012202	2	1	1	1	254	11018701	1	1	1	1
148	11012203	3	1	1	1	265	11019701	1	0	1	1
149	11012204	4	1	1	1	266	11019702	2	0	1	1
150	11012205	5	1	1	1	267	11019703	3	0	1	1
152	11012206	6	1	1	1	268	11019704	4	0	1	1
179	11014101	1	1	1	1	269	11019705	5	0	1	1
173	11014301	1	1	1	1	270	11019706	6	0	1	1
184	11014701	1	1	1	1	271	11019707	7	0	1	1
185	11014702	2	1	1	1	272	11019708	8	0	1	1
186	11014703	3	1	1	1	273	11019709	9	0	1	1
187	11014704	4	1	1	1	274	11019710	10	0	1	1
181	11014801	1	1	1	1	275	11019711	11	0	1	1
58	11015101	1	1	1	1	276	11019712	12	0	1	1
189	11015201	1	0	1	1	1362	11019713	13	0	1	1

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
264	11019714	14	0	1	1	358	11024601	1	0	1	1
277	11019801	1	0	1	1	368	11025301	1	0	1	1
278	11019802	2	0	1	1	369	11025501	1	0	1	1
287	11020001	1	1	1	1	370	11025502	2	0	1	1
281	11020101	1	1	1	1	371	11025601	1	0	1	1
282	11020102	2	1	1	1	376	11025901	1	1	1	1
285	11020201	1	1	1	1	391	11026901	1	0	1	1
283	11020301	1	1	1	1	392	11026902	2	0	1	1
284	11020302	2	1	1	1	385	11026903	3	0	1	1
286	11020401	1	1	1	1	386	11027001	1	1	1	1
291	11020801	1	0	1	1	387	11027002	2	0	1	1
292	11020802	2	0	1	1	393	11027003	3	0	1	1
295	11021101	1	0	1	1	394	11027004	4	0	1	1
296	11021102	2	0	1	1	463	11027005	5	0	1	1
301	11021201	1	1	1	1	397	11027101	1	1	1	1
302	11021301	1	1	1	1	398	11027102	2	0	1	1
304	11021401	1	1	1	1	388	11027103	3	0	1	1
305	11021402	2	1	1	1	408	11027401	1	0	1	1
306	11021403	3	1	1	1	409	11027402	2	0	1	1
308	11021601	1	1	1	1	410	11027403	3	0	1	1
309	11021602	2	1	1	1	411	11027404	4	0	1	1
328	11023801	1	0	1	1	395	11027405	5	0	1	1
329	11023802	2	0	1	1	396	11027406	6	0	1	1
330	11023803	3	0	1	1	399	11027501	1	0	1	1
331	11023804	4	0	1	1	400	11027502	2	0	1	1
332	11023805	5	0	1	1	401	11027503	3	0	1	1
333	11023806	6	0	1	1	402	11027504	4	0	1	1
334	11023807	7	0	1	1	403	11027505	5	0	1	1
335	11023808	8	0	1	1	404	11027506	6	0	1	1
350	11023809	9	0	1	1	405	11027507	7	0	1	1
351	11023810	10	0	1	1	406	11027508	8	0	1	1
352	11023811	11	0	1	1	407	11027509	9	1	1	1
336	11023901	1	0	1	1	424	11027801	1	0	1	1
337	11023902	2	0	1	1	426	11027901	1	0	1	1
338	11023903	3	0	1	1	428	11028201	1	0	1	1
339	11023904	4	0	1	1	1366	11028301	1	0	1	1
340	11023905	5	0	1	1	1367	11028302	2	0	1	1
341	11023906	6	0	1	1	1368	11028303	3	0	1	1
342	11023907	7	0	1	1	429	11028401	1	0	1	1
343	11023908	8	0	1	1	433	11028801	1	1	1	1
344	11024001	1	0	1	1	440	11029301	1	0	1	1
345	11024002	2	0	1	1	441	11029302	2	0	1	1
346	11024003	3	0	1	1	442	11029401	1	0	1	1
347	11024004	4	0	1	1	443	11029402	2	0	1	1
348	11024005	5	0	1	1	444	11029403	1	0	1	1
349	11024006	6	0	1	1	445	11029404	2	0	1	1

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
446	11029405	3	0	1	1	562	11037201	1	1	1	1
456	11029601	1	1	1	1	563	11037202	2	1	1	1
457	11029701	1	1	1	1	564	11037203	3	1	1	1
458	11029702	2	1	1	1	577	11037701	1	1	1	1
459	11029703	3	1	1	1	578	11037702	2	1	1	1
460	11029704	4	1	1	1	579	11037703	3	1	1	1
461	11029705	5	1	1	1	580	11037704	4	1	1	1
462	11029706	6	1	1	1	603	11039601	1	1	1	1
475	11029801	1	1	1	1	604	11039602	2	1	1	1
479	11029901	1	1	1	1	605	11039603	3	1	1	1
483	11029902	2	0	1	1	654	11039604	4	1	1	1
465	11030201	1	0	1	1	655	11039605	5	1	1	1
468	11030501	1	1	1	1	609	11039701	1	0	1	1
469	11030502	2	0	1	1	610	11039901	1	0	1	1
470	11030503	3	0	1	1	611	11040001	1	1	1	1
471	11030504	4	0	1	1	612	11040101	1	1	1	1
472	11030505	5	0	1	1	613	11040102	2	1	1	1
473	11030506	6	0	1	1	614	11040103	3	1	1	1
474	11030507	7	0	1	1	619	11040601	1	1	1	1
1406	11031301	1	1	1	1	623	11041001	1	1	1	1
500	11032301	1	0	1	1	634	11042101	1	0	1	1
501	11032302	2	0	1	1	635	11042102	2	0	1	1
502	11032303	3	0	1	1	636	11042103	3	0	1	1
503	11032304	4	0	1	1	637	11042104	4	0	1	1
499	11032401	1	0	1	1	638	11042105	5	0	1	1
511	11032901	1	1	1	1	639	11042106	6	0	1	1
524	11033301	1	1	1	1	640	11042107	7	0	1	1
525	11033302	2	1	1	1	641	11042108	8	0	1	1
518	11033401	1	0	1	1	642	11042109	9	0	1	1
522	11033401	1	0	1	1	644	11042301	1	0	1	1
519	11033402	2	0	1	1	645	11042401	1	0	1	1
520	11033403	3	0	1	1	646	11042402	2	0	1	1
521	11033404	4	0	1	1	647	11042403	3	0	1	1
529	11034201	1	0	1	1	648	11042404	4	0	1	1
538	11034601	1	1	1	1	649	11042405	5	0	1	1
542	11035001	1	1	1	1	650	11042406	6	0	1	1
543	11035002	2	1	1	1	651	11042407	7	0	1	1
547	11035201	1	1	1	1	656	11042601	1	1	1	1
561	11036401	1	1	1	1	657	11042602	2	1	1	1
570	11037001	1	1	1	1	658	11042603	3	1	1	1

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
660	11042801	1	1	1	1	749	11051302	2	0	1	1
662	11043001	1	1	1	1	751	11051401	1	0	1	1
663	11043101	1	1	1	1	753	11051402	2	0	1	1
664	11043201	1	1	1	1	752	11051403	3	0	1	1
667	11043401	1	1	1	1	754	11051404	4	0	1	1
668	11043601	1	1	1	1	755	11051405	5	0	1	1
670	11043701	1	1	1	1	756	11051406	6	0	1	1
671	11043801	1	1	1	1	757	11051407	7	0	1	1
672	11043901	1	1	1	1	759	11051408	8	0	1	1
673	11043902	2	1	1	1	758	11051409	9	0	1	1
674	11044001	1	1	1	1	761	11051410	10	1	1	1
675	11044101	1	1	1	1	762	11051411	11	1	1	1
681	11044101	1	1	1	1	763	11051412	12	1	1	1
694	11044503	3	1	1	1	764	11051413	13	1	1	1
693	11044504	4	1	1	1	765	11051414	14	0	1	1
1370	11044701	1	1	1	1	766	11051415	15	0	1	1
680	11044801	1	1	1	1	767	11051416	16	0	1	1
688	11044901	1	1	1	1	760	11051501	1	0	1	1
689	11045401	1	1	1	1	800	11051701	1	0	1	1
690	11045501	1	1	1	1	801	11051702	2	0	1	1
692	11045502	2	1	1	1	802	11051703	3	0	1	1
705	11045801	1	0	1	1	803	11051704	4	0	1	1
710	11045901	1	1	1	1	804	11051705	5	0	1	1
713	11046101	1	1	1	1	805	11051706	6	0	1	1
714	11046102	2	1	1	1	806	11051707	7	0	1	1
715	11046103	3	1	1	1	807	11051708	8	0	1	1
716	11046104	4	1	1	1	833	11053301	1	0	1	1
717	11046105	5	1	1	1	840	11053601	1	0	1	1
718	11046201	1	1	1	1	841	11053602	2	0	1	1
719	11046202	2	1	1	1	842	11053603	3	0	1	1
1242	11046701	1	1	1	1	843	11053604	4	0	1	1
1243	11046702	2	1	1	1	844	11053605	5	0	1	1
1244	11046703	3	1	1	1	845	11053606	6	0	1	1
727	11047901	1	1	1	1	846	11053607	7	0	1	1
730	11048201	1	1	1	1	847	11053608	8	0	1	1
1257	11048301	1	1	1	1	848	11053609	9	0	1	1
799	11050601	1	1	1	1	849	11053610	10	0	1	1
731	11050801	1	1	1	1	850	11053611	11	0	1	1
732	11050802	2	1	1	1	785	11054001	1	1	1	1
750	11051301	1	0	1	1	788	11054201	1	0	1	1

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
858	11054202	2	0	1	1	925	11060307	7	0	1	1
855	11054301	1	0	1	1	926	11060308	8	0	1	1
856	11054302	2	0	1	1	927	11060309	9	0	1	1
857	11054303	3	0	1	1	928	11060310	10	0	1	1
876	11054901	1	1	1	1	929	11060311	11	0	1	1
871	11055101	1	1	1	1	930	11060312	12	0	1	1
881	11056301	1	1	1	1	931	11060313	13	0	1	1
890	11057101	1	1	1	1	932	11060314	14	0	1	1
894	11057201	1	1	1	1	933	11060601	1	1	1	1
1283	11059001	1	1	1	1	934	11060602	2	1	1	1
1286	11059301	1	1	1	1	935	11060603	3	1	1	1
1287	11059302	2	1	1	1	939	11061101	1	1	1	1
1296	11059303	3	1	1	1	940	11061201	1	1	1	1
1297	11059304	4	1	1	1	949	11062001	1	1	1	1
1298	11059304	4	1	1	1	962	11063101	1	1	1	1
1290	11059501	1	1	1	1	964	11063301	1	1	1	1
1291	11059502	2	1	1	1	966	11063501	1	1	1	1
1292	11059601	1	1	1	1	967	11063502	2	1	1	1
1294	11059602	2	1	1	1	968	11063601	1	1	1	1
1295	11059603	3	1	1	1	969	11063602	2	1	1	1
1308	11059604	4	1	1	1	973	11063901	1	1	1	1
1309	11059605	5	1	1	1	971	11064001	1	1	1	1
1310	11059606	6	1	1	1	1407	11064801	1	1	1	1
1311	11059607	7	1	1	1	984	11066501	1	0	1	1
1312	11059608	8	1	1	1	1004	11067201	1	1	1	1
1306	11059801	1	1	1	1	1005	11067401	1	1	1	1
1303	11059802	2	1	1	1	1011	11067601	1	1	1	1
1304	11059803	3	1	1	1	1013	11067901	1	1	1	1
1305	11059804	4	1	1	1	1016	11068201	1	1	1	1
1299	11059805	5	0	1	1	1017	11068401	1	1	1	1
1307	11060201	1	1	1	1	1065	11070901	1	1	1	1
1313	11060202	2	1	1	1	1093	11073801	1	1	1	1
1314	11060203	3	1	1	1	1102	11074601	1	1	1	1
1315	11060204	4	1	1	1	1103	11074602	2	1	1	1
919	11060301	1	1	1	1	1114	11075301	1	0	1	1
920	11060302	2	1	1	1	1115	11075302	2	0	1	1
921	11060303	3	1	1	1	1116	11075303	3	0	1	1
922	11060304	4	0	1	1	1117	11075304	4	0	1	1
923	11060305	5	0	1	1	1118	11075305	5	0	1	1
924	11060306	6	0	1	1	1119	11075306	6	0	1	1

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
1120	11075307	7	0	1	1	49	12004601	1	0	1	1
1121	11075308	8	0	1	1	73	12004701	1	0	1	1
1122	11075401	1	1	1	1	71	12005901	1	0	1	1
1123	11075402	2	1	1	1	154	12012101	1	1	1	1
1124	11075403	3	1	1	1	155	12012102	2	1	1	1
1125	11075404	4	1	1	1	156	12012103	3	1	1	1
1126	11075405	5	1	1	1	153	12013801	1	1	1	1
1127	11075406	6	1	1	1	174	12014201	1	1	1	1
1128	11075407	7	1	1	1	175	12014202	2	1	1	1
1129	11075408	8	1	1	1	318	12015301	1	0	1	1
1130	11075409	9	1	1	1	214	12015701	1	1	1	1
1131	11075501	1	1	1	1	241	12016801	1	0	1	1
1132	11075601	1	0	1	1	242	12016802	2	0	1	1
1133	11075602	2	0	1	1	243	12016803	3	0	1	1
1134	11075603	3	0	1	1	230	12017301	1	0	1	1
1109	11078001	1	0	1	1	231	12017302	2	0	1	1
1110	11078002	2	0	1	1	253	12018401	1	0	1	1
1111	11078003	3	0	1	1	293	12020901	1	0	1	1
1214	11078801	1	0	1	1	294	12020902	2	0	1	1
1215	11078802	2	0	1	1	319	12023301	1	0	1	1
1216	11078803	3	0	1	1	323	12023701	1	0	1	1
1217	11078804	4	0	1	1	324	12023702	2	0	1	1
1218	11079101	1	1	1	1	325	12023703	3	0	1	1
1219	11079102	2	1	1	1	326	12023704	4	0	1	1
1388	11079401	1	0	1	1	327	12023705	5	0	1	1
1389	11079402	2	0	1	1	375	12025801	1	0	1	1
1390	11079403	3	0	1	1	413	12027701	1	0	1	1
1391	11079404	4	0	1	1	414	12027702	2	0	1	1
1392	11079405	5	0	1	1	415	12027703	3	0	1	1
1393	11079406	6	0	1	1	416	12027704	4	0	1	1
1394	11079407	7	0	1	1	417	12027705	5	0	1	1
1395	11079408	8	0	1	1	418	12027706	6	0	1	1
1396	11079409	9	0	1	1	419	12027707	7	0	1	1
1397	11079410	10	0	1	1	420	12027708	8	0	1	1
1398	11079411	11	0	1	1	421	12027709	9	0	1	1
1399	11079412	12	0	1	1	422	12027710	10	0	1	1
1400	11079413	13	0	1	1	423	12027711	11	0	1	1
1401	11079414	14	0	1	1	476	12030001	1	0	1	1
1223	11079501	1	0	1	1	477	12030002	2	0	1	1
437	11081701	1	0	1	1	478	12030003	3	0	1	1

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
487	12030004	4	0	1	1	1055	12070702	2	0	1	1
488	12030005	5	0	1	1	1056	12070703	3	1	1	1
467	12030401	1	0	1	1	1057	12070704	4	1	1	1
489	12031401	1	1	1	1	1058	12070705	5	1	1	1
490	12031402	2	1	1	1	1059	12070706	6	1	1	1
576	12037601	1	1	1	1	1060	12070707	7	1	1	1
597	12039801	1	0	1	1	1061	12070708	8	1	1	1
598	12039802	2	0	1	1	1062	12070709	9	1	1	1
599	12039803	3	0	1	1	1063	12070710	10	1	1	1
600	12039804	4	0	1	1	1064	12070711	11	1	1	1
601	12039805	5	0	1	1	1148	12076201	1	1	1	1
602	12039806	6	1	1	1	1149	12076202	2	1	1	1
632	12039807	7	1	1	1	1150	12076203	3	1	1	1
620	12041201	1	1	1	1	1205	12078701	1	0	1	1
621	12041202	2	1	1	1	1206	12078702	2	0	1	1
622	12041203	3	1	1	1	1207	12078703	3	0	1	1
630	12041801	1	1	1	1	1208	12078704	4	0	1	1
631	12041802	2	1	1	1	1209	12078705	5	0	1	1
633	12041901	1	1	1	1	1210	12078706	6	0	1	1
684	12045001	1	1	1	1	1211	12078707	7	0	1	1
696	12045701	1	0	1	1	1212	12078708	8	0	1	1
697	12045702	2	0	1	1	1213	12078709	9	0	1	1
698	12045703	3	0	1	1	1376	12079601	1	1	1	1
699	12045704	4	0	1	1	1375	12079602	2	0	1	1
700	12045705	5	0	1	1	13	13001601	1	0	1	1
701	12045706	6	0	1	1	1338	13002001	1	0	1	1
702	12045707	7	0	1	1	1372	13002002	2	0	1	1
703	12045708	8	0	1	1	137	13011601	1	0	1	1
704	12045709	9	0	1	1	138	13011602	2	0	1	1
720	12046301	1	1	1	1	361	13024901	1	0	1	1
721	12046302	2	1	1	1	362	13024902	2	0	1	1
769	12051701	1	1	1	1	363	13024903	3	0	1	1
870	12055201	1	1	1	1	447	13029201	1	0	1	1
867	12055401	1	1	1	1	448	13029202	2	0	1	1
891	12057301	1	1	1	1	449	13029203	3	0	1	1
1285	12059101	1	1	1	1	450	13029204	4	0	1	1
1293	12059701	1	1	1	1	451	13029205	5	0	1	1
972	12063801	1	1	1	1	452	13029206	6	0	1	1
1029	12069601	1	1	1	1	453	13029207	7	0	1	1
1054	12070701	1	0	1	1	454	13029208	8	0	1	1

Artifacts	Artifact ID	Mna	Pools	Data1	Data2
438	13029209	9	0	1	1
439	13029210	10	0	1	1
590	13038901	1	1	1	1
591	13039001	1	1	1	1
735	13051201	1	0	1	1
736	13051202	2	0	1	1
737	13051203	3	0	1	1
738	13051204	4	0	1	1
739	13051205	5	0	1	1
740	13051206	6	0	1	1
741	13051207	7	0	1	0
1225	13051208	8	0	1	1
912	13051210	10	1	1	1
913	13051211	11	1	1	1
914	13051212	12	1	1	1
915	13051213	13	1	1	1
742	13051214	14	0	1	1
743	13051215	15	1	1	1
911	13051216	16	1	1	1
834	13053401	1	0	1	1
835	13053402	1	0	1	1
836	13053403	1	0	1	1
837	13053404	1	0	1	1
838	13053405	1	0	1	1
839	13053406	1	0	1	1
786	13054101	1	1	1	1
789	13054401	1	0	1	1
790	13054402	2	0	1	1
791	13054403	3	0	1	1
792	13054404	4	0	1	1
793	13054405	5	0	1	1
794	13054406	6	0	1	1
795	13054407	7	0	1	1
1028	13068301	1	1	1	1
1034	13070101	1	0	1	1
1035	13070102	2	0	1	1
1036	13070103	3	1	1	1
1037	13070104	4	1	1	1
1040	13070401	1	1	1	1
1041	13070402	2	1	1	1
1042	13070403	3	1	1	1
1043	13070404	4	1	1	1
1044	13070405	5	1	1	1
1045	13070406	6	1	1	1
1046	13070407	7	1	1	1
1047	13070408	8	1	1	1
1053	13070801	1	0	1	1
322	14023601	1	0	1	2
523	14033501	1	1	1	2
906	14058501	1	1	1	2
908	14058601	1	1	1	2
1049	14070501	1	0	1	2
1050	14070502	2	0	1	2
1051	14070503	3	0	1	2
1052	14070504	4	0	1	2
1033	15070001	1	0	1	1
1175	15078901	1	0	1	1
1176	15078902	2	0	1	1
1177	15078903	3	0	1	1
1178	15078904	4	0	1	1
1179	15078905	5	0	1	1
1180	15078906	6	0	1	1
1181	15078907	7	0	1	1
1182	15078908	8	0	1	1
1183	15078909	9	0	1	1
1184	15078910	10	0	1	1
1185	15078911	11	0	1	1
1186	15078912	12	0	1	1
1187	15078913	13	0	1	1
1188	15078914	14	0	1	1
1189	15078915	15	0	1	1
1190	15078916	16	0	1	1
1191	15078917	17	0	1	1
1192	15078918	18	0	1	1
1193	15078919	19	0	1	1
1194	15078920	20	0	1	1
1195	15078921	21	0	1	1
1196	15078922	22	0	1	1
1197	15078923	23	0	1	1
1198	15078924	24	0	1	1

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
517	16033301	1	1	1	1	210	20016301	1	1	1	1
1387	16053001	1	1	1	1	256	20018901	1	1	1	1
1317	20000901	1	0	1	1	257	20019001	1	1	1	1
1334	20002501	1	0	1	1	260	20019101	1	1	1	1
1332	20002502	2	0	1	1	261	20019201	1	1	1	1
1333	20002503	3	0	1	1	258	20019301	1	1	1	1
15	20002601	1	0	1	1	259	20019401	1	1	1	1
16	20002602	2	0	1	1	262	20019501	1	1	1	1
17	20002603	3	0	1	1	263	20019601	1	1	1	1
1231	20002801	1	1	1	1	288	20020501	1	1	1	1
79	20006701	1	1	1	1	289	20020601	1	1	1	1
80	20006801	1	1	1	1	290	20020701	1	1	1	1
107	20009001	1	1	1	1	194	20022001	1	1	1	1
127	20010601	1	1	1	1	195	20022101	1	1	1	1
128	20010701	1	1	1	1	200	20022201	1	1	1	1
129	20010801	1	0	1	1	196	20022301	1	1	1	1
130	20010901	1	0	1	1	197	20022401	1	1	1	1
131	20011001	1	0	1	1	198	20022501	1	1	1	1
132	20011101	1	0	1	1	199	20022601	1	1	1	1
133	20011201	1	0	1	1	298	20022701	1	1	1	1
160	20012301	1	1	1	1	297	20022801	1	1	1	1
161	20012401	1	1	1	1	299	20022901	1	1	1	1
162	20012501	1	1	1	1	300	20023001	1	1	1	1
165	20012601	1	1	1	1	303	20023101	1	1	1	1
163	20012701	1	1	1	1	380	20026401	1	0	1	1
164	20012801	1	1	1	1	381	20026501	1	0	1	1
166	20012901	1	1	1	1	382	20026601	1	0	1	1
167	20013001	1	1	1	1	389	20027201	1	1	1	1
168	20013101	1	1	1	1	390	20027301	1	1	1	1
169	20013201	1	1	1	1	434	20028901	1	1	1	1
170	20013301	1	1	1	1	435	20029001	1	1	1	1
171	20013401	1	1	1	1	436	20029101	1	1	1	1
159	20013501	1	1	1	1	484	20031001	1	1	1	1
158	20013601	1	1	1	1	486	20031201	1	1	1	1
157	20013701	1	1	1	1	496	20032101	1	0	1	1
172	20014401	1	1	1	1	540	20034701	1	1	1	1
183	20014501	1	1	1	1	539	20034801	1	1	1	1
182	20014601	1	1	1	1	544	20035101	1	1	1	1
208	20016101	1	1	1	1	548	20035401	1	1	1	1
209	20016201	1	1	1	1	551	20035501	1	1	1	1

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
549	20035601	1	1	1	1	1264	20050201	1	1	1	0
550	20035701	1	1	1	1	830	20053101	1	1	1	1
554	20036001	1	1	1	1	779	20053401	1	0	0	1
569	20037101	1	1	1	1	781	20053601	1	0	1	1
584	20038301	1	1	1	0	782	20053701	1	0	1	1
583	20038401	1	1	1	0	783	20053801	1	0	1	1
587	20038601	1	1	1	1	784	20053901	1	0	0	1
589	20038701	1	1	1	1	863	20054601	1	0	1	1
588	20038801	1	1	1	1	862	20054701	1	0	1	1
592	20039101	1	1	1	1	877	20056101	1	1	1	1
593	20039201	1	1	1	1	878	20056102	2	1	1	1
595	20039301	1	1	1	1	879	20056103	3	1	1	1
594	20039401	1	1	1	1	887	20056501	1	1	1	0
596	20039501	1	1	1	1	886	20056601	1	1	1	0
616	20040701	1	1	1	1	885	20056701	1	0	1	0
617	20040801	1	1	1	1	884	20056801	1	0	1	0
618	20040901	1	1	1	1	883	20056901	1	0	1	0
661	20042901	1	1	1	1	882	20057001	1	1	1	0
1245	20046801	1	1	1	1	896	20057401	1	1	1	1
1246	20046901	1	1	1	1	901	20057601	1	1	1	1
1247	20047001	1	1	1	1	902	20057701	1	1	1	1
1248	20047101	1	1	1	1	900	20057801	1	1	1	1
1249	20047201	1	1	1	1	899	20057901	1	1	1	1
1250	20047301	1	1	1	1	897	20058001	1	1	1	1
1251	20047401	1	1	1	1	903	20058101	1	1	1	1
1252	20047501	1	1	1	1	892	20058201	1	1	1	1
1253	20047601	1	1	1	1	904	20058201	1	1	1	1
1254	20047701	1	0	1	1	893	20058301	1	1	1	1
1255	20047801	1	0	1	1	905	20058301	1	1	1	1
1268	20049101	1	1	1	0	898	20058401	1	1	1	1
1267	20049201	1	1	1	0	942	20061301	1	1	1	1
1266	20049301	1	1	1	0	943	20061401	1	1	1	1
1265	20049401	1	1	1	0	965	20063401	1	1	1	1
1281	20049501	1	1	1	0	970	20063701	1	1	1	1
1280	20049601	1	1	1	0	995	20066601	1	0	1	1
1279	20049701	1	1	1	0	996	20066701	1	0	1	1
1278	20049801	1	1	1	0	1371	20066801	1	0	1	1
1277	20049901	1	1	1	0	1073	20071801	1	0	0	1
1262	20050001	1	1	1	0	1074	20071901	1	1	1	1
1263	20050101	1	1	1	0	1075	20072001	1	1	1	1

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
1076	20072101	1	1	1	1	98	21008201	1	1	1	1
1077	20072201	1	1	1	1	106	21008901	1	1	1	1
1078	20072301	1	1	1	1	180	21013901	1	1	1	1
1079	20072401	1	1	1	1	176	21014001	1	1	1	1
1080	20072501	1	1	1	1	177	21014002	2	1	1	1
1081	20072601	1	1	1	1	178	21014003	3	1	1	1
1085	20073001	1	1	1	1	201	21015401	1	1	1	1
1097	20074201	1	1	1	1	228	21016601	1	0	1	1
1104	20074701	1	1	1	1	236	21017401	1	1	1	1
1105	20074801	1	1	1	1	237	21017501	1	1	1	1
1106	20074901	1	1	1	1	245	21017601	1	0	1	1
1108	20075001	1	1	1	1	251	21018601	1	0	1	1
1107	20075101	1	1	1	1	279	21019901	1	1	1	1
1136	20075901	1	1	1	1	280	21019902	2	1	1	1
1146	20076001	1	1	1	1	307	21021501	1	1	1	1
1147	20076101	1	1	1	1	317	21021801	1	1	1	1
1159	20077101	1	1	1	1	310	21021901	1	1	1	1
1160	20077201	1	1	1	1	311	21021902	2	1	1	1
1161	20077301	1	1	1	1	312	21021903	3	1	1	1
1162	20077401	1	1	1	1	313	21021904	4	1	1	1
1163	20077501	1	1	1	1	314	21021905	5	1	1	1
1164	20077601	1	1	1	1	315	21021906	6	1	1	1
1382	20079801	1	1	1	1	316	21021907	7	1	1	1
1377	20079901	1	1	1	1	320	21023401	1	1	1	1
832	20081501	1	1	1	1	353	21024101	1	0	1	1
1082	20202701	1	1	1	1	364	21024801	1	0	1	1
1	21000101	1	0	1	1	1405	21025401	1	1	1	1
1358	21000601	1	0	1	1	372	21025701	1	0	1	1
35	21003701	1	0	1	1	373	21025702	2	0	1	1
33	21003801	1	0	1	1	374	21025703	3	0	1	1
34	21003901	1	0	1	1	377	21026201	1	0	1	1
36	21004001	1	0	1	1	412	21027601	1	0	1	1
1359	21004101	1	1	1	1	430	21028501	1	1	1	1
37	21004201	1	0	1	1	455	21029501	1	0	1	1
59	21005401	1	1	1	1	485	21031101	1	1	1	1
61	21005501	1	1	1	1	497	21032001	1	0	1	1
78	21006101	1	1	1	1	504	21032501	1	0	1	1
81	21007301	1	1	1	1	505	21032502	2	0	1	1
85	21007401	1	1	1	1	506	21032503	3	0	1	1
86	21007402	2	1	1	1	507	21032504	4	0	1	1

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
508	21032505	5	0	1	1	822	21046611	11	0	0	1
556	21032506	6	0	1	1	813	21046612	12	0	0	1
509	21032601	1	1	1	1	823	21046612	12	0	0	1
515	21033101	1	1	1	1	814	21046613	13	0	0	1
526	21033601	1	1	1	1	1260	21048501	1	1	1	1
535	21034401	1	1	1	1	1261	21048502	2	1	1	1
536	21034402	2	1	1	1	828	21052801	1	1	1	1
537	21034501	1	1	1	1	772	21053101	1	1	1	1
541	21034901	1	1	1	1	773	21053201	1	1	1	1
545	21035301	1	1	1	1	868	21055301	1	1	1	1
546	21035302	2	1	1	1	866	21055501	1	1	1	1
585	21038101	1	1	1	1	889	21057001	1	1	1	1
586	21038501	1	1	1	1	895	21057501	1	1	1	1
615	21040201	1	1	1	1	1282	21058901	1	1	1	1
625	21041301	1	1	1	1	1288	21059401	1	1	1	1
652	21042201	1	1	1	1	1289	21059402	2	1	1	1
653	21042501	1	1	1	1	918	21060901	1	1	1	1
665	21043301	1	1	1	1	917	21061001	1	1	1	1
682	21044601	1	1	1	1	944	21061601	1	1	1	1
683	21044602	2	1	1	1	945	21061602	2	1	1	1
706	21045901	1	0	1	1	946	21061701	1	1	1	1
707	21045902	2	0	1	1	950	21062101	1	1	1	1
708	21045903	3	0	1	1	951	21062102	2	1	1	1
709	21045904	4	0	1	1	952	21062103	3	1	1	1
711	21046001	1	1	1	1	960	21062901	1	1	1	1
712	21046002	2	1	1	1	961	21063001	1	1	1	1
796	21046601	1	0	1	1	963	21063201	1	1	1	1
797	21046602	2	0	1	1	1003	21067101	1	1	1	1
798	21046603	3	0	1	1	1006	21067501	1	1	1	1
744	21046604	4	0	1	1	1007	21067502	2	1	1	1
745	21046605	5	0	1	1	1008	21067503	3	1	1	1
746	21046606	6	0	1	1	1009	21067504	4	1	1	1
747	21046607	7	0	1	1	1018	21068501	1	1	1	1
809	21046608	8	0	1	1	1039	21070301	1	1	1	1
819	21046608	8	0	1	1	1071	21071501	1	1	1	1
810	21046609	9	0	0	1	1090	21073501	1	1	1	1
820	21046609	9	0	0	1	1092	21073701	1	1	1	1
811	21046610	10	0	0	1	1098	21074301	1	1	1	1
821	21046610	10	0	0	1	1099	21074302	2	1	1	1
812	21046611	11	0	0	1	1112	21075201	1	0	1	1

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
1113	21075202	2	0	1	1	60	31005601	1	1	2	3
1137	21075801	1	1	1	1	246	31017001	1	1	2	3
1138	21075802	2	0	1	1	1316	32001001	1	0	2	3
1139	21075803	3	0	1	1	1325	32001401	1	0	2	3
1140	21075804	4	0	1	1	1360	32005701	1	1	2	3
1141	21075805	5	0	1	1	532	32033901	1	0	2	3
1142	21075806	6	0	1	1	533	32033902	2	0	2	3
1143	21075807	7	0	1	1	534	32033903	3	0	2	3
1144	21075808	8	1	1	1	726	32046401	1	0	2	3
1145	21075809	9	1	1	1	722	32046501	1	0	2	3
1166	21078001	1	0	1	1	723	32046502	2	0	2	3
1167	21078002	2	0	1	1	724	32046503	3	0	2	3
1168	21078003	3	0	1	1	725	32046504	4	0	2	3
1169	21078004	4	0	1	1	1135	32075701	1	0	2	4
1170	21078005	5	0	1	1	937	33060701	1	0	2	4
1171	21078006	6	0	1	1	938	33060801	1	0	2	4
1172	21078007	7	0	1	1	1220	33079201	1	0	2	4
1173	21078008	8	0	1	1	7	41000501	1	0	3	5
1174	21078009	9	0	1	1	993	41065901	1	0	3	5
1222	21079301	1	0	1	1	1002	41067001	1	0	3	5
1374	21079701	1	1	1	1	383	42026701	1	0	3	6
774	21080901	1	0	1	1	481	42030801	1	0	3	6
775	21080902	2	0	1	1	864	43054501	1	0	3	7
776	21080903	3	0	1	1	1012	43067801	1	0	3	7
777	21080904	4	0	1	1	384	51026801	1	0	4	9
778	21080905	5	0	1	1	480	51030701	1	0	4	8
571	21081901	1	1	1	1	818	51052201	1	0	4	9
572	21081902	2	1	1	1	831	51053201	1	1	4	9
188	22015101	1	1	1	1	994	51065801	1	0	4	9
378	22026301	1	0	1	1	1048	51070602	1	1	4	9
379	22026302	2	0	1	1	1363	52023203	1	0	4	9
464	22030101	1	0	1	1	482	52030901	1	0	4	9
780	22053501	1	0	1	1	608	52040301	1	0	4	9
859	22054401	1	0	1	1	606	52040401	1	0	4	9
695	23042001	1	1	1	1	607	52040501	1	0	4	9
869	24055601	1	1	1	1	643	52042201	1	0	4	9
126	25011301	1	0	1	1	748	52051102	1	0	4	9
151	25011302	2	1	1	1	770	52052903	1	0	4	9
255	25018801	1	1	1	1	787	52054301	1	0	4	9
669	25043501	1	1	1	1	1284	52059201	1	1	4	9

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
1000	52066104	1	0	4	9	1364	70026001	1	0	6	13
998	52066201	1	0	4	9	1365	70026101	1	0	6	13
997	52066301	1	0	4	9	425	70028001	1	0	6	13
981	52066401	1	0	4	9	427	70028101	1	0	6	13
999	52066401	1	0	4	9	367	70029401	1	0	6	13
985	52066901	1	0	4	9	466	70030301	1	0	6	13
824	53052301	1	0	4	9	527	70033701	1	0	6	13
825	53052401	1	0	4	9	528	70033801	1	0	6	13
827	53052501	1	0	4	9	530	70034001	1	0	6	13
826	53052601	1	0	4	9	531	70034101	1	0	6	13
72	60006001	1	1	5	10	1369	70034301	1	0	6	13
1331	70001901	1	0	6	13	552	70035801	1	0	6	13
1339	70002201	1	0	6	13	553	70035901	1	0	6	13
1337	70002401	1	0	6	13	559	70036101	1	1	6	13
38	70004301	1	0	6	13	560	70036501	1	1	6	13
39	70006501	1	0	6	13	581	70037801	1	1	6	13
40	70006601	1	0	6	13	582	70038201	1	1	6	13
88	70007501	1	1	6	13	659	70042701	1	0	6	13
135	70011801	1	1	6	13	685	70045101	1	1	6	13
134	70011901	1	1	6	13	686	70045201	1	1	6	13
136	70012001	1	1	6	13	687	70045301	1	1	6	13
50	70014901	1	0	6	13	728	70048001	1	1	6	13
212	70016001	1	1	6	13	729	70048101	1	1	6	13
249	70017601	1	0	6	13	1256	70048401	1	1	6	13
248	70017701	1	0	6	13	808	70050801	1	1	6	13
247	70017801	1	0	6	13	733	70050901	1	1	6	13
232	70017901	1	1	6	13	734	70051001	1	1	6	13
233	70018001	1	1	6	13	815	70051901	1	0	6	13
235	70018101	1	1	6	13	816	70052001	1	0	6	13
234	70018201	1	1	6	13	817	70052101	1	0	6	13
1373	70021001	1	0	6	13	829	70052901	1	1	6	13
321	70023501	1	0	6	13	771	70053001	1	1	6	13
354	70024201	1	0	6	13	851	70053701	1	0	6	13
355	70024301	1	0	6	13	852	70053801	1	0	6	13
356	70024401	1	0	6	13	853	70053901	1	0	6	13
357	70024501	1	0	6	13	854	70054001	1	0	6	13
359	70024701	1	0	6	13	860	70054101	1	0	6	13
360	70025001	1	0	6	13	865	70055001	1	1	6	13
365	70025101	1	0	6	13	880	70056201	1	1	6	13
366	70025201	1	0	6	13	907	70058701	1	1	6	13

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
909	70058801	1	1	6	13	1221	70079301	1	0	6	13
910	70058901	1	1	6	13	1404	70081001	1	1	6	13
1301	70059901	1	1	6	13	1403	70081101	1	1	6	13
1300	70060001	1	1	6	13	1402	70081201	1	1	6	13
1302	70060101	1	1	6	13	555	70081601	1	0	6	13
916	70060401	1	1	6	13	1165	71077901	1	0	6	8
941	70061501	1	0	6	13	861	73054801	1	0	6	8
953	70062201	1	0	6	13	1096	80074101	1	1	7	11
954	70062301	1	0	6	13	1224	80079001	1	0	7	11
955	70062401	1	0	6	13	514	81030601	1	0	7	11
956	70062501	1	0	6	13	513	81032801	1	0	7	11
957	70062601	1	0	6	13	1408	81081601	1	0	7	11
958	70062701	1	0	6	13	1320	90001101	1	1	0	0
959	70062801	1	1	6	13	1319	90001201	1	1	0	0
983	70064901	1	0	6	13	1318	90001301	1	1	0	0
982	70065001	1	0	6	13	1227	90003001	1	1	0	0
991	70065101	1	0	6	13	1229	90003001	1	1	0	0
992	70065201	1	0	6	13	1226	90003201	1	1	0	0
990	70065301	1	0	6	13	54	90004901	1	1	0	0
989	70065401	1	0	6	13	53	90005001	1	1	0	0
987	70065501	1	0	6	13	55	90005101	1	1	0	0
988	70065601	1	0	6	13	56	90005201	1	1	0	0
986	70065701	1	0	6	13	57	90005301	1	1	0	0
1001	70066001	1	0	6	13	77	90006201	1	1	0	0
1100	70074401	1	0	6	13	76	90006301	1	1	0	0
1101	70074501	1	0	6	13	75	90006401	1	1	0	0
1151	70076301	1	1	6	13	74	90006501	1	1	0	0
1152	70076401	1	1	6	13	87	90006901	1	1	0	0
1153	70076501	1	1	6	13	82	90007001	1	1	0	0
1154	70076601	1	1	6	13	83	90007101	1	1	0	0
1156	70076701	1	1	6	13	84	90007201	1	1	0	0
1155	70076801	1	1	6	13	89	90007601	1	1	0	0
1157	70076901	1	1	6	13	90	90007701	1	1	0	0
1158	70077001	1	1	6	13	91	90007801	1	1	0	0
1199	70078101	1	0	6	13	92	90007901	1	1	0	0
1200	70078201	1	0	6	13	93	90008001	1	1	0	0
1201	70078301	1	0	6	13	101	90008601	1	1	0	0
1202	70078401	1	0	6	13	100	90008701	1	1	0	0
1203	70078501	1	0	6	13	117	90009401	1	1	0	0
1204	70078601	1	0	6	13	120	90009501	1	1	0	0

Artifacts	Artifact ID	Mna	Pools	Data1	Data2	Artifacts	Artifact ID	Mna	Pools	Data1	Data2
121	90009601	1	1	0	0	1259	90048601	1	1	0	0
122	90009701	1	1	0	0	1269	90048701	1	1	0	0
118	90009801	1	1	0	0	1270	90048801	1	1	0	0
119	90010001	1	1	0	0	1271	90048901	1	1	0	0
1361	90010101	1	1	0	0	1258	90049001	1	1	0	0
123	90010201	1	1	0	0	1276	90050301	1	1	0	0
124	90010301	1	1	0	0	1274	90050401	1	1	0	0
125	90010401	1	1	0	0	1275	90050501	1	1	0	0
1235	90015001	1	1	0	0	768	90050601	1	1	0	0
432	90028601	1	1	0	0	1273	90050601	1	1	0	0
431	90028701	1	1	0	0	1272	90050701	1	1	0	0
493	90030701	1	1	0	0	874	90055701	1	1	0	0
491	90031501	1	1	0	0	873	90055801	1	1	0	0
492	90031601	1	1	0	0	872	90055901	1	1	0	0
494	90031801	1	1	0	0	875	90056001	1	1	0	0
495	90031901	1	1	0	0	888	90056401	1	1	0	0
498	90032201	1	1	0	0	936	90060501	1	1	0	0
512	90032701	1	1	0	0	947	90061801	1	1	0	0
510	90033001	1	1	0	0	948	90061901	1	1	0	0
516	90033201	1	1	0	0	974	90064101	1	1	0	0
558	90036201	1	1	0	0	976	90064201	1	1	0	0
557	90036301	1	1	0	0	975	90064301	1	1	0	0
575	90036701	1	1	0	0	977	90064401	1	1	0	0
574	90036801	1	1	0	0	978	90064501	1	1	0	0
573	90036901	1	1	0	0	979	90064601	1	1	0	0
565	90037301	1	1	0	0	980	90064701	1	1	0	0
566	90037401	1	1	0	0	1010	90067701	1	1	0	0
567	90037501	1	1	0	0	1014	90068001	1	1	0	0
568	90037601	1	1	0	0	1015	90068101	1	1	0	0
624	90041101	1	1	0	0	1019	90068601	1	1	0	0
626	90041401	1	1	0	0	1020	90068701	1	1	0	0
627	90041501	1	1	0	0	1021	90068901	1	1	0	0
629	90041601	1	1	0	0	1022	90069001	1	1	0	0
628	90041701	1	1	0	0	1023	90069101	1	1	0	0
666	90043401	1	1	0	0	1024	90069201	1	1	0	0
679	90044201	1	1	0	0	1025	90069301	1	1	0	0
678	90044301	1	1	0	0	1026	90069401	1	1	0	0
676	90044401	1	1	0	0	1027	90069501	1	1	0	0
677	90044501	1	1	0	0	1030	90069801	1	1	0	0
691	90045601	1	1	0	0	1032	90069801	1	1	0	0

Artifacts	Artifact ID	Mna	Pools	Data1	Data2
1031	90069901	1	1	0	0
1038	90070201	1	1	0	0
1066	90071001	1	1	0	0
1067	90071101	1	1	0	0
1068	90071201	1	1	0	0
1069	90071301	1	1	0	0
1070	90071401	1	1	0	0
1072	90071601	1	1	0	0
1083	90072801	1	1	0	0
1084	90072901	1	1	0	0
1086	90073101	1	1	0	0
1087	90073201	1	1	0	0
1088	90073301	1	1	0	0
1089	90073401	1	1	0	0
1091	90073601	1	1	0	0
1094	90073901	1	1	0	0
1095	90074001	1	1	0	0
1378	90080001	1	1	0	0
1380	90080101	1	1	0	0
1379	90080201	1	1	0	0
1383	90080301	1	1	0	0
1384	90080401	1	1	0	0
1385	90080501	1	1	0	0
1386	90080601	1	1	0	0
1381	90080701	1	1	0	0

Appendix F

Artifact Counts by Class

Class	Count	% of Total
Ceramics	1103	n=1408
Speleothems	116	0.78
Faunal remains	26	0.08
Groundstone	17	0.02
Chipped stone	7	0.01
Slate	5	0.005
Monument	1	0.004
Unknown	133	0.001
		0.09

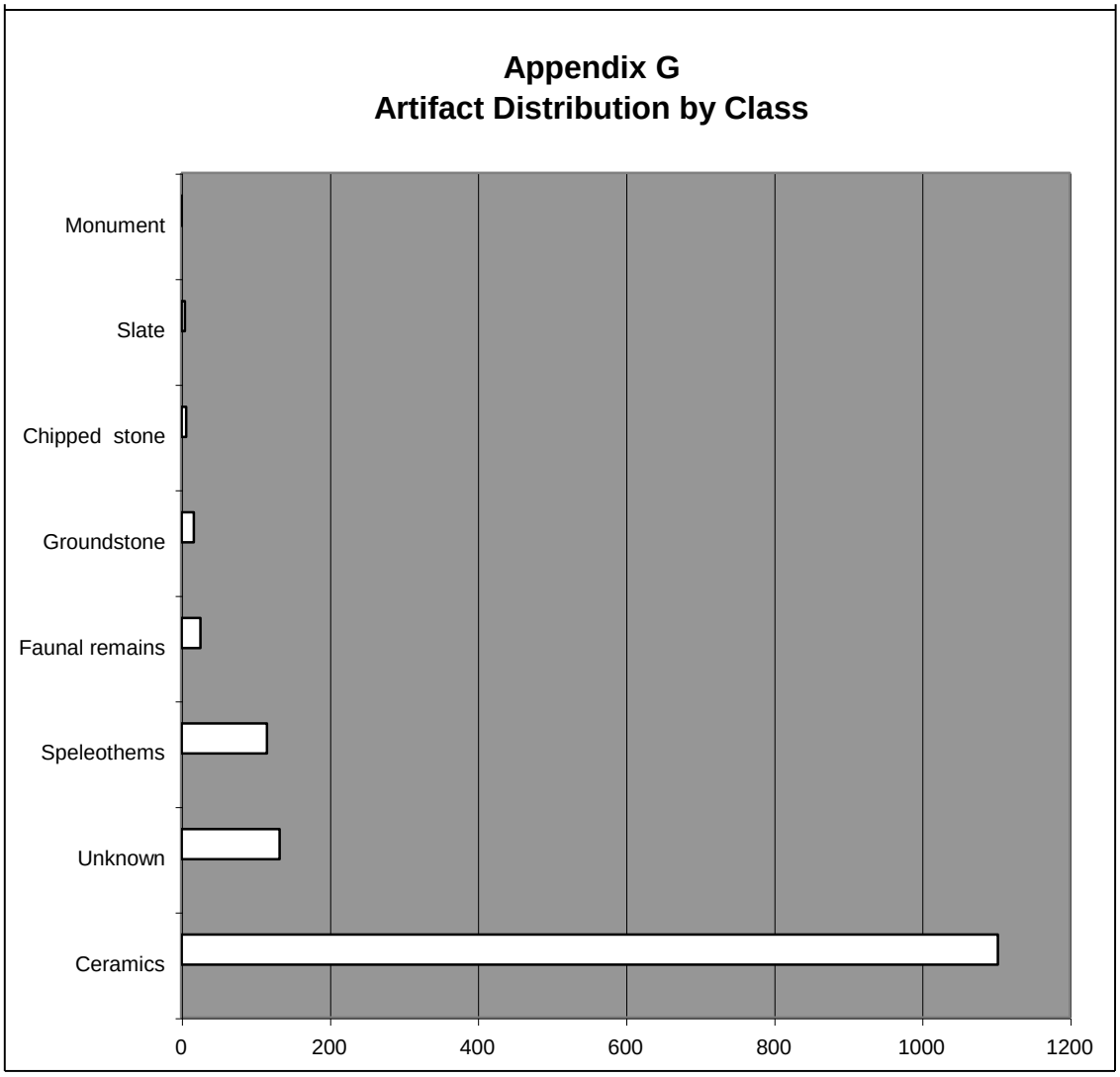
Artifact Counts by Sub-class

	Count	% of Total	% of class
Ceramics		n=1408	n=745
Jars	543	0.38	0.72
Bowls	108	0.08	0.14
Dishes	59	0.04	0.08
Shoe pots	25	0.02	0.03
Whistles	8	0.005	0.01
Vases	2	0.001	0.003
Single Sherds			n=358
Jars	163	0.16	0.46
Bowls	6	0.004	0.008
Dishes	0	0	0
Shoe pots	4	0.003	0.01
Whistles	1	0	0.001
Vases	0	0	0
Unknown	184	0.13	0.51
Ceramics & Single Sherds Combined			n=1103
Jars	706	0.5	0.64
Bowls	114	0.08	0.1
Dishes	59	0.04	0.05
Shoe pots	29	0.02	0.04
Whistles	9	0.006	0.008
Vases	2	0.001	0.002
Unknown	184	0.13	0.17

Appendix F Continued

Groundstone		n=1408	n=16
Metates	12	0.007	0.69
Celts	3	0.002	0.19
Manos	2	0.001	0.13
Chipped stone			n=7
Obsidian	3	0.002	0.43
Quartzite	2	0.001	0.29
Pyrite	2	0.001	0.29
Faunal remains			n=26
Bat bone	11	0.008	0.42
Shell	6	0.004	0.23
Teeth	4	0.003	0.15
Jaguar bone	2	0.001	0.08
Unknown bone	2	0.001	0.08
Claw	1	0.001	0.04

Appendix G
Artifact Distribution by Class



Appendix H

MNA Artifact Counts by Class

Class	Count	% of Total
		n=718
Ceramics	551	0.77
Speleothems	116	0.16
Faunal remains	26	0.04
Groundstone	12	0.02
Chipped stone	7	0.01
Slate	5	0.007
Monument	1	0.001

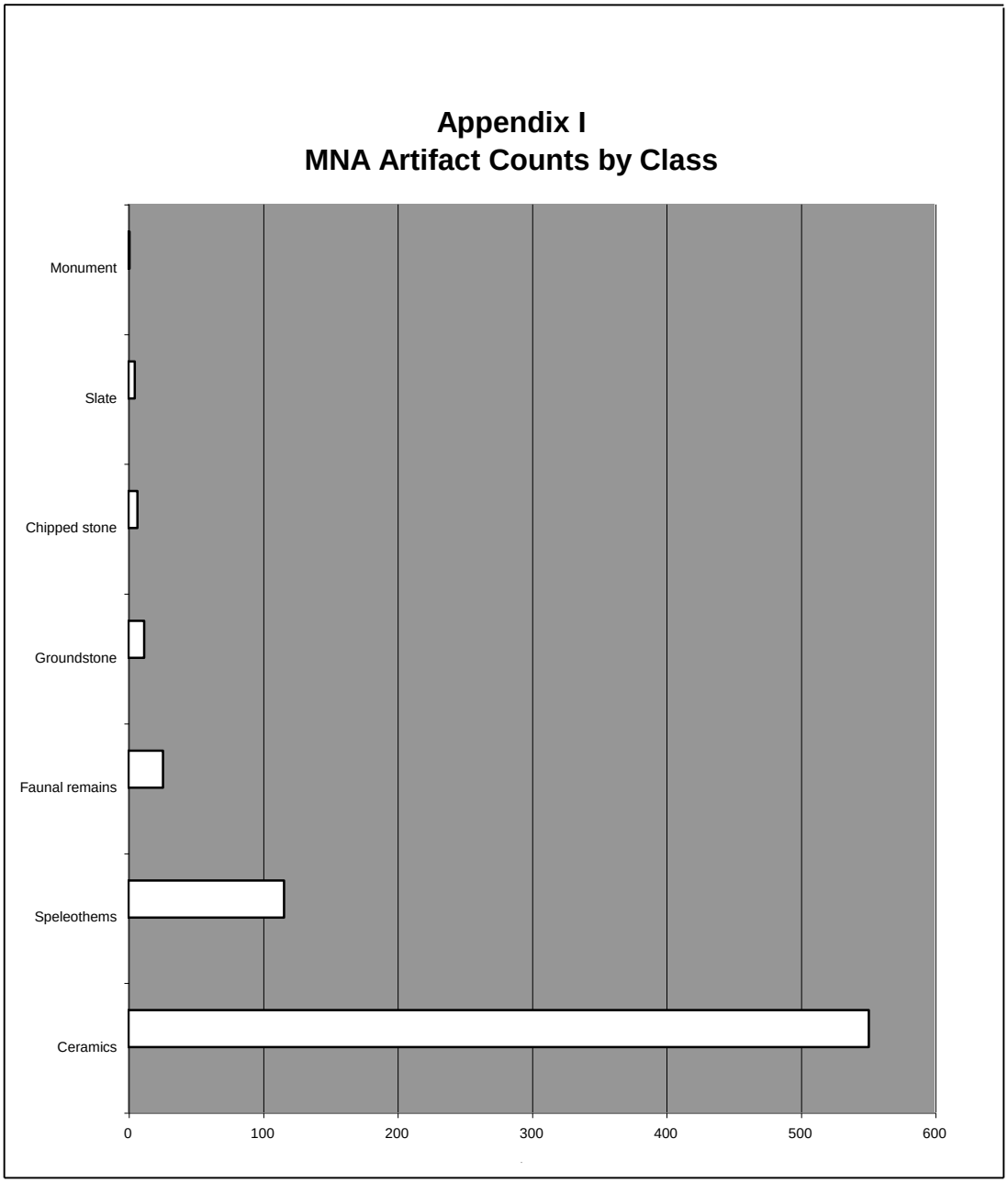
MNA Artifact Counts by Sub-class

	Count	% of Total	%of Class
Ceramics		n=718	n=273
Jars	205	0.29	0.75
Bowls	40	0.06	0.15
Dishes	19	0.03	0.07
Whistles	5	0.007	0.018
Shoe pots	2	0.003	0.007
Vases	2	0.003	0.007
Single sherds			n=278
Jars	91	0.13	0.32
Bowls	5	0.007	0.02
Dishes	0	0	0
Whistles	1	0.001	0.004
Shoe pots	3	0.004	0.01
Vases	0	0	0
Body sherds	178	0.25	0.64
Ceramics & Single Sherds Combined	n=551		
Jars	296	0.41	0.54
Bowls	45	0.06	0.08
Dishes	19	0.03	0.03
Whistles	6	0.008	0.01
Shoe pots	5	0.007	0.009
Vases	2	0.003	0.004
Body sherds	178	0.25	0.32

Appendix H Continued

Groundstone			n=12
Manos	2	0.003	0.17
Metates	7	0.01	0.58
Celts	3	0.004	0.25
Chipped stone			n=7
Obsidian	3	0.004	0.42
Quartzite	2	0.003	0.29
Pyrite	2	0.003	0.29
Faunal remains			n=26
Shell	6	0.008	0.23
Jaguar bone	2	0.003	0.08
Bat bone	11	0.02	0.42
Unknown bone	2	0.003	0.08
Teeth	4	0.006	0.15
Claw	1	0.001	0.04

Appendix I
MNA Artifact Counts by Class



Appendix J

Artifact #	Art. ID #	Mna	X_coord	Y_coord	Type/Variety
2	11000201	1	55.5837	13.38765	Cayo Unslipped:Cayo Variety
4	11000401	1	54.894	16.3872	Cayo Unslipped:Unspecified(red slip)
8	11000301	1	55.0908	16.78784	Cayo Unslipped:Unspecified(red slip)
13	13001601	1	57.1455	23.42583	Roaring Creek Red: Roaring Creek Variety
32	11000701	1	55.7408	18.68954	Cayo Unslipped:Unspecified(red slip)
41	11004401	1	56.1387	30.82446	Cayo Unslipped:Unspecified(red slip)
47	11004501	1	56.3103	30.08309	Cayo Unslipped:Cayo Variety
49	12004601	1	56.1499	29.9836	Garbutt Creek Red:Tunichil Variety
51	11004701	1	55.6568	30.5894	Cayo Unslipped:Unspecified(red slip)
52	11004801	1	55.8648	30.58504	Cayo Unslipped:Cayo Variety
58	11015101	1	54.5754	31.5852	Cayo Unslipped:Cayo Variety
62	11005801	1	56.5113	31.7558	Cayo Unslipped:Unspecified(red slip)
71	12005901	1	56.4342	31.82508	Vaca Falls Red:Vaca Falls Variety
78	21006101	1	54.4807	32.75151	Cayo Unslipped:Unspecified(red slip)
85	21007401	1	55.5251	35.08703	Tu-tu Camp Striated:Tzimin Variety
94	11008301	1	58.8222	33.85575	Cayo Unslipped:Unspecified(red slip)
97	11008101	1	58.7675	33.32607	Cayo Unslipped:Cayo Variety
99	11008401	1	58.576	33.89671	Cayo Unslipped:Cayo Variety
102	11008501	1	57.9324	34.23969	Cayo Unslipped:Unspecified(red slip)
105	11008801	1	56.9774	35.06503	Cayo Unslipped:Unspecified(red slip)
108	11009301	1	56.2819	37.35648	Cayo Unslipped:Cayo Variety
112	11009201	1	57.4316	39.26114	Cayo Unslipped:Cayo Variety
114	11010501	1	57.3268	39.37036	Cayo Unslipped:Unspecified(red slip)
126	25011301	1	53.873	37.16386	Shoe-shaped Vessel
137	13011601	1	52.1739	35.44093	Roaring Creek Red: Roaring Creek Variety
139	11011501	1	52.4935	35.6738	Tu-tu Camp Striated:Tzimin Variety
143	11011701	1	51.8037	37.21166	Tu-tu Camp Striated:Tzimin Variety
146	11012201	1	53.7492	36.59925	Cayo Unslipped:Unspecified(red slip)
153	12013801	1	53.1892	36.59111	Garbutt Creek Red: Garbutt Creek Variety
154	12012101	1	53.094	36.46595	Garbutt Creek Red:Tunichil Variety
173	11014301	1	53.1353	38.81068	Cayo Unslipped:Unspecified(red slip)
176	21014001	1	53.1282	38.43393	Cayo Unslipped:Unspecified(red slip)
180	21013901	1	52.6897	38.43135	Cayo Unslipped: Cayo Variety
181	11014801	1	52.8175	38.38942	Tu-tu Camp Striated:Tzimin Variety
184	11014701	1	53.0434	41.88661	Cayo Unslipped:Unspecified(red slip)
189	11015201	1	53.5192	32.70232	Tu-tu Camp Striated:Tzimin Variety
201	21015401	1	49.2344	36.16512	Plumbate
202	11015501	1	49.3983	35.60073	Cayo Unslipped:Cayo Variety

211	11015901	1	48.7286	34.80277	Alexander's Unslipped:Beaverdam
213	11015601	1	48.7563	35.94983	Roaring Creek Red: Roaring Creek Variety
215	11015801	1	49.1038	34.96646	Alexander's Unslipped:Beaverdam
216	11016501	1	47.7888	37.98522	Cayo Unslipped:Unspecified(red slip)
225	11016401	1	48.1769	38.83501	Roaring Creek Red: Roaring Creek Variety
228	21016601	1	48.0957	38.59186	Tu-tu Camp Striated:Tzimin Variety
229	11016701	1	48.1166	37.94236	Cayo Unslipped:Cayo Variety
230	12017301	1	48.4937	37.79665	Vaca Falls Red:Vaca Falls Variety
238	11017201	1	47.3199	37.79439	Cayo Unslipped:Unspecified(red slip)
240	11017101	1	47.3601	37.62879	Cayo Unslipped:Unspecified(red slip)
241	12016801	1	48.2508	37.65532	Garbutt Creek Red: Tunichil Variety
244	11016901	1	48.2142	37.43953	Alexander's Unslipped:Alexanders Variety
250	11018301	1	47.9348	40.35244	Tu-tu Camp Striated:Tzimin Variety
251	21018601	1	62.7557	40.71313	Cayo Unslipped:Unspecified(red slip)
253	12018401	1	64.1704	37.87006	Kaway Impressed:Kaway Variety
254	11018701	1	48.0253	43.86711	Cayo Unslipped:Cayo Variety
255	25018801	1	51.8882	42.89207	Shoe-shaped Vessel
265	11019701	1	54.0513	41.7092	Tu-tu Camp Striated:Tzimin Variety
277	11019801	1	54.4445	41.68642	Cayo Unslipped:Cayo Variety
283	11020301	1	49.1895	46.53531	Cayo Unslipped:Cayo Variety
285	11020201	1	49.5133	47.02044	Cayo Unslipped:Cayo Variety
286	11020401	1	48.9095	46.52857	Cayo Unslipped:Cayo Variety
287	11020001	1	49.7501	45.77269	Cayo Unslipped:Cayo Variety
291	11020801	1	49.2855	48.47829	Cayo Unslipped:Cayo Variety
293	12020901	1	48.8528	48.19444	Garbutt Creek Red: Paslow Variety
295	11021101	1	49.2851	47.262	Cayo Unslipped:Cayo Variety
301	11021201	1	50.4061	47.63712	Cayo Unslipped:Unspecified(red slip)
302	11021301	1	50.1522	47.61495	Alexander's Unslipped:Alexanders Variety
307	21021501	1	52.1095	46.88603	Cayo Unslipped:Variety Unspecified (red)
308	11021601	1	53.3092	48.15968	Cayo Unslipped:Cayo Variety
310	21021901	1	52.2808	50.11407	Cayo Unslipped:Variety Unspecified (red)
319	12023301	1	43.4401	55.87797	Garbutt Creek Red: Paslow Variety
323	12023701	1	26.6235	63.97192	Rubber Camp Brown:Rubber Camp Variety
328	11023801	1	38.8031	63.44939	Tu-tu Camp Striated:Variety Unspecified (Beaverdam)
336	11023901	1	38.0224	64.18321	Cayo Unslipped:Unspecified(red slip)
344	11024001	1	38.3153	64.37168	Tu-tu Camp Striated:Variety Unspecified (Beaverdam)
353	21024101	1	38.0927	64.3177	Cayo Unslipped:Unspecified(red slip)
358	11024601	1	38.7718	64.1622	Tu-tu Camp Striated:Variety Unspecified (Beaverdam)
361	13024901	1	38.1427	64.87654	Roaring Creek Red: Roaring Creek Variety
364	21024801	1	38.1193	65.01728	Cayo Unslipped:Unspecified(red slip)
368	11025301	1	38.4544	64.91521	Tu-tu Camp Striated:Variety Unspecified (Beaverdam)
369	11025501	1	47.0918	64.29274	Cayo Unslipped:Variety Unspecified (red)
371	11025601	1	47.4812	64.37273	Cayo Unslipped:Variety Unspecified (red)
372	21025701	1	32.5283	63.00475	Tu-tu Camp Striated:Variety Unspecified (Beaverdam)
375	12025801	1	32.6925	63.26567	Garbutt Creek Red:Paslow Variety
376	11025901	1	45.8801	62.92036	Cayo Unslipped:Unspecified(red slip)
377	21026201	1	32.6652	64.60679	Tu-tu Camp Striated:Variety Unspecified (Beaverdam)
378	22026301	1	33.4811	65.0696	Garbutt Creek Red:Paslow Variety

386	11027001	1	37.6272	67.16894	Cayo Unslipped:Cayo Variety
391	11026901	1	37.4399	67.02434	Cayo Unslipped:Variety Unspecified (red)
397	11027101	1	37.5678	67.74041	Cayo Unslipped:Unspecified(red slip)
399	11027501	1	38.0338	67.94562	Cayo Unslipped:Unspecified(red slip)
408	11027401	1	38.199	67.83438	Cayo Unslipped:Cayo Variety
413	12027701	1	35.4595	69.52744	Garbutt Creek Red: Garbutt Cr.
424	11027801	1	44.6543	69.87876	Cayo Unslipped:Variety Unspecified (red)
426	11027901	1	44.7167	69.46584	Cayo Unslipped:Cayo Variety
428	11028201	1	45.7118	69.81564	Cayo Unslipped:Cayo Variety
429	11028401	1	49.3482	69.4472	Cayo Unslipped:Unspecified(red slip)
430	21028501	1	42.5709	70.40554	Tu-tu Camp Striated:Tu-Tu Camp Variety
433	11028801	1	45.1463	66.60457	Cayo Unslipped:Cayo Variety
437	11081701	1	47.219	71.15224	Cayo Unslipped:Cayo Variety
440	11029301	1	47.5265	70.16148	Tu-tu Camp Striated:Tu-Tu Camp Variety
442	11029401	1	48.2278	70.97256	Cayo Unslipped:Unspecified(red slip)
447	13029201	1	48.4254	70.46571	Roaring Creek Red: Roaring Creek Variety
455	21029501	1	34.094	72.46491	Tu-tu Camp Striated:Tu-Tu Camp Variety
456	11029601	1	35.9834	71.27814	Cayo Unslipped:Unspecified(red slip)
457	11029701	1	45.0449	71.12395	Cayo Unslipped:Unspecified(red slip)
464	22030101	1	41.8081	72.76488	Roaring Creek Red: Roaring Creek Variety
467	12030401	1	33.5457	75.75536	Garbutt Creek Red: Garbutt Cr.
475	11029801	1	41.1729	72.04414	Tu-tu Camp Striated:Variety Unspecified (Beaverdam)
476	12030001	1	40.5299	73.16901	Garbutt Creek Red: Paslow Var.
479	11029901	1	40.3414	72.84599	Tu-tu Camp Striated:Tu-Tu Camp Variety
489	12031401	1	42.8702	76.09063	Garbutt Creek Red: Paslow Var.
499	11032401	1	47.9433	77.3605	Cayo Unslipped:Unspecified(red slip)
500	11032301	1	47.6109	77.63944	Cayo Unslipped:Variety Unspecified (red)
504	21032501	1	47.2407	77.80467	Cayo Unslipped:Variety Unspecified (red)
511	11032901	1	34.569	77.37054	Cayo Unslipped:Cayo Variety
517	16033301	1	42.1631	78.35136	Roaring Creek Red: Roaring Creek Variety
518	11081801	1	42.6452	78.37631	Cayo Unslipped:Cayo Variety
522	11033401	1	45.4532	77.39429	Cayo Unslipped:Cayo Variety
524	11033301	1	45.0038	77.5289	Tu-tu Camp Striated:Tu-Tu Camp Variety
526	21033601	1	45.0011	77.7684	Cayo Unslipped:Variety Unspecified (red)
535	21034401	1	46.9217	78.84596	Cayo Unslipped:Unspecified(red slip)
537	21034501	1	47.6333	78.43365	Tu-tu Camp Striated:Tu-Tu Camp Variety
538	11034601	1	48.0137	79.18793	Cayo Unslipped:Unspecified(red slip)
541	21034901	1	64.2531	73.74131	Cayo Unslipped:Variety Unspecified (red)
542	11035001	1	61.7871	74.56166	Cayo Unslipped:Cayo Variety
545	21035301	1	65.3627	73.33716	Cayo Unslipped:Cayo Variety
547	11035201	1	65.6446	72.9737	Cayo Unslipped:Unspecified(red slip)
561	11036401	1	40.0243	81.42505	Tu-tu Camp Striated:Variety Unspecified (Beaverdam)
562	11037201	1	33.4134	80.35938	Tu-tu Camp Striated:Variety Unspecified (Beaverdam)
570	11037001	1	46.6289	80.65376	Tu-tu Camp Striated:Variety Unspecified (Beaverdam)
571	21081901	1	40.8645	81.21499	Roaring Creek Red :Roaring Creek Variety
576	12037601	1	46.8629	80.81217	Garbutt Creek Red:Paslow Variety
577	11037701	1	46.9557	81.04148	Tu-tu Camp Striated:Tu-Tu Camp Variety
585	21038101	1	43.1306	80.77983	Tu-tu Camp Striated:Tu-Tu Camp Variety
590	13038901	1	49.8746	80.61193	Roaring Creek Red: Roaring Creek Variety

603	11039601	1	35.255	82.11684	Cayo Unslipped:Unspecified(red slip)
609	11039701	1	35.0016	82.06403	Cayo Unslipped:Cayo Variety
610	11039901	1	34.8222	81.93971	Cayo Unslipped: Cayo Variety
611	11040001	1	34.9748	81.79374	Cayo Unslipped:Unspecified(red slip)
612	11040101	1	34.8045	81.73283	Cayo Unslipped:Cayo Variety
615	21040201	1	34.7566	81.6035	Cayo Unslipped:Cayo Variety
620	12041201	1	48.9033	82.56988	Garbutt Creek Red: Garbutt Creek Variety
623	11041001	1	49.3565	82.72764	Cayo Unslip: Variety Unspecified(Buff)
625	21041301	1	46.2853	81.4079	Cayo Unslipped:Cayo Variety
630	12041801	1	50.3868	81.66331	Garbutt Creek Red:Paslow Variety
633	12041901	1	50.4771	81.6143	Garbutt Creek Red: Variety Unspecified (brown interior)
634	11042101	1	33.5311	82.60483	Tu-tu Camp Striated:Tu-Tu Camp Variety
644	11042301	1	35.0281	82.35859	Cayo Unslipped:Unspecified(red slip)
645	11042401	1	35.2947	82.39969	Cayo Unslipped:Unspecified(red slip)
652	21042201	1	35.6661	82.69756	Cayo Unslipped:Unspecified(red slip)
653	21042501	1	35.9688	82.93999	Cayo Unslipped:Unspecified(red slip)
656	11042601	1	34.0613	81.96797	Tu-tu Camp Striated:Tu-Tu Camp Variety
660	11042801	1	36.9874	82.63277	Cayo Unslipped:Unspecified(red slip)
662	11043001	1	38.5287	82.72845	Cayo Unslipped:Variety Unspecified (red)
663	11043101	1	38.5499	83.26891	Cayo Unslipped:Cayo Variety
664	11043201	1	41.0731	82.59373	Cayo Unslipped:Cayo Variety
665	21043301	1	40.8998	82.40494	Cayo Unslipped:Cayo Variety
667	11043401	1	41.8222	82.3796	Cayo Unslipped:Unspecified(red slip)
668	11043601	1	36.3595	83.60085	Cayo Unslipped:Cayo Variety
669	25043501	1	36.428	83.55137	Shoe-shaped Vessel
670	11043701	1	41.0442	83.8984	Cayo Unslipped:Unspecified(red slip)
671	11043801	1	40.7286	83.41656	Cayo Unslipped:Unspecified(red slip)
672	11043901	1	40.5359	83.73496	Cayo Unslipped:Cayo Variety
680	11044801	1	41.4376	83.47385	Cayo Unslipped:Cayo Variety
682	21044601	1	42.1857	83.41445	Tu-tu Camp Striated:Tu-Tu Camp Variety
684	12045001	1	42.8766	84.17114	Garbutt Creek Red: Paslow Variety
688	11044901	1	39.1426	85.11724	Cayo Unslipped:Variety Unspecified (red)
689	11045401	1	52.2176	83.48542	Tu-tu Camp Striated:Variety Unspecified (Beaverdam)
690	11045501	1	52.9888	83.55123	Tu-tu Camp Striated:Variety Unspecified (Beaverdam)
695	23042001	1	50.6522	81.91576	Roaring Creek Red: Roaring Creek Variety
696	12045701	1	37.09	84.81593	Garbutt Creek Red:Paslow Variety
705	11045801	1	37.3116	84.52029	Cayo Unslipped:Cayo Variety
706	21045901	1	37.1713	84.68307	Cayo Unslipped:Cayo Variety
710	11045901	1	37.7053	80.75745	Tu-tu Camp Striated:Tu-Tu Camp Variety
713	11046101	1	38.0517	84.75518	Tu-tu Camp Striated:Variety Unspecified (Beaverdam)
720	12046301	1	37.9788	85.09318	Garbutt Creek Red: Variety Unspecified (brown interior)
727	11047901	1	40.454	85.46358	Cayo Unslipped:Unspecified(red slip)
730	11048201	1	42.359	85.5012	Tu-tu Camp Striated:Variety Unspecified (Beaverdam)
731	11050801	1	52.8794	85.46613	Cayo Unslipped:Cayo Variety
750	11051301	1	37.6508	87.19059	Tu-tu Camp Striated:Tzimin Variety
751	11051401	1	37.679	87.21425	Cayo Unslipped:Unspecified(red slip)
773	21053201	1	39.0031	87.1959	Cayo Unslipped:Unspecified(red slip)
774	21080901	1	38.0197	88.21087	Cayo Unslipped:Unspecified(red slip)

785	11054001	1	40.6125	87.84396	Cayo Unslipped:Cayo Variety
786	13054101	1	51.1162	87.85654	Roaring Creek Red: Roaring Creek Variety
788	11054201	1	36.8299	89.69859	Cayo Unslipped:Cayo Variety
789	13054401	1	37.0821	89.7074	Roaring Creek Red: Roaring Creek Variety
796	21046601	1	37.6608	85.1832	Tu-tu Camp Striated:Tu-Tu Camp Variety
799	11050601	1	37.6294	85.14417	Tohil Plumbate
800	11051701	1	37.5042	85.26718	Tu-tu Camp Striated:Tu-Tu Camp Variety
828	21052801	1	40.109	88.85346	Tu-tu Camp Striated:Tu-Tu Camp Variety
833	11053301	1	50.5323	89.35828	Tohil Plumbate
834	13053401	1	51.3569	90.00148	Roaring Creek Red: Roaring Creek Variety
840	11053601	1	37.6008	90.93279	Cayo Unslipped:Unspecified(red slip)
855	11054301	1	37.8451	89.80613	Cayo Unslipped:Unspecified(red slip)
859	22054401	1	38.1524	89.45147	Rubber Camp Brown:Rubber Camp
866	21055501	1	40.9021	91.24776	Tu-tu Camp Striated:Tu-Tu Camp Variety
867	12055401	1	41.0499	91.35727	Garbutt Creek Red:Paslow Variety
868	21055301	1	41.2333	91.22676	Cayo Unslipped:Variety Unspecified (Buff)
870	12055201	1	40.9378	91.07718	Garbutt Creek Red:Paslow Variety
876	11054901	1	41.3327	90.83371	Cayo Unslipped:Unspecified(red slip)
889	21057001	1	45.0594	90.03351	Cayo Unslipped:Cayo Variety
890	11057101	1	45.0148	91.35521	Cayo Unslipped:Variety Unspecified (red)
891	12057301	1	45.0459	91.60896	Garbutt Creek Red: Garbutt Cr.
894	11057201	1	45.1766	91.73202	Cayo Unslipped:Cayo Variety
917	21061001	1	40.055	93.60125	Cayo Unslipped:Unspecified(red slip)
919	11060301	1	39.7526	95.21204	Cayo Unslipped:Cayo Variety
933	11060601	1	40.1217	94.66593	Tu-tu Camp Striated:Tzimin Variety
939	11061101	1	41.9857	92.66475	Cayo Unslipped:Unspecified(red slip)
946	21061701	1	38.9996	93.38965	Cayo Unslipped:Variety Unspecified (red)
949	11062001	1	38.182	96.83363	Cayo Unslipped:Cayo Variety
962	11063101	1	42.0785	96.36221	Cayo Unslipped:Unspecified(red slip)
963	21063201	1	42.014	96.60137	Cayo Unslipped:Cayo Variety
964	11063301	1	42.4258	96.60012	Cayo Unslipped:Unspecified(red slip)
966	11063501	1	38.8679	97.5004	Cayo Unslipped:Unspecified(red slip)
968	11063601	1	38.3959	97.65459	Cayo Unslipped:Unspecified(red slip)
984	11066501	1	35.4774	98.10648	Alexander's Unslipped:Alexanders Variety
1011	11067601	1	40.0355	98.84229	Cayo Unslipped:Cayo Variety
1013	11067901	1	40.8758	99.08362	Cayo Unslipped:Cayo Variety
1028	13068301	1	37.5797	99.52663	Roaring Creek Red: Roaring Creek Variety
1029	12069601	1	41.9602	99.91531	Garbutt Creek Red: Garbutt Creek Variety
1034	13070101	1	35.2758	100.3696	Roaring Creek Red: Roaring Creek Variety
1039	21070301	1	41.7644	100.1149	Cayo Unslipped:Unspecified(red slip)
1040	13070401	1	40.5392	100.3501	Roaring Creek Red: Roaring Creek Variety
1054	12070701	1	34.1616	101.0399	Dolphin Head Red: Dolphin Head
1065	11070901	1	35.9148	102.5334	Cayo Unslipped:Unspecified(red slip)
1090	21073501	1	39.1547	108.224	Cayo Unslipped:Cayo Variety
1092	21073701	1	38.4189	107.9653	Cayo Unslipped:Cayo Variety
1093	11073801	1	36.1748	111.5805	Alexander's Unslipped: Beaverdam Variety
1098	21074301	1	35.674	112.3621	Tu-tu Camp Striated:Tzimin Variety
1109	11078001	1	26.9082	144.2211	Tu-tu Camp Striated:Tzimin Variety
1112	21075201	1	12.4443	160.925	Tu-tu Camp Striated:Tzimin Variety
1114	11075301	1	13.7435	161.0141	Cayo Unslipped:Variety Unspecified (red)

1122	11075401	1	13.0446	163.621	Tu-tu Camp Striated:Tzimin Variety
1137	21075801	1	16.0405	175.1666	Tu-tu Camp Striated:Tu-Tu Camp Variety
1148	12076201	1	21.3778	175.3367	Garbutt Creek Red:Tunichil Variety
1166	21078001	1	27.0538	177.0388	Tu-tu Camp Striated:Tzimin Variety
1205	12078701	1	29.2443	175.7822	Garbutt Creek Red:Paslow Variety
1214	11078801	1	29.1559	175.5635	Cayo Unslipped:Cayo Variety
1222	21079301	1	36.573	178.9126	Tu-tu Camp Striated:Tu-Tu Camp Variety
1223	11079501	1	37.7373	181.7586	Tu-tu Camp Striated:Tu-Tu Camp Variety
1228	11002901	1	56.6256	28.75107	Roaring Creek Red: Roaring Creek Variety
1232	11002701	1	57.4497	28.75375	Cayo Unslipped:Cayo Variety
1237	11003601	1	58.9167	28.70409	Cayo Unslipped:Cayo Variety
1242	11046701	1	46.7012	85.04626	Cayo Unslipped:Variety Unspecified (red)
1257	11048301	1	48.0258	85.86635	Cayo Unslipped:Cayo Variety
1283	11059001	1	36.9327	92.16643	Tu-tu Camp Striated:Tu-Tu Camp Variety
1285	12059101	1	37.1287	92.54855	Garbutt Creek Red:Paslow Variety
1286	11059301	1	36.2349	93.28491	Cayo Unslipped:Unspecified (red slip)
1288	21059401	1	35.9613	93.31789	Cayo Unslipped:Cayo Variety
1290	11059501	1	36.7683	93.54433	Tu-tu Camp Striated:Tzimin Variety
1292	11059601	1	36.6331	93.67582	Cayo Unslipped:Unspecified(red slip)
1293	12059701	1	36.4294	93.73492	Garbutt Creek Red:Paslow Variety
1306	11059801	1	36.9301	93.87173	Cayo Unslipped:Unspecified(red slip)
1307	11060201	1	36.5214	94.40969	Tu-tu Camp Striated:Tzimin Variety
1324	11001501	1	54.4567	23.63211	Cayo Unslipped:Unspecified(red slip)
1329	11000801	1	57.4716	20.52063	Cayo Unslipped:Unspecified(red slip)
1335	11002301	1	55.4573	26.73746	Cayo Unslipped:Cayo Variety
1338	13002001	1	56.0684	26.58998	Roaring Creek Red: Roaring Creek Variety
1341	11003301	1	59.6011	26.38914	Cayo Unslip:Variety Unspecified (Buff)
1346	11003501	1	59.3559	26.70439	Cayo Unslipped:Unspecified(red slip)
1355	11003401	1	59.1486	27.84784	Cayo Unslipped:Cayo Variety
1366	11028301	1	46.0269	69.55531	Cayo Unslipped:Cayo Variety
1370	11044701	1	41.5984	83.4902	Cayo Unslipped:Cayo Variety
1376	12079601	1	40.7272	87.79329	Garbutt Creek Red:Paslow Variety
1387	16053001	1	41.2147	89.59495	Roaring Creek Red: Roaring Creek Variety
1406	11031301	1	31.8589	76.61433	Cayo Unslipped:Cayo Variety
1407	11064801	1	36.9572	98.27097	Tu-tu Camp Striated:Tu-Tu Camp Variety

Appendix K

Preliminary Analysis of Artifact Proximity to Cave Features

n=1408	Buffers	.25m	0.5m	1m	1.5m	%.25m	% .5m	% 1m	% 1.5m
Walls & Walkways		240	394	658	833	17.05	27.98	46.73	59.16
Boulders		226	386	681	851	16.05	27.41	48.37	60.44
Stalagmitic/Stalacto-stalag.		199	284	422	477	14.13	20.17	29.97	33.88
	Sum					30.18	47.58	78.34	94.32
	%					47%	75%	125%	153%
	Contained within								
Alcoves		75	75	75	75	5.33	5.33	5.33	5.33
Breakdown		112	112	112	112	7.95	7.95	7.95	7.95
Niches		186	186	186	186	13.21	13.21	13.21	13.21
	Sum					73.72	102.05	151.56	179.97
	%					74%	102%	152%	180%
	Presence/Absence								
Pools		720	720	720	720	51.13	51.13	51.13	51.13
	Sum					124.85	153.18	202.69	231.1
	%					125%	153%	203%	231%

Hierarchy of Artifact Proximity to Cave Features Using .25m Buffers

Pools	51%
Walls & Walkways	17%
Boulders	16%
Stalagmitic/Stalacto-stalag.	14%
Niches	13%
Breakdown	8%
Alcoves	5%

Hierarchy of Artifact Proximity to Cave Features Using .50m Buffers

Pools	51%
Walls & Walkways	28%
Boulders	27%
Stalagmitic/Stalacto-stalag.	20%
Niches	13%
Breakdown	8%
Alcoves	5%

Appendix K Cont….

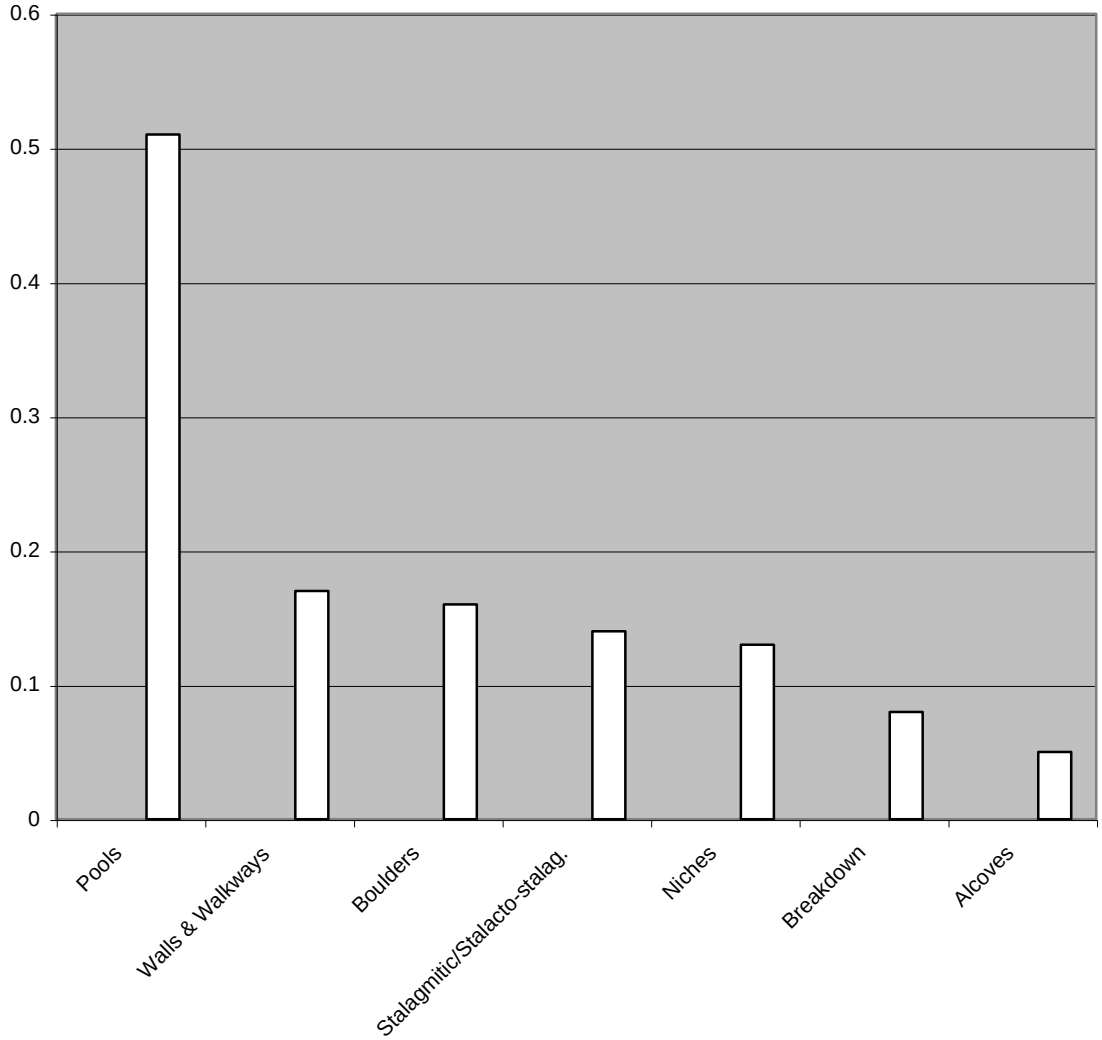
Hierarchy of Artifact Proximity to Cave Features Using 1m Buffers

Pools	51%
Boulders	48%
Walls & Walkways	47%
Stalagmitic/Stalacto-stalag.	30%
Niches	13%
Breakdown	8%
Alcoves	5%

Hierarchy of Artifact Proximity to Cave Features Using 1.5m Buffers

Pools	51%
Boulders	60%
Walls & Walkways	59%
Stalagmitic/Stalacto-stalag.	34%
Niches	13%
Breakdown	8%
Alcoves	5%

Appendix L
Results of Preliminary Analysis
Based on Percentage
Artifact Proximity to Cave Features
Using .50m. Buffers
n=1408



Appendix M
Coefficient of Variation

#Cluster Configurations			Sum CV of X+Y
240	**X**	**Y**	
Cluster 9	0.003544	0.00141	
Cluster 23	0.003654	0.004538	
Cluster 44	0.003204	0.003433	
Cluster 78	0.003489	0.000873	
Cluster 158	0.010506	0.002558	
Cluster 175	0.002127	0.002558	
Cluster 176	0.00618	0.003911	
Sum	0.032704	0.018694	**0.051398**
250	**X**	**Y**	
Cluster 9	0.003868	0.003588	
Cluster 23	0.003577	0.000863	
Cluster 44	0.0023	0.003025	
Cluster 78	0.001723	0.000558	
Cluster 158	0	0	
Cluster 175	0.003039	0.004539	
Cluster 176	0	0	
Sum	0.014507	0.012573	**0.02708**
251	**X**	**Y**	
Cluster 9	0.048249	0.001874	
Cluster 23	0.009631	0.002315	
Cluster 44	0	0	
Cluster 78	0	0	
Cluster 158	0	0	
Cluster 175	0.006205	0.003074	
Cluster 176	0.001325	0.001584	
Sum	0.06541	0.008847	**0.074257**
252	**X**	**Y**	
Cluster 9	0.005986	0.001586	
Cluster 23	0.002831	0.003286	
Cluster 44	0.005489	0.001771	
Cluster 78	0.000804	0.000439	
Cluster 158	0	0	
Cluster 175	0	0	
Cluster 176	0.003489	0.000873	

Sum	0.018599	0.007955	**0.026554**

	253	**X**	**Y**
Cluster 9		0.004122	0.003787
Cluster 23		0.004122	0.003787
Cluster 44		0.00045	0.00537
Cluster 78		0.001558	0.00029
Cluster 158		0	0
Cluster 175		0	0
Cluster 176		0.00368	0.000467
Sum		0.013932	0.013701 **0.027633**

	254	**X**	**Y**
Cluster 9		0.001116	0.00097
Cluster 23		0	0
Cluster 44		0.009841	0.005433
Cluster 78		0.007023	0.001223
Cluster 158		0	0
Cluster 175		0.001315	0.003961
Cluster 176		0.004085	0.001597
Sum		0.02338	0.013184 **0.036564**

	255	**X**	**Y**
Cluster 9		0.000109	0.002131
Cluster 23		0.000125	0.000379
Cluster 44		0.008839	0.000994
Cluster 78		0.012517	0.001615
Cluster 158		0.002784	0.002218
Cluster 175		0.021724	0.000516
Cluster 176		0.010232	0.015845
Sum		0.05633	0.023698 **0.080028**

	264	**X**	**Y**
Cluster 9		0.003868	0.002337
Cluster 23		0	0
Cluster 44		0.006741	0.00158
Cluster 78		0.00334	0.001068
Cluster 158		0.00336	0.001645
Cluster 175		0.02362	0.001103
Cluster 176		0.001281	0.006555
Sum		0.020952	0.014288 **0.03524**

Appendix N

Coefficient of Variation for K-Means Cluster Configurations

Number of Clusters	Coefficient of Variation X+Y
240	0.0514
250	0.0271
251	0.0743
252	**0.0266**
253	0.0276
254	0.0366
255	0.08
264	0.0352

.. ….Appendix O

Results of K-means Clusters in Proximity to Cave Features

n=252	Buffer	.10m	.25m	.5m	.75m	1m	%.10m	%.25m	%.5m	%.75m	%1m
Walls & Walkways		45	70	91	108	124	17.86	**27.8**	36.11	42.86	49.21
Boulders		43	58	84	102	115	17.6	**23**	33.33	40.48	45.63
Stalagmitic/Stalacto-stalag.		36	42	51	65	68	14.29	**16.7**	20.24	25.79	26.98
	Sum						49.75	**67.5**	89.68	109.13	121.8
	%						50%	**68%**	90%	109%	122%
	Intersects with										
Niches		30	30	30	30	30	11.9	**11.9**	11.9	11.9	11.9
Alcoves		19	19	19	19	19	7.54	**7.54**	7.54	7.54	7.54
Breakdown		18	18	18	18	18	7.14	**7.14**	7.14	7.14	7.14
	Sum						76.33	**94.08**	116.3	135.71	148.4
	%						76%	**94%**	116%	136%	148%
	Presence/Absence										
Pools	152	152	152	152	152		60.31	**60.31**	60.31	60.31	60.31
	Total=						136.64	**154.4**	176.6	284.11	208.7
	%						137%	**154%**	177%	284%	209%

Hierarchy of Artifact Proximity to Cave Features Using .10m Buffers

Pools	61%
Walls & Walkways	18%
Boulders	18%
Stalagmitic/Stalacto-stalag.	14%
Niches	12%
Alcoves	8%
Breakdown	7%

Hierarchy of Artifact Proximity to Cave Features Using .25m Buffers

Pools	61%
Walls & Walkways	28%
Boulders	23%
Stalagmitic/Stalacto-stalag.	17%
Niches	12%
Alcoves	8%
Breakdown	7%

Appendix O Cont….

Hierarchy of Artifact Proximity to Cave Features Using .5m Buffers

Pools	61%
Walls & Walkways	36%
Boulders	33%
Stalagmitic/Stalacto-stalag.	20%
Niches	12%
Alcoves	8%
Breakdown	7%

Hierarchy of Artifact Proximity to Cave Features Using .75m Buffers

Pools	61%
Walls & Walkways	43%
Boulders	40%
Stalagmitic/Stalacto-stalag.	26%
Niches	12%
Alcoves	8%
Breakdown	7%

Hierarchy of Artifact Proximity to Cave Features Using 1m Buffers

Pools	61%
Walls & Walkways	50%
Boulders	46%
Stalagmitic/Stalacto-stalagmite	27%
Niches	12%
Alcoves	8%
Breakdown	7%

Appendix P
Relationship of *K-means* Clusters to Cave Features
Actual vs. Expected Values

Clusters n=252
TA= Total area of Main Chamber= 4,540square meters
Clusters per sq.m.= clusters(252) / total area(4540) = .055506608 clusters per square meter
FA= Sum total of feature area class in square meters
AV= Actual values of number of clusters in feature area
EV= Expected values = FA (Clusters per sq.m)
FI= Frequency index = (AV-1) / EV

Feature Category	FA(m^2)	AV	EV	FI	AverageFI
Alcoves	64.24	30	3.5657	8.4134	8.4134
Breakdown	1071.7	18	59.486	0.3026	0.3026
Niches	14.95	19	0.8298	22.896	22.896
Pools	1853.3	152	102.87	1.4678	1.4776
Buffers(meters)					
Boulders					
0.01	131.67	43	7.3086	5.8835	
0.25	186.69	58	10.363	5.5971	
0.5	290.31	84	16.114	5.2128	
0.75	408.99	102	22.702	4.4931	
1	539.16	115	29.927	3.8427	5.0058
Stalagmitic/stalacto-stalagmitic formations					
0.01	256.65	36	14.246	2.5271	
0.25	345.46	42	19.175	2.1903	
0.5	505.44	51	28.055	1.8178	
0.75	691.9	65	38.405	1.6925	
1	843.99	68	46.847	1.4515	1.9358
Walls & Walkways					
0.01	293.81	45	16.308	2.7593	
0.25	540.88	70	30.022	2.3316	
0.5	1016.5	91	56.424	1.6128	
0.75	1515.2	108	84.106	1.2841	
1	1915.7	124	106.33	1.1662	1.8308

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