Ephemeral Rites: Understanding Ancient Maya Cave Ritual using Geochemical Signatures from Platform Surfaces at Las Cuevas

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The cave at Las Cuevas located in Belize, is somewhat unique as it features an extensively architecturally-modified entrance chamber including platforms, staircases, and terraces. Most of the architecture has been plastered and much of it is still intact. Our research aims to discover the ritual function of the platforms in the cave entrance by using unique methodologies. We hypothesize these platforms may have been used for bloodletting and ritual performance. Using geochemical analysis in addition to more traditional archaeological methods, we have had promising results that support our initial hypothesis. Analyses were conducted in the field using portable XRF (pXRF) and samples were collected for Fourier Transform Infrared Spectroscopy (FTIR), and to test for the presence of hemoglobin. Here we present the preliminary results of these analyses and discuss their importance for understanding past ritual practice.
The cave at Las Cuevas, features an extensive architecturally-modified, massive entrance chamber with running water at the base of an interior cenote that sits in the center of the chamber. The mouth of the cave is located directly beneath the eastern structure of the mid-sized site of Las Cuevas. Over the last four field seasons (2011 - 2014) the Belize Cave Research Project (BRCP) in conjunction with the Las Cuevas Archaeological Reconnaissance (LCAR) have mapped and recorded 73 platforms, seven staircases, and two sets of terraces in the cave entrance. Most of the architecture has been plastered, and many of the thick plaster floors are still intact. This research aims to discover the function of the platforms in the cave entrance. We hypothesize that these platforms were used for ritual activities, which may have included burned offerings, dancing, and bloodletting. To test these hypotheses we used morphological and geochemical analyses. Detailed mapping of the platforms allowed us to examine minute differences in topography and Portable X-Ray Fluorescence (pXRF) and Fourier Transform Infrared Spectroscopy (FTIR) were conducted to gather elemental data.

BACKGROUND

To understand the importance of the layout of this site, one has to comprehend ancient Maya cosmology and sacred geography, which consists of a mountain/cave/water complex. To the Maya, the landscape is at the heart of their cosmology. According to Vogt and Stuart (2010), in all of their constructions the Maya refer to and replicate the sacred landscape, constructing temples to represent sacred mountains and rooms at their summits to imitate sacred caves. Natural caves are the most sacred cosmological features on the landscape, particularly those that contain life-giving water, like the cave at Las Cuevas. They are considered to be entrances to the underworld and the home of deities associated with fertility, rain, and the sacred earth. This
association explains why natural caves were and continue to be used exclusively as ritual spaces among the Maya (Christenson 2004; Brady and Prufer 2010; Moyes and Brady 2012). As a path to power, ancient Maya rulers linked themselves to cosmological forces, ideologically and practically by co-opting the natural landscape through cave ritual and creating artificial caves in their site constructions (Brady and Veni 1992; Moyes 2006; Moyes et al. 2009). With this relationship to the landscape and cosmology in mind we can appreciate the cosmological symbolism inherent in the Las Cuevas site layout and its evident importance in Late Classic ritual life.

At Las Cuevas we have an opportunity to investigate ritual performance at the end of the Late Classic period, just prior to the site’s abandonment. This case study provides insight into the process of societal collapse and illustrates how ritual performance may have been one of the strategies implemented by elites to encourage social cohesion during times of stress. Moyes et al. (2009) have suggested that cave use in western Belize dating to this period constituted a Late Classic drought cult undertaken by lesser elites as a response to weakening apical elite power and hegemony. The erection of a massive ritual complex at Las Cuevas may also be part of the story of how people reacted to a crumbling traditional political system.

**PLATFORM DESCRIPTION**

The cave’s Entrance Chamber measures approximately 105 meters on its north/south axis and up to 40 meters at its widest point (Figure 1). The Entrance Chamber is partitioned along the north-south axis by the large cenote in the light zone of the cave and along the east-west axis by a large natural archway. This archway also marks the edge of the twilight zone where the light fades...
quickly from the entrance. The platforms in this chamber begin in the bottom of the cenote and continue up to the ceiling at the edges of the chamber, connected by a series of stairways and walkways. According to Barbara Voorhies’ cave excavations during the 2011 field season, Platform 1 was constructed with “three discernable microstrata:” a cobble layer and a pebble layer comprise the subfloor and then a finely smoothed plaster was laid on the subfloor (Moyes et al. 2011). Many other platforms in the cave exhibit this same construction technique. This is evidenced by exposed platform cross-sections that were damaged either from looting or natural collapse. There are a few exceptions to this including Platforms 42 and 60 as discussed below.

For this project, nine platforms were selected, surveyed and extensively sampled. During the 2013 field season platforms 14, 29, 59, 60, and 61 were sampled and analyzed and in the 2014 field season we added platforms 26, 31, 37, and 42. Selection of platforms was based on the following criteria: 1) completeness, 2) location, 3) preservation, and 4) uniqueness. We tried to sample such that platforms were selected to include different sizes, as well as intact subsurface platforms from all areas of the cave.

Platform 14 is the largest and most intact platform in the cave entrance located near the cave entrance along the north wall and in the light zone of the cave. The platform is nearly complete measuring approximately 3.3 m long by 2.6 m wide. The plaster surface is approximately 5 cm thick. It is the topmost platform of a tiered set of three platforms. Although the second platform is no longer intact (Platform 14A), we estimate it was 23 cm below platform 14. Platform 13 the basal platform, is located approximately 1.2 meters below platform 14. The north-west portion of Platform 14 is directly beneath a large overhang that inhibits standing, which would directly
affect the types of activities that could take place on the platform. The plaster surface is also characterized by several dark spots, which could be attributed to burning. A total of 27 ceramic sherds were collected during the excavation of this platform. Lithics were also collected including: two chert bifaces, slate and two obsidian blade fragments.

Platform 29 is located near the center of the cave entrance chamber in the twilight zone. Platform 29 also consists of a series of tiered platforms; it is the middle of these tiers. The smallest is more shelf-like in size than a platform but appears to be part of the same complex. The thickness of the plaster floor, while varied, is approximately 2.5 cm thick. A pile of ash was discovered above the burnt plaster surface along the western boundary of the platform. The view of the cave entrance is partially obscured by the large overhang covering a portion of the platform to the east. This overhang limits mobility and inhibits standing on most of the platform. The only artifact type found on the platform was ceramics, of which a total of 78 sherds were collected. However, an obsidian blade fragment was found along the cave wall just adjacent to the platform.

Platforms 59, 60, and 61, are located in the north-eastern area, distant from the cave entrance where the cave begins to fade into darkness. Platform 59 is unique; it measures approximately 2 m by 2.2 m, and is surrounded by a set of upright inset stones, an architectural style that is distinct from other platform constructions. The plaster on this platform is noticeably thicker than the others; measuring on average 15 cm. Stalagmites formed on the surface but were broken off in antiquity. Though it is possible that the plaster has preserved underneath, it is not possible to remove the remaining speleothem formation without damaging the plaster surface. Surface finds included 58 ceramic sherds and one obsidian blade fragment.
Platforms 60 and 61 were excavated in Unit 3, a broad horizontal excavation (Voorhies 2012). Platform 60 measures approximately 1.2 m by .60 m and platform 61 measures 2 m by 1.4 m. These two platforms are completely intact although their plaster shows signs of degradation, which is to be expected since they were found under a thick alluvial deposit. Additionally Platform 60 was partially excavated to expose the construction chronology and technology during the 2012 field season (Voorhies 2012). The excavation revealed a subfloor mixed with an abundance of jute (*Pachychilus* sp., freshwater gastropod) (See Voorhies 2012 for further discussion). Since these two platforms were found during excavation it is difficult to determine the number and types of artifacts associated with the platforms themselves though Voorhies (2012) argues that they were kept clean in antiquity.

Platform 26 is located in the cave Entrance Chamber on the north side of the cenote. It is located in the light zone of the cave built on a retaining wall that at its maximum stands approximately 2.3 m tall. The wall was built up on a large piece of breakdown that was modified with large boulders. The platform was levelled with smaller cobbles then the plaster was applied to the surface. Steps lead down the east side of the platform and appear to be plastered; however, these were not excavated. The west side may also have steps but are not well preserved. The north side of the platform is bounded by another retaining wall that stands approximately 1.5 m above the plaster surface. Most of the Entrance Chamber can be viewed from the platform; this includes a clear view of the window. Additionally, the ceiling is several meters above the platform so mobility is not restricted. The platform was very wet from multiple drips and the surface of the platform had at least six inactive speleothems that had not been active in some time, as well as
active flowstone and a small, empty pool along the western edge of the platform. During clearing a small piece of slate and a conch disk were found. A total of 31 ceramic sherds were also recovered during cleaning.

Platform 31 is located along the south wall of the cave Entrance Chamber. It also sits on modified breakdown approximately 3.2 m above the cave floor. The east side of the platform may have been modified to provide easier access to the platform but one must climb up either the east or west side of the breakdown in order to reach the platform. It should be noted that the window in Chamber 8 that overlooks the cave entrance is not visible from this platform. The platform itself is approximately 2.5 m long by 2.6 m wide. The plaster was well preserved on the surface probably because it is unlikely to have been disturbed. The southern edge of the platform abuts the cave wall. Along this wall, there is a small natural shelf 20 cm above the platform surface. A calcite crust has formed from within the shelf and extending 30 cm onto the platform itself. Along the central eastern portion of the platform, an ash deposit was discovered. The ash from this deposit was collected for further lab testing. The platform was cleared from debris and guano and in some cases calcite crust. In some places the crust was quite thick and was subsequently left intact. Only two artifacts were recovered when clearing platform 31: a Vaca Falls Red bowl base and a cave pearl; both found in the sediment above the plaster. While the presence of a cave pearl is certainly not remarkable, it was not found in a drip where cave pearls naturally form, and was therefore moved to this location.

Platform 37 is a subsurface platform located within excavation Unit 4 along the north wall of the cave entrance near the light zone/twilight zone boundary. It is the upper platform of two tiered
platforms. Platform 70 is the lower tier sitting approximately 20 cm below Platform 37; for a discussion of its construction and relationship to Platform 37 see Arksey and Voorhies (2015). Platform 37 was not well preserved and perhaps even collapsed in antiquity; however, its boundaries were well defined. It is approximately 3.3 m wide by 2.8 m long. A portion of the plaster extends into a small alcove into the north wall of the cave and was given the feature designation 4K-8. Burnt areas of the plaster and associated ash piles were identified in the center of the northern edge of the platform and inside the small alcove. The plaster of this platform was on average 2 cm thick. During excavation of this platform, 176 ceramic sherds were recovered. Additional recovered artifacts include a metate fragment, a hammerstone, jute, a shell bead, quartz, possible bone needle, a mano, a donut stone, and an obsidian blade. The abundance of artifacts on this platform could be due to the fact that it is a subsurface platform and is located in an area that may be subject to alluvial deposits, or due to its association with the small alcove.

Platform 42 can be found just to the east of excavation Unit 4 along the north wall of the cave entrance. The platform measures approximately 2.9 m by 1.1 m. This platform is unusual in that it features two distinct floors. Platform 42, like some of the other platforms sampled, is the uppermost platform in a set of tiered platforms. However, the lower tiers have been completely destroyed and we cannot estimate their height. The plaster was laid over a tamped earth subfloor. The plaster of the lower floor is approximately 5 cm thick and the upper floor 6 cm thick. Much of the original platform was destroyed; however, the northwestern portion was covered by a calcite crust and was therefore in good condition. Twenty-two ceramic sherds were recovered from Platform 42. Most of these ceramics were found within the layers of calcite crust in the northwestern edge of the platform. They appear to have washed from a large boulder that bounds
the western edge of Platform 42 and the eastern edge of Platform 37.

METHODOLOGY

Portable x-ray fluorescence or pXRF was used to identify both light and heavy elements on the plaster surface. Though commonly used for obsidian sourcing in archaeology, pXRF in conjunction with other techniques can be very useful in identifying the elemental assemblage of the plaster surface. It is very quick, only takes a couple minutes, and very portable making it ideal for non-destructive work in situ. It works by bombarding an atom with x-rays that have enough energy to displace inner-orbital electrons. The energy that is released from the interaction is element specific. Meaning each element has a characteristic energy signature that allows us to identify most elements in the sample. Within several minutes, elemental concentrations can be calculated in parts per million. However this does not tell us what compounds are found in the sample. A Bruker Tracer III-V handheld XRF, on loan from California State University, Long Beach courtesy of Dr. Hector Neff was used for analysis.

To determine the structure of the elements on the surface we utilized Fourier Transform Infrared Spectroscopy, or FTIR. This method of analysis allows researchers to obtain information about crystalline and amorphous materials as well as organic materials. Infrared waves interact with the sample during which a portion of the radiation in the infrared spectrum is absorbed by the materials, causing the chemical bonds to vibrate. This leads to a peak in the absorbance spectrum. The location, shape and size of an absorbance peak are indicative of specific chemical bonds. When combined with other peaks, the set is characteristic of specific materials. This allows us to identify the form of the elements located in the sample. Therefore we used FTIR to
supplement our pXRF data and get the “big-picture” view of the chemical composition of the plaster surface. A Bruker Alpha Diamond-ATR FTIR located at California State University, Long Beach was used for the analysis. Samples were systematically collected and analyzed in the lab. They were homogenized and run in solid form. This particular type of FTIR uses minimal sample preparation and allows the user to process large amounts of data in a short amount of time.

We began by excavating surface sediments and sweeping the floors to ensure that we were capturing the data from the surface itself. These were only lightly swept to ensure that we did not erode the plaster surfaces. To control sample location and ensure that the in situ and lab data came from the same sample, a physical grid was placed on top of the platforms in 20 cm increments (Figure 2). Then, using the grid as a guideline, we mapped the surfaces of the platforms making sure to record all features including cracks, burnt areas, and speleothem formation on the surface. The high-resolution mapping was conducted using a Sokkia Set 650-RX total station and prism reflector. Points were collected at 5cm intervals across the surface of the plaster floor. These data were then analyzed in ArcGIS and a Triangular Irregular Network (TIN) was created and then smoothed by converting the point data to raster data. From this, we hoped to see patterns of activity, where the platform had either been compacted or worn away.

*In situ* analysis was also performed on Platforms 14, 29, and 59 using the Bruker Tracer Handheld pXRF. All of these samples were run on high energy and Platform 14 was also run on low energy following the same specifications listed below. Physical samples were collected from each intersection on all platforms, with assistance from Andrew Neff, Daniel Neff and Hector
Neff. These samples were brought back to the lab for FTIR analyses and additional subsurface pXRF analysis. The samples were homogenized in the lab and run on high and low energy. The high energy was run using a green filter at 40 kV and 26 µA and the low energy was run using a blue filter at 15 kV and 27 µA with a vacuum pump.

RESULTS

High-resolution mapping was utilized to look for signs of impaction or erosion, possibly due to dancing. Figure 3 is the raster data set created from the TIN. Analysis showed that the front edge of the platform slopes downward away from the cave wall. Although this may not suggest dancing per se, as we would expect a depression in the center of the platform, it may suggest increased areas of activity as the distance from the cave wall increases.

After mapping, pXRF data were collected. High iron content on Platform 14’s plaster surface was present on large portions of the platform. Initially we suspected this might be due to a clay temper used in the plaster matrix. Comparisons of the iron and silicon concentrations of the samples corroborate this hypothesis, with a positive linear correlation with an $r^2$ value of 0.66. However, further analysis has called this assumption into question. Figure 4 demonstrates the clustering of the iron spikes further away from the overhang. In general iron content was lower underneath the overhang, suggesting the iron was not part of the plaster fabric, but was deposited through activity on the platform. If we assume that iron is not part of the plaster matrix but on the surface and use iron concentration as a proxy for activity areas, then we see a similar pattern matching the elevation map from the platform surface.
Using the Kimmel Center for Archaeological Science Infrared Standards Library from the Weizmann Institute of Science (2014), we were able to conduct a preliminary analysis of the FTIR data. As expected, the most predominate material comes from the calcite mineral from the calcium carbonate plaster matrix. Analysis has shown that it is indeed pyrogenic calcite made from heating limestone to high temperatures. However one large peak and several smaller peaks, around the 1050 cm$^{-1}$ wavelength, still needed to be identified. This particular wavenumber can be related to either phosphates or silicates. The presence of silicate clays could be possible based on our analysis of the XRF data however it lacks the broad peak at the high end of the spectrum. Additionally, we found that these peaks were completely absent from subsurface samples. If the iron was associated with silicates then we would expect to find them in the plaster matrix, but this is not the case.

Preliminary results suggest that the peaks at 1050 cm$^{-1}$ wavelength represent a phosphate mineral created through the interaction between phosphoric acid from bat guano and the plaster surface. As explained by Hutson and Terry (2006), residues can remain imbedded in the plaster in the ‘reactive zone’ just below the surface by migrating there through trampling of the plaster surface. Though in the case of the cave, trampling is not the only type of post-depositional modification; acidic-bat guano and drip water interacts with the basic calcium carbonate plaster. Therefore the results suggest that it is actually a phosphate mineral created through the interaction between phosphoric acid from bat guano and the plaster surface. According to cave research from Romania conducted by Giurgiu and Tămas (2013) and Dumitras and colleagues (2008), hydroxylapatite is the most common phosphate mineral in bat guano deposits especially in drier caves as could be considered the case with the cave at Las Cuevas.
Though iron is not in the ideal chemical formula for hydroxylapatite, which is 5 calcium, 3 phosphates and a hydroxyl group, $\text{Ca}_5(\text{PO}_4)_3\text{OH}$, hydroxylapatite can undergo cation substitution and the calcium can be substituted with iron and become associated with the hydroxylapatite. The mechanisms and locations of this specific cation substitution are not yet well understood.

**CONCLUSION**

Future research will be aimed at understanding both the guano plaster interactions and the iron presence on the plaster surface. Statistical analysis of the FTIR and pXRF data may allow us to determine areas of pronounced diagenesis of guano sediments. We also plan to examine the sediments that were removed from the plaster surface to understand their mineralogy and chemical composition.

Based on the morphological, fluorescence and infrared data we suspect the iron might be related to human activity. Iron is a common element making identification of the source difficult. We are looking into several possibilities, such as blood sacrifice or additional guano plaster interactions. The obsidian blades make a compelling argument for the former but additional analysis must be completed to say with any degree of certainty whether this was the pathway. Based on the location of the platforms, we believe they may have had some use as ritual surfaces but evidence thus far has not given us clear indication as to the types of activity that took place on the platforms save for a few burned areas, suggesting burned offerings. However, we are hopeful that future studies may lead us to a better understanding of the unknown deposits and potential activities performed on the plaster surfaces.
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Figure 1. Map of cave entrance chamber

Figure 2. Photograph of grid laid over Platform 14.
Figure 3. Rasterized map of Platform 14.

Figure 4. Iron concentrations of Platform 14. Collected from pXRF