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Reflectance Transformation Imaging: Documenting Graffiti in the Maya Lowlands

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REFLECTANCE TRANSFORMATION IMAGING:
DOCUMENTING INCISED GRAFFITI IN THE MAYA LOWLANDS

by

RACHEL GILL
B.A. Boston University, 2016

A thesis submitted in partial fulfillment of the requirements
for the degree of Master of Arts
in the Department of Anthropology
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ABSTRACT

In the late 19th century, explorers identified graffiti etched in stucco walls of residences, palaces, and temples in the Maya Lowlands. By the mid-20th century, scholars acknowledged that the ancient Maya produced these incised images. Today, archaeologists struggle with documenting these instances of graffiti with precision and accuracy, often relying solely on to-scale line drawings to best represent the graffitied image they see before them. These images can be complex, multilayered, and difficult to see so identifying the sequence of creation of the incisions can be challenging. Reflectance Transformation Imaging (RTI) is a method that uses a moving light source and photography in order to visualize, interact with, and analyze a three-dimensional object in a two-dimensional image. Performed on a series of 20 unique graffiti from the Maya archaeological site of Holtun, RTI showed promise as a viable technique for documenting and preserving graffiti as cultural heritage and for providing new information about an enigmatic aspect of Maya archaeology. Additionally, RTI is compared to other common methods used to document incised graffiti in the Maya lowland area including to-scale line drawing, tracing, photogrammetry, and scanning to show the new and unique information and data that can be gathered from this method. Finally, RTI is a low-cost, low-maintenance alternative data-gathering method for highly remote archaeological projects where other technology is difficult to obtain and use in the field setting.

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CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

Since the late 19th century, Maya archaeologists have known that graffiti existed in what is referred to as the lowland area, which is primarily comprised of the Yucatan Peninsula of Mexico, the Petén region of Guatemala, Belize, and northern Honduras (Sharer and Traxler 2006). For many decades, archaeologists believed this graffiti to originate from historical Spanish squatters who used the buildings as shelter after the Ancient Maya abandoned the site (Žračka 2014). In the mid-20th century, scholars began to entertain the idea that these graffiti were actually created during the time the site was occupied by the ancient Maya and therefore were a part of the Maya culture. Today, archaeologists struggle with documenting these instances of graffiti with precision and accuracy, often relying solely on to-scale line drawings to best represent the graffitied image they see before them. Additionally, because of graffiti's location on often fragile surfaces, any study beyond what the actual images represent is nearly impossible. I propose that the study of ancient Maya incised graffiti can be enhanced using a variety of photography techniques and that even in the field environment, Reflectance Transformation Imaging (RTI) is a viable technique to record and recover data on graffiti.

Over the course of this thesis, I used a photography technique known as RTI in the field environment on a series of 20 unique graffiti from the Maya archaeological site known as Holtun to see what new information, if any, can be gained using this method. Additionally, I will compare this method to other methods used to document incised graffiti in the Maya lowland area including to-scale line drawing, tracing, photogrammetry, and scanning. Finally, I will assess whether this method is worth pursuing in a field context and how it can be modified to fit

an environment outside of the lab and still function to provide new information about incised Maya graffiti.

The Study of Graffiti

“Graffiti” or the plural of the word “graffito” is an Italian term literally translating to “a scratch or scribble” (Merriam-Webster Online Dictionary). In the archaeological sense, the term was first used in the 18th century to describe the incised markings found on the walls of Pompeii and was a descriptor of an informal artistic style and figure rendering (Żrałka 2014:25). The term “graffiti” in the years since has taken on somewhat of a more loaded cultural definition. Street artists like Banksy seek to highlight cultural wrongdoings, things society as a whole seems to ignore. Others use graffiti to articulate ideas or become a type of media outlet for subcultures reaching across the globe (Żrałka 2014:26). In this sense, graffiti and those who produce it can give insight into the subculture, into their beliefs and understandings of the larger culture around them. This makes understanding and studying graffiti anthropologically interesting and useful especially in subcultures where it is a common form of artistic expression of ideas. However, because of its omnipresence in nearly every country and culture in the world, lying in both natural and built environments, this makes graffiti almost impossible to define (Lovata and Olton 2015:13).

Archaeological occurrences of graffiti can lead to similar information and insights into cultures that have long since passed into history. In the recent decades, scholars have attempted to define and study graffiti in a way that will allow archaeologists to potentially answer cultural

questions from another perspective, but there is no certain or concrete definition for the term all archaeologists can agree on (Żrałka 2014:35). However, the common ground between all of the definitions is its nature of informality—that it was not specifically commissioned and part of the original plan for the structure or art on it and it is not arranged in any formal manner. Others rely on its location to dictate whether art should be considered graffiti: in ancient Egypt graffiti was often textual and painted, making distinguishing whether it was formal or informal very difficult, so its placement, in this case on boulders outside of urban centers, is what distinguishes it as graffiti (Żrałka 2014:35). Lovata and Olton (2015:14) agree that graffiti is dependent on context and form because of its difficult-to-define nature. In the case of the ancient Maya, graffiti is typically defined by both: its informality and placement inside structures or rooms instead of outside for the rest of the population to see.

However, archaeologists must take caution when evaluating even the definition of graffiti—projecting current ideas of the cultural role graffiti has in today’s western world may obscure the meaning of graffiti in the context the archaeologists are investigating (Fredrick and Clarke 2014:55). Because of the deeply political and artistic expression of very specific subcultures, separating the ideas of “modern” graffiti—which emerged proper in the mid-twentieth century in the northeast United States—with archaeological definitions and analysis is difficult but crucial to placing graffiti within its context (Żrałka 2014:26). Regarding ancient graffiti as unauthorized acts of illegal vandalism may produce some problematic interpretations (Żrałka 2014:33).

Archaeological inquiries into graffiti have greater time depth in the classic world where this form of art has been seen to be a form of insight into social, political, and domestic life for over a century. Crucially, old world archaeologists recognized graffiti as a form of writing, which is critical in a number of ways. When understood as a writing activity, archaeologists and other scholars can recognize graffiti as a form of communication as well as a dialectic and performative undertaking (Fredrick and Clarke 2015:55). Olton's (2015) study of the palatial graffiti at Tikal takes this form of performative dialogue to heart, suggesting that these graffiti are a form of political subversion. Furthermore, she states that the isolated nature of the palace walls keeps the artist from anonymity; those who live and work in the structure know exactly who created the images and understand the political commentary being made in a more private setting (Olton 2015:164). The surface where graffiti is placed is also worthy of study because it can contribute to the understanding scholars have of the relationship between the author or artist and their audience (Lovata and Olton 2015:75). This relationship contributes to narratives of place and scholastic interpretation of the viewer's experience (Lovata and Olton 2015:75).

Most frequently, Maya graffiti in particular is incised or scratched onto a much harder surface including limestone architecture, stuccoed surfaces, cave walls, and in certain cases ceramic vessels or sherds (Żrałka 2014:37). In fact, over 90% of all documented Maya graffiti are thin, incised lines within architecture (Żrałka 2014:87). Often, they are found in secluded contexts but are not necessarily hidden from view (Lovata and Olton 2015:139). The most important aspect of defining ancient Maya graffiti, whether they were scratched, pressed, or painted, is contingent on the fact that they were not part of the original design of the architecture or its decoration and were included as a secondary addition (Żrałka 2014:39). Often this means

something of lower quality and less clarity, but this is not always the case as the graffiti from Nakum and Holtun can demonstrate. Additionally, with Maya graffiti, there is a distinct lack of concrete spatial arrangement to the images. Unlike wall-paintings, graffiti tend to be scattered and chaotically distributed on walls, floors, or other architectural elements with no stylistic cohesion (Żrałka 2014:40).

Several notable Mayanists began documenting cases of ancient Maya graffiti as early as the late nineteenth century and this documentation was done primarily through to-scale line drawings of the incisions (Żrałka 2014:76). However, the first full-scale inquiry into dating and understanding function and interpretation of graffiti in the context of the Maya as a whole began with the Tikal Project in 1956 (Triak and Kampen 1983). Using the information gathered by scholars in the mid to late nineteenth century, members of the Tikal project systematically documented and published the first (and to date only) monograph of all of the instances of graffiti at a single Maya site (Triak and Kampen 1983). Despite the agreement that the Tikal graffiti, along with the ancient Maya graffiti as a whole, were important enough to be the subject of study, scholars disagreed in regard to the function, meaning, and dating of the graffiti (Żrałka 2014:80). Regardless of these interpretive disagreements, the project proved that the graffiti discovered at the site was made *before* the site's abandonment, which was a complete deviation from what was originally thought about the incised images (Webster 1963).

At that point, the graffiti discovered in the Maya lowlands was thought to be entirely arcane, “doodlings of bored, inattentive voices” and for a while this cursory examination of the scribbles seemed adequate (J. Eric Thompson 1954:25). However, when scholars began to

approach graffiti as an alternative to state-sponsored artistic propaganda, other questions began to arise (Olton 2015:159). Now, Maya graffiti can be understood as a variety of things from events archive, practice sketches, child's drawings, drawings influenced by various hallucinogens, to politically transgressive commentary (Haviland and Haviland 1995, Hutson 2011, Olton 2015). Often, graffiti reflects familiarity with elite tradition and artistic cannon and therefore should be studied as its own artistic genre instead of worthless doodles (Olton 2015:159). However, once graffitied images were identified as being done by the ancient Maya themselves, study into graffiti declined even though many more instances have been documented at other sites and in other projects (Żrałka 2014:83). In fact, when graffiti has been documented in recent decades, they are brief mentions within larger site reports with no drawings at all (Żrałka 2014:82). Still, there are several prominent scholars that have invested in studying and documenting graffiti at a select few sites around the Maya lowlands including the site studied here: Holtun.

Holtun

Holtun is a medium-sized civic center located in the Peten region of Guatemala, only 35 km from the famous Classic Period site, Tikal, and also quite near the notable sites of Yaxha, Nakum, and Naranajo (Callaghan et al. 2016:26). This region of Guatemala is considered to be a part of the Maya lowland area that also consists of parts of the Yucatan, Belize, and the northern portion of Honduras, which have been occupied by the Maya for over 5000 years (Sharer and Traxler 2006:42). Consisting of a large urban epicenter full of monumental construction as well as several outlying residential groups, previous excavations have shown occupations at the site

ranging from the Middle Preclassic (800 B.C.) to the Late Classic Period (900 A.D.) (Callaghan et al. 2016:26).

The structure containing the graffiti used in this analysis is in Group F, located at one of the highest points of the site in the southeast portion of the site (Figure 1). This is also the location of the site's E-group—a set of monumental structures in Maya architecture commonly accepted to have been established in first the Middle Preclassic (Inomata et al. 2015). Named for the group at Uaxactun where this specific architectural group was initially identified, this set of structures contains a large pyramidal structure to the west and then a long range structure to the east, and are commonly thought to be used for specific astronomical purposes (Hansen 1998). The east range structure is thought to have specific markers for the summer and winter solstices and the equinox, but it may also serve a series of other purposes including denoting agricultural cycles (Hansen 1998; Doyle 2012). It is also possible that the eventual construction of these E-groups, while initially part of a communal cooperative event, could have led to establishing these seeds of social inequality (Doyle 2012; Inomata et al. 2015). Holtun's E-group has been suggested to originate in the Middle Preclassic—ceramic and other artifacts make us relatively certain of this particular timeline (Callaghan 2016:284). In the case of Holtun, two later additions to the range structure were also added during the Late Preclassic Period. The westernmost part of this structure is where the graffiti for this study was discovered (Figure 2).

Originally discovered in the 2016 field season, a series of six graffiti were uncovered, identified, and documented but due to time and budget constraints, the entire room and all of its walls could not be excavated. The goal of the 2017 field season was to complete excavations of

the room, uncover all the walls and determine whether there was any more graffiti on the walls. At least 15 more specific instances of graffiti were uncovered and documented during that season after the entire room was excavated. It is speculated there are more graffiti beneath the dirt that could not be cleaned from the fragile stucco walls during the 2017 field season.

The room itself is only 3.00M long from north to south and no more than 1.50M wide from east to west (Figure 3). It is constructed of a series of six pillars covered in limestone stucco as well as a thick plaster limestone floor. There is clear evidence of red pigmented paint on the stucco on several of the walls, and a series of postholes above the pillars suggest a roof made of a perishable material like wood once covered it (Figure 4). The actual purpose of the structure is unclear—its location in front of the highly ceremonial range structure of an E-group, well outside of residential compounds suggests a ritual nature to the building. Additionally, in the center of the structure cut into the limestone bed rock, a cruciform was discovered, which may have contained a series of ceramic vessels but was looted before archaeological discovery (Figure 5). Previously in this region, highly ritualized Middle Preclassic offerings were specifically made in cruciform cuts into the bedrock (Estrada-Belli 2006). It seems clear there is some form of ritual memory because ceremonial structures are then placed directly on top of these offerings (Estrada-Belli 2006; Ayoama et al. 2017). This ritualized offering directly beneath the floor in the center of this structure also suggests something ceremonial about the building itself.

The structure containing the graffiti (structure F2-Sub1) is thought to have been constructed in the Late Preclassic based on analysis of the structure fill taken directly from inside

the sealed context of the building (Callaghan 2016:351). Additional ceramic material was taken from the sealed context beneath a thick limestone plaster floor, which places at least the date of construction no later than the Late Preclassic period (Callaghan 2016:351). Furthermore, a lack of later ceramic styles within the construction fill place the termination date for the structure in the Late Preclassic or even very Early Classic period (Callaghan 2016:351). Based on these ceramic dates within the sealed contexts of the structure itself, it is possible to conclude that the graffiti themselves date to the Late Preclassic and no later than the very Early Classic period; radiocarbon dates are needed as further confirmation (Callaghan 2016:351). An absence of highly distinct Early Classic ceramics not just in Group F but throughout all the architectural groups at Holtun suggests an abandonment of the city center and recycled use during the Late and Terminal Classic periods (Callaghan 2016). At this point in the site's history, however, it seems F2-Sub1 had been filled in and sealed off from those who reoccupied the site.

Stylistically, this early date also seems to hold—the long, tall figures are reminiscent of official Late Preclassic art seen in the murals at San Bartolo (Saturno et al. 2001). All of this is significant because, with a few notable exceptions, most ancient Maya graffiti dates to the Late Classic period, much later in Maya history than the collection at Holtun appears to be (Żrałka 2014:190). This could be due to several reasons, both taphonomically and culturally. It is certainly possible that incised graffiti was an artistic style that was primarily used in the Classic period and was only regionally used in the Preclassic in the Holtun-Yaxha area—but, while potentially interesting, is purely speculative. More concretely, many of the sites in the southern lowlands have very large Classic period population sizes, which lead to a sharp increase in monumental construction. The Maya built like Russian nesting dolls, filling in each previous

occupation of a structure to build a larger, more impressive structure on top of it (Hansen 1998). This is likely due to create structurally sound buildings but also for likely holding onto past ritual memory (Estrada-Belli 2006; Hansen 1998). Large Classic period occupations often obscure earlier Preclassic period structures, even during tunnel excavations and much information about that site's Preclassic population is lost. When they are easily accessible, they are frequently looted and therefore all of the artifacts that would be present are missing, so there is certainly a gap in knowledge about the Preclassic period. Additionally, because the Preclassic period is inherently older there is much more of a chance of environmental destruction of structures and walls where incised graffiti is potentially housed.

Moreover, the transition from the Preclassic period to the Classic period is one of contention and debate on how exactly the Classic period political and economic structure came about. It is now widely accepted that the Late Preclassic period sees the early emergence of Maya state-level complexity (Friedel and Schele 1988; Hansen 1998). With the Holtun graffiti tentatively dated to this critical period of transition—in a vital area of the Maya lowlands where Classic period sites first emerged—it makes this graffiti a part of understanding the social construction of the time period. Architecturally and at the state-level, preferential access to certain groups began to emerge, and idea that can be enhanced by the study of the Holtun graffiti (Hansen 1998). By understanding how others outside of commissioned artists viewed myth, legend, and leadership, a better understanding of how these things emerged and transitioned into their Classic iterations may become clearer. The RTI of the Holtun graffiti lends itself to being progressively studied—photographs preserve the cultural heritage in an interactive way, one that

allows more details to be recorded and analyzed and therefore is always a source to look to in order to understand the transition from the Preclassic to the Classic period.

Contents of this Study

In the following pages, I describe the basic concepts and outline the execution of RTI as a method, both in ideal circumstances and its adaptations for its use in the field environment. Additionally, I will discuss this method and its resulting data in comparison to other methods that have been used to document incised graffiti, both at the site of Holtun and around the Maya lowlands. I will also discuss the limitations of RTI as a field method and what could be done to improve this study with more time and funding. Finally, I will use the data gathered from the RTI to postulate a few early interpretations of several instances of the graffiti, which are based in iconographic study and a tentative understanding of the Preclassic-to-Classic Period transition.

CHAPTER 2: METHDOLOGY

RTI as a Method

With the growth of the digital world, archaeological sciences and methods have also grown to embrace this digital atmosphere and a number of digital techniques have been taken and used by archeologists to fully document and analyze important archaeological discoveries. Reflectance Transformation Imaging, or RTI, is one of those methods and it relies on the movement of light in order to visualize and analyze an object from a variety of angles. This method was initially developed in 2001 in the Hewlett-Packard research laboratories and at the time was called Polynomial Texture Mapping (Earl et al 2010). PTM essentially represents images as mathematical functions instead of as values of color by incorporating light reflectance information into each specific pixel (HP Website). PTMs are often used to increase photorealism in a photographed object when lighting varies and can help enhance existing colors within the pixels (Malzbender et al 2001). Once it was clear that this method could be applied outside of enhancing photorealism, and that the computer programs were not just capable of mapping textures through the polynomials, but instead could digitize and enhance information on reflectance, the name was changed, and PTM became a subset of RTI (Newman 2015).

In this technique, the camera and object being photographed both remain stationary which avoids the need for complex geometry and other more complicated texture models (Malzbender et al 2001). The only movement is from the single light source, but this light source must remain at the same *distance* from the object even when the *angle* of the light source changes. Keeping these particular variables consistent is required by the software program that

will eventually render these images into a single RTI file where all of these images can be viewed at one time. If the locations of the camera or object, or the distance of the light source changes, the output file will be at best blurry and unclear or at worst completely corrupt and unviewable entirely. Twenty-four to sixty photos per object is recommended and the goal is to create a dome of light around the object. In order for the software to detect what angle the light is coming from, two reflective black spheres are also placed in the frame of the photo. These spheres may be cropped out of the final RTI files, but they serve to tell the software where the light is located within the image.

In theory, the final images should reflect something similar to Figures 6, 7, and 8. Figure 6 shows the mounted camera with remote triggers to avoid moving the camera during the process, the black spheres to reflect the light, the actual light source as well as the object being photographed. Figure 7 shows an example in the middle of the process; one person is using a string in order to measure the correct distance between the light and the object while the other person holds the light at that particular distance from the object. The person controlling the light source is also presumably controlling the remote trigger for the camera in order to capture the image. In Figure 8, there are two black spheres that show the likely and ideal distribution of lights after the capture of the images. The first example shows gaps due to camera placement and the second shows the ideal distribution of the light points.

The RTI builder software has several algorithmic fitters that may be accessed and used with the same base set of photos. Polynomial Texture Mapping is one of them, and was discussed in the section above. Highlight based detection fitters function in a similar way to

developing PTM's, allowing for the software to formulate how light will reflect off an object and then to construct this in an interactive digital atmosphere. Highlight detection differs in the fact that the information created can undergo "specular enhancement" where the surface shape can be more easily distinguished, and the program uses a series of reflective spheres to find the light source (Earl et al 2010). In the following paragraphs, I will outline exactly how the image capture and image process portions of RTI is ideally completed. Following that, I will describe how these methods were modified for the field and tunnel environments.

Image Capture

In order to conduct the actual image capture, the RTI kit with the black reflective spheres along with various methods to prop up those spheres is required. Additionally, a DSLR camera with a manual and adjustable zoom as well as aperture, ISO, and shutter speed settings that may be manually adjusted is also needed. The developers also suggest a tripod to maintain the camera at a steady and solid height as well as a laptop computer that may remotely trigger the camera. If a laptop cannot be acquired, any other method of remote trigger can be used. It is also suggested that the camera be connected to a power source—that way the batteries will not die during the image capture process and the entire process will not have to start over. Finally, a separate, movable light source is required. This light source can range from a remotely trigger flash to a lamp with a consistent beam of light.

Camera Set-Up

After all of these tools are acquired, the main set up is consistent no matter the object being photographed with this method. The camera can be set securely to the tripod, whether that

tripod is downward-facing or not, and the remote trigger can be linked to the camera. These two first steps are necessary to ensure no movement or vibration of the camera, which negatively affects the final RTI file. This can be seen in Figure 9: this was one of the first RTI capture attempts of the field season and it is clear from the images there was some camera movement. All of the images captured could not be overlaid one on top of the other and this ultimately results in a blurry file. In Figure 10, the corrected RTI file can be seen with new photographs with light from the same angle. The difference between the photographs with movement and the photographs without (Figure 9 versus Figure 10) is clear.

Object and Reflective Sphere Placement

Once the physical camera setup is complete, whatever object that is desired to be photographed can be placed in the center of the camera frame on a neutrally colored backdrop (black, white, or grey). Two black reflective spheres then also have to be placed next to that object within the frame of the camera. As stated before, these spheres act to capture the reflection of the light source and then are used in the RTI Builder software to detect the direction from which the light is coming. Without these two spheres, the analysis will not work. Ideally, these spheres should be at least 250 pixels of the final image and the provided kit comes with spheres of various sizes to be used for a variety of objects. Photographers can get creative in mounting the spheres so they are present in the image—the RTI starter kit from the developer (Cultural Heritage Imaging) includes several washers and stands for them, but as you can see from Figures 11, 12, and 13 spheres can be glued to wooden dowels, propped on Legos, or attached with double sided sticky tape. The spheres should also be close enough to the object so the camera can

focus on both the object and the spheres, but far enough away that the spheres can be cropped out of the final RTI file. Finally, the photographer has to be aware of the shadows cast by the spheres in the image when the light source is moved so that they do not overlap onto the desired object.

Light Sources and Positioning

When positioning the light, this source must be the same distance from the object while the angle of the light changes. Measuring this distance can be done in a variety of ways but the developers of the program and method itself suggest using measured string because, in the end, the results end up being the most accurate. The end of the string should be taped or attached in some way to the end of the light source or flash unit and the end of the measurement to the object can be marked by tying a knot or attaching a piece of tape to the further end of the string. As a note, the string must be removed before capturing the image. This distance should be two to four times the diagonal measurement of the object. If this is impossible, then the light should be as far away from the object as possible and at minimum should be twice the diagonal length of the object being photographed.

The lights themselves can be continuous or flash units and each come with their own advantages or disadvantages. Continuous lights are best used for indoor spaces where all ambient light can be controlled and there is a controlled power source. Additionally, continuous lights do not need to be timed with the camera shutter in order for the light to capture on the image. Flash units are better used for outdoor spaces in high-ambient light environments and are better for

shooting large objects. These units also use less battery power and are therefore good for spaces without a controlled access to a power source.

Camera Settings

Before the image capture session can begin, the camera must be set to manual mode so all of the settings necessary for an acceptable RTI photo can be inputted by the photographer. Additionally, the focus on the lens of the DSLR must be taken off of “auto” after the initial focus is determined to maintain a consistent focus throughout the image capture session. If the focus changes between photos, then the set of images is useless in the RTI Builder software. The switch itself is on the lens and the focus mode must be switched very carefully in order to avoid moving the focus ring of the lens or jostling the camera out of position.

The aperture setting, which is used to establish the depth of field in a captured image, allows a certain level of light to enter the camera lens. This functions almost like the human eye—the smaller the aperture, the less light is let through the lens and the darker the image (Figure 14). Additionally, smaller apertures allow for more of the image to be in focus from front to back (or depth of field) and larger apertures allow for a very specific part of the image to be in focus (Figure 15). For clarity, larger apertures are represented by smaller numbers and vice versa and are represented as a f-stop or f-number on the camera (i.e. f/2, f/12, etc.). In RTI, the aperture should not be smaller than f/11 because smaller apertures (larger numbers) degrade the image quality—the depth of field is increased but the sharpness of the image declines. Ideally, the aperture number should lie between f/5 and f/11 in order to balance the amount of light

allowed into the image and the depth of field. If the image exposure must then be lightened or darkened, the ISO can be changed in the settings as well.

Exposure is determined through three separate test shots—one with the light source at 65 degrees above the camera and one at 15 degrees above the camera with the same aperture and light intensity and then one with the light source absent. These first two test shots can then be checked using the camera's histogram feature. Ideally, there should be no peaks at the white end of the spectrum as this end indicates a blown-out exposure (Figure 16). The darkest image (with the light at 15 degrees above the camera) should have a histogram that has most of its peaks at the black end of the spectrum (Figure 17). The lightest image (with the light at 65 degrees above the camera) should have a relatively consistent distribution of light to dark. The final test shot with the light source absent should appear completely black. This can be achieved by modifying both the aperture value and the ISO value. Lower ISO values darken an image and higher ISO values brighten it back up again. Ideally, to avoid noise in a photo, the base ISO of 100 should be used in all RTI conditions. Shutter speed can also be adjusted to acquire a brighter, more exposed photograph. The longer the shutter is open, the more light is let into the image. Adjusting to a shortened shutter speed may help to darken the unlit image further.

It is also suggested to use a neutral gray card (18% gray) to determine proper white balancing in the image after the capture session and before processing in the RTI Builder software. A single test shot should be taken with the light at 65 degrees above the camera with the gray card within the image and then later, the RGB color values can be compared. If they all

fall within a five-point range of each other, the white balance on the image is correct. If not, all of the RTI photos must be white-balanced before processing can begin.

The images themselves should be captured as RAW image files—these are the largest files on the camera settings, but they allow for significantly more data to be captured within the image and the photo can be converted to a variety of other files later in the process. More importantly, these files allow for a record of the processing applied to the image. If something were to go wrong, the RAW files would allow the analyst to go back to the beginning and not only figure out what went wrong in the process, but still obtain and retrieve usable data. RAW files also limit the amount of post processing done within the camera itself. JPEGs are often processed in the camera within its own set of algorithms with no record of what was done to the image and it cannot be controlled; therefore, the final RTI data may ultimately be different if the images were shot originally as JPEGs versus RAW files.

Image Processing

In order to later process the images, which in the case of this study was done on-site, the RTI Builder software must be installed on the computer. This open-source software is available for download via the Cultural Heritage Imaging website. The first step is to transfer the original RAW files from the memory card of the camera to the work station computer. Then, review each of the photos and delete unusable images—which could be due to shadows or other things that obscure the object being photographed—inside any image processing software (Adobe Photoshop, Lightroom, etc). Then, within that same image processing software, convert those RAW files into both JPEG files and DNG files. The DNG files are used as a backup for the

primary capture data while the JPEGs will be used within the RTI Builder applications. These JPEGs will have to be saved in a folder jpeg-exports which will then be uploaded into the application. At this point, the black spheres that were placed in the photo *should not* be cropped out. They are needed for the analysis in the program.

Once all processing of the photos is entirely complete, then this jpeg-exports folder may be uploaded into the RTI Builder application. At this point, there is a selection to be made as far as which fitting algorithm to use in order to process the images and create an RTI file. Here, there is a Polynomial Texture Map (PTM) algorithm or a Hemispherical Harmonics (HSH) algorithm. Typically, the PTM algorithm produces a better image and HSH algorithm produces better data (Cultural Heritage Imaging Forum 2012). When it is considered that PTMs were specifically developed to enhance realism of objects in photographs, it is unsurprising that PTM files produce a better image. Because they produce more data, HSH algorithms have the capability to render material of objects much better than PTMs can. For example, this means that shiny objects actually appear shiny with an HSH fitter (Cultural Heritage Imaging Forum 2012). Selecting one or the other requires a trade-off, but regardless of which fitting algorithm was chosen to complete the analysis, the following processing steps are identical for both. Once the selection is made, the photos may be uploaded into the program.

Within the application itself, before completing further steps, the metadata for all of the photos may be changed as well. This is entirely optional but may be beneficial for maintaining the integrity of the data and prevent any loss of information regarding those photos. It is also

important to go through the images once more and remove any that should not be used to calculate the RTI.

Next, the light positions must be identified in a two-step process: identifying the spheres and then detecting the highlights, both of which are interactive processes. The first step is to identify the area around the black reflective sphere so the software can detect the highlights and then use them to compute the light positions for each image. Once that is complete, the program can then detect the actual outline of the black sphere itself in each of the individual images. The goal is to get the outlined area to match as closely as possible with the defined sphere within each of the images—that way the highlight detection and subsequent computation of the light positions is as accurate as possible.

After identifying the spheres, the highlight detection can begin. This process—done entirely by the software—is lengthy but will result in a final composite image of all the detected highlights on the black sphere. This is a useful resource during analysis—it can show where there were more light points, and where light potentially lacked. For example, in Graffito C4-A, it is clear that there were no light positions present in the upper left. In this case, this is due to limitations specific to the tunnel itself—the wall and ceiling simply prohibited light at the proper distance from that position. The composite image can make the limitations especially clear for potential analysis. Finally, the black spheres can now be cropped out of the image since the highlight detection is complete. Once the final product is cropped, the final RTI file can be saved to be later analyzed.

RTI As a Field Method—Modifications to the Process

The reality of using this method in the field creates certain challenges of its own. The Holtun graffiti were located in a small structure, Structure F2--Substructure 1, comprised of a series of six walls or pillars that were exposed through tunneling (Figure 3). F2-Sub1 is theorized to be a Late Preclassic (400 B.C-100 A.D) extension of a large Middle Preclassic (1000-400 B.C.) range structure that is part of the site's E-group (see: *Site Background* section for more detail). In order to access Substructure 1, excavators used an old looter's trench that exposed the back of Substructure 1 and the front of Substructure 2. From there, we tunneled beneath the roots of the large trees that sat on top of the mound, exposing all of the walls and opening up most of the room. A few portions of the structure could not be opened and retention walls of the original fill of the structure had to remain in place (see Figures 3 and 18).

At its widest, the tunnel was approximately 0.80M and ranged to approximately 0.25M wide. The height of the tunnel ranged from about 1.30M to 1.60M (Figures 19 and 20). Even at its highest point, I personally would not have been able to stand upright while performing the RTI. Additionally, because of the tight quarters, it was very difficult as a singular person to move around inside of the tunnels *before* all of the RTI equipment was in place and could not be moved. After the necessary equipment was put in place, it was nearly impossible to move from one side of a wall to another. A few attempts were made to use two people, like suggested in the RTI Image Capture Guide, but two people inside of the tunnel, which, at its widest, was less than a meter, allowed more time for different kinds of error. The most prevalent was the accidental movement of the camera or reflective spheres, which meant the process must be started over. It

was then determined that there would be less error in the actual method if a single person was present inside the tunnels and managing all aspects of the actual image capture, with a few exceptions.

The nature of the tunnels and the location of the graffiti at particular points on the walls led to certain limitations in the method as well, as briefly stated in the previous section. Because the camera and the light source must be two to three times the diagonal distance of the image away from the actual object, these distances limited the potential size of the actual image. For this reason, whole walls could not be captured in a single image and only instances of previously-defined graffiti were included in this study. For future analyses, each wall exposed should be cleaned with a conservator present to avoid damaging the walls or incisions and systematically photographed using this method in order to completely document all potential instances of graffiti.

Additionally, the close proximity of the walls and the roof of the tunnel limited where the light could actually be placed. Therefore, there are some angles of light that could not be used. An example of this can be seen in Figure 21, which was taken from C4-A where it is clear from the reflective sphere composite that there were places where the light simply could not be to fit within the required distances. Despite this limitation, the RTI capture and processing guides are optimistic about still obtaining useable data even if specific angles are blocked. The software will not be able to detect the light changes from those specific area but will still be able to detect the light from other areas.

An advantage of performing this type of method inside an underground tunnel is specifically related to camera settings. For RTI, in order for the camera to pick up only the specific light source that will move around over the course of the process, the ISO and aperture settings must be set so that when the light used for the photograph is not shining on the object, the image appears completely black i.e. so no ambient light is picked up in the image. Typically, a low ISO and medium aperture will achieve this. While working underground, the only ambient light came from the entrance to the tunnel into the structure and therefore these settings did not have to be adjusted at all between the documentation of each graffito. This provided consistency throughout the entire process and allowed each graffito to be documented using the same camera settings. For all documented graffiti, the ISO was set at the base of 100 and the aperture was maintained at $f/5.6$, which is considered to be a very “medium” aperture. The shutter speed was not adjusted within the tunnel because the unlit image appeared naturally black. Any differences in the exposure of the images is due to differences in light sources used throughout the study. Because of the tight quarters of the tunnel, and the older version of the DSLR used in the study, a remote flash could not be used, and a variety of battery-powered headlamps were used for the study. Once the batteries ran low on one, the batteries were replaced, or in some cases a different headlamp was used. This unfortunately led to low and inconsistent light intensity and therefore is not ideal. However, because of the limited access to resources in the field, it was necessary for capturing the required images.

Furthermore, in many of the images, the shadows of the reflective spheres could not be eliminated entirely so the focus was on making sure those shadows did not overlap with the specific graffito. The reason these shadows could not be eliminated entirely is due to, once again,

the confining space of the tunnel. In order to make sure the spheres were close enough to be visible in the image while far enough away from the graffiti that they could later be cropped out, the shadows could not be eliminated entirely. There was also an attempt to use smaller spheres, which would in theory take up less space and in turn cast smaller shadows, but they were not large enough to register in the RTI Builder software. However, while there are shadows present in the image, the graffiti was not affected.

Once the images were captured in the field, they were transferred from the camera directly onto the computer with the RTI Builder software and processed immediately. This allowed for faulty capture sessions to be caught immediately and redone on the same day. Furthermore, with a long battery life, multiple image capture sessions can be processed on-site with no problem and because the processing software does not require internet access, this can be done in semi-remote locations like the site of Holtun. Additionally, unlike using other equipment, RTI is relatively inexpensive to perform and at its most basic requires just a camera, a light source, and two reflective spheres of equal size.

CHAPTER 3: RESULTS

RTI Compared to Other Methods

In the field of anthropology and archaeology, RTI has predominantly been used in a variety of settings including the field but is most common in a museum or laboratory setting with an environment that can be completely controlled (Newman 2015). Artifacts like incised bone can be documented in a way that allows archaeologists to later interact with the material without the potential for damage (Newman 2015). When done in the field, the focus is on objects with high relief where a PTM is easily created from the series of photographs (Earl et al 2010). With the growing threat not only of looting but environmental factors potentially destroying cultural patrimony and heritage in the Maya Lowlands, the need to bring methods like this into the field to document objects and walls with more minimal relief is growing. The rainforest environment of the lowland areas of Guatemala, Mexico, and Belize often have high humidity which can disintegrated the fragile limestone stucco when exposed (Żrałka 2014:94). In addition, fungi, algae, and root systems can destroy stucco and limestone bricks in places where the walls are not entirely exposed (Żrałka 2014:95).

Incised graffiti on stucco has been known to be notoriously difficult to document and often methods are dependent on the environment the graffiti is found in. At Tikal and Nakum, graffiti is often found not incised in fragile stucco but instead on the limestone building bricks directly and in an open and exposed environment. In this case, archaeologists placed a plastic film directly on the surface and traced over the incised lines of the graffiti using the natural daylight available to them (Żrałka 2014:98). However, in many cases graffiti is found on much

more fragile stucco surfaces and during the course of tunneling through structures. In these cases, and in order to preserve the stucco, it is inadvisable to place anything directly on the surface and in many situations the only light available is at least a simple headlamp or flashlight and at most a few lights powered by a portable generator. In these situations, RTI has proven to be a valuable supplement to accurately and precisely document graffiti. By taking not just one, but a series of photographs from the exact same angle with different light sources, the fragile incised graffiti can be interacted with and studied remotely and digitally without missing details or creating any further threat to the fragile environment they are located in.

In the past, graffiti has been documented in a variety of ways that have provided useful information, but there are areas that still lack in terms of data recovery. The most common methods in documenting any form of Maya art are standard line drawings, photogrammetry, tracing, and scanning. Digital documentation like photogrammetry and scanning of stucco and painted monuments and murals is much more common in this region, and photogrammetry itself can create a Polynomial Texture Map so it is certainly a step in the right direction (Macdonald and Robson 2010). This comparison is not meant to denounce any of the previously mentioned methods—they all provide vital information when recording Maya art, but all have strengths and weakness as well that often can and should be used in conjunction with each other to provide supplemental data. In the following sections, I will discuss each of these techniques individually and then in relation to the RTI method.

Line Drawings

One of the most quintessential methods to record any archaeological material is a line drawing. These to-scale, realistic drawings are used to document everything from ceramic sherds to structure profiles to skeletons found in burial contexts. They provide necessary detail and data in a clear, compact and concise manner required for any kind of analysis and in archaeological record-keeping, there is no replacement for to-scale line drawings.

However, line drawings—with all their advantages—have certain limitations that frequently are not considered when using them for analysis. First, they are inherently biased towards the artist and their interpretation of what is important enough to include in the rendering and what should be left out. They draw based entirely on what they see, and it is frequently possible that one artist will see different detail than another. Drawing these graffiti relies on what the artist sees in the moment, shapes and figures they are capable of making out. Often this subjectivity leads to potential mistakes or something being missed and provides a bias that, once the original artifact, structure, etc. is gone can no longer be corrected.

This is not to say that line drawings are not crucial to archaeological record keeping. Photographs alone are also not enough of a representation on their own because they do not provide information of scale and in the case of wall art, actual specific details regarding their location on the wall and in relation to other images. Instead they should be used in *conjunction* with other newer digital techniques in order to get a more complete understanding of what these images actually represent instead of an artist's interpretations.

Photogrammetry

Photogrammetry has exploded in popularity in the last decade and has been used to digitally reconstruct everything from ceramic sherds to entire structures, though the technology has been around and used sparingly for over 30 years (Anderson 1982:200). This method and its programming utilizes overlapping photographs in order to create a three-dimensional representation of the desired object. The program finds points of commonality between the overlapping photographs, determines depth of those points of commonality and then shows the object in three-dimensional spaces. The advantage to using this method is similar to the advantage for using RTI or any other digital method of documentation: its objectivity. The camera records whatever is in front of the lens regardless of what the archaeologist deems to be important aspects of the image (Sapirstein and Murray 2017). Of course, it can be argued that the archaeologist has to determine what to photograph, but they also have to determine what to excavate as well—the fact of the matter is there will always be some level of subjectivity regarding archaeology, but digital methods of documentation may provide a way to eliminate some of that subjectivity. Photogrammetry's shrinking expense has also contributed to its wide use and distribution as a method not just on a global scale but in Maya archaeology as well; previously photogrammetry was an expensive undertaking that few archaeologists would have been able to pursue (Anderson 1982: 201). Despite its more widespread use, archaeologists still have not been able to agree on achieving a standard metric accuracy and recording (Sapirstein and Murray 2017:337).

Just on this project alone, photogrammetry was done on a portion of a frieze in a pyramid structure in the site center, on a stucco mask on the range structure of the site's E-group, and to construct a preliminary version of the graffiti room in three-dimensions (Figures 22 through 27). Because of both RTI and photogrammetry's use of specific camera features, they are particularly well equipped to be used together. For example, the reconstruction of the graffiti room allows for a series of possibilities for future design and research—with a completely reconstructed space and then the interactive capabilities of the RTI, it is possible to give an analyst the full experience of being in a space and interacting with it without ever having to have been there. This could limit the exposure of these important images and preserve them not just for the future of archaeology and its developing methods, but also for the people whose heritage these images belong.

RTI provides a specific advantage over photogrammetry when it comes to the shifting light source—photogrammetry relies on shifting depth of field data within the pixels of the image and uses a broad light source from the same point over the course of the photography session. In this case of incised graffiti, photogrammetry is only able to provide a single view of these incised lines and may miss specific details too small to be rendered in the software. RTI provides a targeted view of the incised lines of the graffiti specifically and will provide more data regarding those incisions and images.

Tracing

Many of the instances of graffiti at Tikal and Nakum have been documented using a tracing technique that captures a great amount of detail in the image, provides proper scale for

the image, and then can be later scaled down to fit in a site report or publication (Figure 28). However, the graffiti documented using this method was incised on hard limestone bricks rather than fragile stucco surfaces and allowed for much more physical pressure to be placed on the image. Additionally, these graffiti are in well-lit and open-air areas of those site's structures. The deep incised lines are much more easily seen in these open areas than in other, darker and more obscured contexts.

It is important to note that any material placed directly on the surface of a wall or structure may warp in a way that takes away from the accuracy of the drawing (Żrałka 2014:94). To combat this, other scholars have taken to using acetate laminates or even plexiglass as one archaeologist on the Holtun project did (Vidal and Muñoz 2008: 6, 2009: 102; Callaghan et al. 2017; Figure 29). In many cases, in order to distinguish between scenes, artists will use different colored water-proof markers to indicate a change in scene or which lines are considered to be important (Żrałka 2014:98). Furthermore, tracing also represents the same issue highlighted when discussing line drawing—the interpretation of what lines are important and part of the image being rendered. Żrałka (2014:94) introduces a unique example of this; Trik and Kampen both traced over an identical image of Tikal graffiti yet produced very different images (Figure 30). Trik's is heavily edited based on what lines she believed were part of the overall image being depicted while Kampen traced nearly every line, even to the point of partially obscuring the image.

Because Mayanists so frequently tunnel into structures in order to fully understand every phase of architecture, many instances of graffiti are hidden deep within these tunnels and

underground where good lighting is nearly impossible to achieve. Furthermore, many graffitied images are incised on the stucco covering the harder limestone bricks, and any pressure put onto that stucco risks damaging the entire wall. Żrałka (2014:100) recommends that preservation steps should be taken before any documentation takes place; however, in many cases this may not be possible, and documentation is done not in place of preservation steps but prior to them in case preservation of the wall itself is not possible.

It is also noted that often tracing in epigraphic and iconographic studies is done directly from photographs taken of the walls or objects instead of the physical objects themselves (Żrałka 2014:100). While scale becomes an issue here, this is where RTI and tracing can coincide to provide better data and documentation of these incised lines. A single photograph may not fully capture the detail needed for an accurate trace, especially in places where natural lighting is impossible to achieve. However, the multiple photographs provided by RTI and the ability to interact digitally with the direction of the light source could provide the analyst with the angles needed to trace the image with accuracy and precision. Additionally, another analyst can go back and reexamine the RTI file, trace, and field line drawing and compare them in the future without having to just rely on what one particular archaeologist deemed important.

Scanning

At this point, scanning in the Maya area has only been used to document murals and monuments (like in the case of San Bartolo, Copan, and Tikal) but has not yet been used to document incised graffiti (Żrałka 2014:101). This method has been used in the Old World in Pompeii with promising results and detail. Because these scanners use a triangulation-based laser

scanner where a light emitter produces a thin laser sheet refracted by mirrors and a video sensor picks up the reflected light, they produce well-rendered three-dimensional models of the scanned object (Balzani et al. 2004:4). The 3D scanners produce almost the same information as photogrammetric and RTI analyses do by creating dimensional meshes and differences in light positions; however, the scanner used in Balzani et al.'s 2004 study costs upwards of \$3,000 in today's market and the program while the RTI kit costs no more than \$100. Additionally, the scanning kit requires an almost constant power source as well as heavy software that can only be granted through the purchase of the machine. It would certainly be worth investigating whether this type of scanning would provide a good basis for documenting and preserving ancient Maya graffiti; however, for archaeologists working under budget constraints in remote and secluded locations in the rainforest where this type of equipment may malfunction, using RTI is a cheaper and more accessible option for similar data.

This is not to say that scanning will always been this inaccessible and expensive—photogrammetry has gotten significantly cheaper since its inception in the 1980's. If this trend continues, then scanning may prove to be the most effective way to document and preserve graffiti. At this point, RTI is a useful stepping stone towards more accessible and inexpensive scanning technology.

Analyzed Graffiti Using RTI

At the conclusion of the field season, a total of 19 specific instances of graffiti were documented using the RTI capture method and RTI builder software and the final instance of graffiti was not due to unexcavated space. In Figure 31, the walls and graffiti are labeled, and the

analysis of each graffiti will start first by column—named alphabetically—then by the wall number on that pillar—named numerically with wall 1 located on the north side of the structure—and finally, by the graffiti—named alphabetically based on the graffiti’s location on the wall from top to bottom. Five different images screen captures from the RTI are shown for each graffiti: four from four corners with raking light and the fifth chosen by the analyst that best shows the graffiti. The measurements indicated by the caption are based on the direction of light; the first number indicates where the light sits on the x-axis and the second number indicates where the light sits on the y-axis.

Column A

A1-A

This corresponds to a graffiti found in the 2016 season. In Mary Clarke’s drawing (2016; Figure 32), this graffiti is labeled as Grafito B and in Coronado’s plan drawing (2016) it is labeled as Grafito A. This confusion was specifically why the new nomenclature system was put into place. From this point on, it will only be referred to as A1-A.

As for the actual content of the graffiti, it actually consists of three separate images. Two appear to be anthropomorphic figures, one of a torso with what look like legs, the other of legs standing on top of a step or platform. The third is not readily identifiable as human or animal. Figures 33-37 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. It is also clear from the RTI images that this was before the conservators were able to preserve and clean the stucco—there are several holes in the stucco walls and a system of roots can be seen as

well. Figure 38, a screen capture taken from the photogrammetry reconstruction of the structure done after the completion of the conservationist's work, shows the difference between the initial RTI image and the final conserved stucco. Figure 32 exhibits the line drawing of the graffiti. Finally, Figure 39 shows the composite black sphere to indicate all the changing light sources.

A2-A

This graffiti is an anthropomorphic face with a nose and an eye that looks like a scroll or swirl. Protruding from the lower part of the face appears to be a large chin. Less than 0.10M wide, this small face is located about halfway up the wall along with several apparently unrelated instances of graffiti. Figures 40-44 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 45 exhibits the line drawing of the graffiti. Finally, Figure 46 shows the composite black sphere to indicate all the changing light sources.

A2-B

This graffiti is a series of crosshatching lines. Much of it is obscured by dirt that could not be cleaned this season due to the high volume of conservation work that had to be done on walls with more immediate needs. It is likely that once it is clean, the overall image will be much clearer; however, it has been noted that cross hatching lines within hieroglyphs are often associated with iconography related to darkness (Stone and Zender 2011). Figures 47-51 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 45 exhibits the line

drawing of the graffiti. Finally, Figure 52 shows the composite black sphere to indicate all the changing light sources.

A2-C

This graffiti is what looks like a knot, with two interweaving ropes. In the Preclassic and into the Classic periods, knots and ropes are often associated symbols of leadership and kingship because they so closely resemble the mat symbol (Robicsek 1975; Stone and Zender 2011). This graffiti is also less than 0.10 M wide and is the lowest incised image on this particular wall, only around 0.30 M above the surface of the floor. Figures 53-57 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 45 exhibits the line drawing of the graffiti. Finally, Figure 58 shows the composite black sphere to indicate all the changing light sources.

Column B

B1-A

This graffiti, discovered in the 2016 season, is referred to in that site report as Grafito C (Callaghan 2016). This tall anthropomorphic figure, spanning nearly a meter, is completely nude with what appears to be an intentionally modified cranium. Nudity in Maya art is extremely rare and usually is only associated with captives or male genital bloodletting (Houston et al. 2013). Other scholars have suggested some level of homoeroticism present in nudity from the Late Classic period (Joyce 2000). Few examples of male nudity exist in documented Preclassic art, the most notable being the San Bartolo murals where a single male figure is depicted performing

male genital bloodletting (Taube et al. 2010). Since in this case, the long male figure is missing hands entirely and there is no indication of any form of bloodletting, the reason for his nudity is yet unknown. Regardless, the scale of the apparently intentionally modified cranium is also worthy of note here, since it does not appear to match the scale of the rest of the body.

Because of the figure's great length and the very small space the RTI could be performed in, three separate capture sessions had to be performed in order to capture all of the figure. Given more time and a few creative minds, a single image could likely be produced; however, the goal was to capture as many images in a very brief period. In order to completely gather the data, it was necessary and faster to split it up into three different capture sessions. Figures 59-61 show each of the three images with the light coming from the same angle. Figure 62 exhibits the line drawing of the graffiti. Finally, Figure 63-65 shows the composite black spheres to indicate all the changing light sources.

B1-B

This graffito, discovered in the 2016 field season, is referred to in that site report as Grafito D. This also consists of an anthropomorphic figure, this one appearing to be clothed with a distended belly. The figure also appears to have a detailed face, facial adornments, and a modest headdress. Figures 66-70 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 71 exhibits the line drawing of the graffito. Finally, Figure 72 shows the composite black sphere to indicate all the changing light sources.

B2-A

This graffito, discovered in the 2016 season, is referred to in that site report as Grafito E. This large image is an anthropomorphic face with what looks to be hair coming off the back. The figure also appears to have a series of facial adornments and detailed lines inside the confines of the face. The red pigment is still very much present on this wall and there is some obvious cleaning that should take place before many of the lines might become clearer. The RTI of this graffito shows new and different lines not present on the line drawing done in 2016 and the texture of the face and what appear to be hair are much more apparent in the RTI images. Figures 73-77 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 78 exhibits the line drawing of the graffito. Finally, Figure 79 shows the composite black sphere to indicate all the changing light sources.

Column C

C1-A

This graffito, discovered in the 2016 season, is referred to in that site report as Grafito H (Figure 80). This image consists of a series of incisions that appear to be hieroglyphic in nature, though they have not been directly translated yet. Unfortunately, due to the retention wall that was left in place, there was not sufficient room to perform the RTI analysis. This retention wall is highlighted in Figure 81.

C4-A

This graffito, discovered in the 2016 season, is referred to in that site report as Grafito F. This image consists of two anthropomorphic figures, one of a head and face with a lot of fine detail, and the other of a cruder style, less detail, and a torso and legs. The original red pigment of the wall is clearly visible and forms a mat pattern on the wall behind it, which has been known to represent kingship (Stone and Zender 2011). Like the rest of the graffiti on this column, these figures are relatively close to the top of the wall. Figures 82-86 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 87 exhibits the line drawing of the graffiti. Finally, Figure 88 shows the composite black sphere to indicate all the changing light sources.

C6-A

This graffito, discovered in the 2016 field season, is referred to in that site report as Grafito G. This image consists of a series of incisions that appear to be hieroglyphic in nature and may be two distinct glyphs but have not yet been officially translated. Their position so close and perpendicular to the other graffito that is also hieroglyphic in nature is notable and once they are translated, they may prove to be related. Figures 89-93 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 87 exhibits the line drawing of the graffito. Finally, Figure 94 shows the composite black sphere to indicate all the changing light sources.

Column D

D4-A

Discovered this season, this graffito consists of two zoomorphic figures. One appears to be a deer or rabbit figure and the other may be a fox or some kind of serpent. Located near the top of the wall, this is one of the largest graffiti discovered and some of the only zoomorphic figures found within the structure. The RTI in this case was particularly beneficial—it is clear that the artist missed large portions of the body of the first animal figure including what appears to be a body and several limbs. A crescent shape also becomes clear near the body of the first animal figure. Previously in Maya iconography, the moon goddess has been associated with the rabbit in myth (Looper 2002; Stone and Zender 2011). Figures 95-99 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 100 exhibits the line drawing of the graffiti. Finally, Figure 101 shows the composite black sphere to indicate all the changing light sources.

D4-B

This graffito consists of an anthropomorphic head that appears to have some sort of cranial modification, hair, and other detail on the front of the face. Located halfway up on the same wall with the zoomorphic figures, this small face is one of the clearest graffiti in the structure with some of the deepest incised lines. Figures 102-106 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 100 exhibits the line drawing of the

graffiti. Finally, Figure 107 shows the composite black sphere to indicate all the changing light sources.

Column E

E2-A

This graffito appears to be a large rectangle with a series of intersecting lines inside of it that all cross in the center of the rectangle. Some scholars on the project have suggested this to be a cosmogram, which are defined as graphic representations of the cosmos (Smith 2005). More research into cosmograms must be done to confirm this, but it is an interesting possibility. Figures 108-112 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 113 exhibits the line drawing of the graffiti. Finally, Figure 114 shows the composite black sphere to indicate all the changing light sources.

E3-A

This graffito appears to be a large headdress or bird with long feathers that fall halfway down the wall. It is topped by a series of round objects that resemble jewels or hieroglyphs, but the center is muddled and unclear. In the top, east corner of the wall, the image spans nearly half a meter down the length of the wall and is easily one of the most intricate of the graffitied images present in the tunnel. Thankfully, it's location on the far east portion of the wall made it possible capture the entire thing in one RTI image capture session. Figures 115-119 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth

chosen directly by the analyst that best shows the graffiti. Figure 120 exhibits the line drawing of the graffiti. Finally, Figure 121 shows the composite black sphere to indicate all the changing light sources.

E3-B

This graffito is the most unique out of all the graffiti in the tunnels because it appears to be a large continuous scene. Reading it from left to right, there are first two anthropomorphic figures that are tall with large legs and cranial modifications that resemble the nude figure from B1-A without having any exposed genitalia. These two figures are standing in front of what appears to be a head inside a bowl or other vessel that are both seated on top of what looks like scaffolding. In Maya iconography, the Maize god is frequently depicted in the Classic period with his head in a sacrificial bowl (Just 2009). Scaffoldings are frequently associated with kingship and rulership (Stone and Zender 2011). RTI in this case revealed a third figure behind the scaffolding, and several details that appeared to be botanical in nature coming around and through the scaffolding that were missed in the original line drawing.

Because this graffito appears to be a composed scene, it stands apart from the scattered figures present throughout most of the structure and most graffiti in general. As previously stated, graffiti is typically marked by a *lack* of artistic composition and is often scattered without any clear connection. This graffito, while it does not have any clear connection with the graffiti around in and throughout the structure apart from stylistic similarities, has at least three figures that appear compositionally connected with each other. The RTI of this complete scene may prove to offer more analyzable details and could shed light on what this scene could ultimately

represent. Figures 122-126 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 127 exhibits the line drawing of the graffiti. Finally, Figure 128 shows the composite black sphere to indicate all the changing light sources.

Column F

F2-A

This graffiti is a small, deeply incised cross. There are several possible places where this cross is replicated within the structure, but this wall especially is covered in dirt that obscures many of the images. It is also possible that this cross is connected to other portions of graffiti on this wall in particular but it is unclear with the current data set. Figures 129-133 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 134 exhibits the line drawing of the graffiti. Finally, Figure 135 shows the composite black sphere to indicate all the changing light sources.

F2-B

This graffiti is another detailed anthropomorphic head with facial adornments and an apparent headdress. Seated inside what could be described as a boat only seen once the RTI was completed, this figure is one of the most detailed in the structure and is stylistically much different than the other figures and graffiti on the walls around it. Boats in Maya iconography are frequently depicted in scenes carrying leaders into the watery underworld (Stone and Zender

2011). RTI in this case revealed that this figure is much more detailed than first thought and the images could provide much more information about the figure itself and what he is seated in. Figures 136-140 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 134 exhibits the line drawing of the graffiti. Finally, Figure 141 shows the composite black sphere to indicate all the changing light sources.

F2-C

This graffiti appears to be two intertwining ropes running down the north edge of the wall. It is stylistically unique from graffiti A2-C, the previous graffitied knot, and with this thin rope could also represent ideas of kingship and mat symbols. Figures 142-146 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 134 exhibits the line drawing of the graffiti. Finally, Figure 147 shows the composite black sphere to indicate all the changing light sources.

F3-A

This graffiti appears to be two crude anthropomorphic figures of a similar style to each other, but in a much different style than many of the other graffiti within the structure. Notably, if compared to graffiti F2-B, the styles are clearly different. The original line drawing did not capture the body of one of the figures, and the RTI has revealed several other details that were not initially seen. This wall was also subject to several cleaning and conservation sessions after the RTI was performed. The modifications to the wall can be seen in a screen capture from the

final photogrammetry reconstruction (Figure 148). Figures 149-153 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 154 exhibits the line drawing of the graffiti. Finally, Figure 155 shows the composite black sphere to indicate all the changing light sources.

F3-B

This graffito was discovered last season and is referred to in Mary Clarke's drawing as Grafito A but in Coronado's plan drawing as Grafito B. This figure is vaguely anthropomorphic with a head and curled nose, two legs and a torso. This particular RTI is significantly darker than the others; this has to do with the batteries from the light source fading. Regardless, the software was able to pick up the highlights from the black sphere so the data were usable. Figures 156-160 show five different light positions highlighting the graffiti, four from the four corners of raking light, and the fifth chosen directly by the analyst that best shows the graffiti. Figure 161 exhibits the line drawing of the graffiti. Finally, Figure 162 shows the composite black sphere to indicate all the changing light sources.

CHAPTER 4: CONCLUSIONS

Limitations

Due to time constraints and other experts' needs to consolidate and preserve the fragile stucco walls, the photographs taken for this study were done in just under two weeks. Any corruption in the data will not be able to be corrected for (i.e. new photographs cannot be taken in the time allowed) therefore the current dataset is, as of now, the only dataset. Additionally, photographs were taken before conservators cleaned and preserved the stucco on the walls and for this reason, some of the photographs may prove to be unclear due to imperfections on the walls.

The camera used, a Canon Rebel XT, was released in 2003 and the model ceased being produced in 2005. At the time the study was performed, this was the newest, highest quality camera with the capabilities needed to perform the RTI image capture and in the field, a newer model could not be obtained. This makes the camera used in the study at minimum twelve years old. The quality of the camera does not degrade; however, the standards for what is considered the highest quality of photograph has changed with changing technology. At the time of its release, this camera was considered to be the peak of capturing a high-quality image—now, the images appear fuzzy when zoomed in or cropped to be smaller. In future studies at Holtun, a camera from at least the last five years should be used to keep with the standard of photo quality in the current decade.

The modifications to the process that were made in the field may also prove to be a limitation; the challenging environment and limited space inside the excavated tunnels inhibit the

ideal number of photos and light angles that were expressed in the RTI Capture Guide. While the capture guide indicates that usable data can still be gathered from the capture session, the fact of the matter is there is still missing data that cannot be recovered. One instance of graffiti (C1-A, Figure 80) could not be documented using this method at all due to its location on a wall that was not completely exposed during excavation. This wall, highlighted in Figure 81, was left unexcavated due to the unsafe conditions that would have been present had the retention wall been removed. This could have likely led to a tunnel collapse that would not only have set back excavations but possibly destroyed some of the structure we were attempting to preserve. This example shows that, as versatile as RTI photography can be, there are specific requirements of camera position and space that still must be met. Therefore, even though RTI can be performed in remote, hard-to-reach locations, there are still some places that RTI simply cannot be done.

Avenues for Future Study

Specifically at Holtun, due to time constraints, only instances of identified graffiti were used and photographed in this study. In the future, all of the walls within the structure should be cleaned off of dirt under the direction of a conservator and then photographed systematically to reveal any potential instances of graffiti missed during the initial investigation. Not only would this systematic documentation of every exposed wall of the structure help to potentially discover new instances of graffiti, but it could also preserve the state of the structure in a series of photographs for future studies.

Furthermore, this method should be tested at sites outside of Holtun and outside of the Maya lowlands in general. While the results of this study are promising for the documentation

and analysis of incised Maya graffiti, there are certainly other applications for this method that could be explored. In the Maya lowlands, RTI could potentially benefit the study of limestone production and the use of tools. Sculpture could be documented in the field and the PTM's generated from the RTI photographs could potentially lead to clues on how different aspects of sculpture were created. Artifacts could also be analyzed with RTI, as Newman did in her 2015 study of incised animal bone taken from the Maya lowlands.

Outside of the Guatemalan lowlands, RTI can be applied anywhere in the world in even the most remote of field sites for a relatively inexpensive price tag. It could provide a wealth of information not just on incised graffiti, but potentially on any number of immovable archaeological features that lend themselves to being difficult to photograph or document with any sense of realism. Used in combination with other digital and archaeological record keeping techniques, a more complete picture of the past can be constructed. Analysis can be done by scholars years into the future and from miles away from the actual feature itself. For delicate materials prone to speedy degradation, this method of documentation and analysis would limit graffiti and stucco exposure to harmful environments but still allow analysis of the materials to continue.

Ancient Maya graffiti themselves are an understudied aspect of archaeology, one that is critical to uncovering how other portions of the population interact with iconography, myth, and legend. When considering graffiti outside of the limited Western perspective as vandalism, and identifying it as its own specific artform, it unlocks the potential to understanding other aspects of those familiar myths and legends and how they are interpreted. Archaeology as a subset of

anthropology means looking at the people creating these images themselves instead of just the images. By preserving every aspect of the incised graffiti, archaeologists then are allowed to pursue avenues of investigation into social and artistic behavior that were once elusive over the course of years into decades.

**APPENDIX A:
CHAPTERS ONE AND TWO FIGURES**

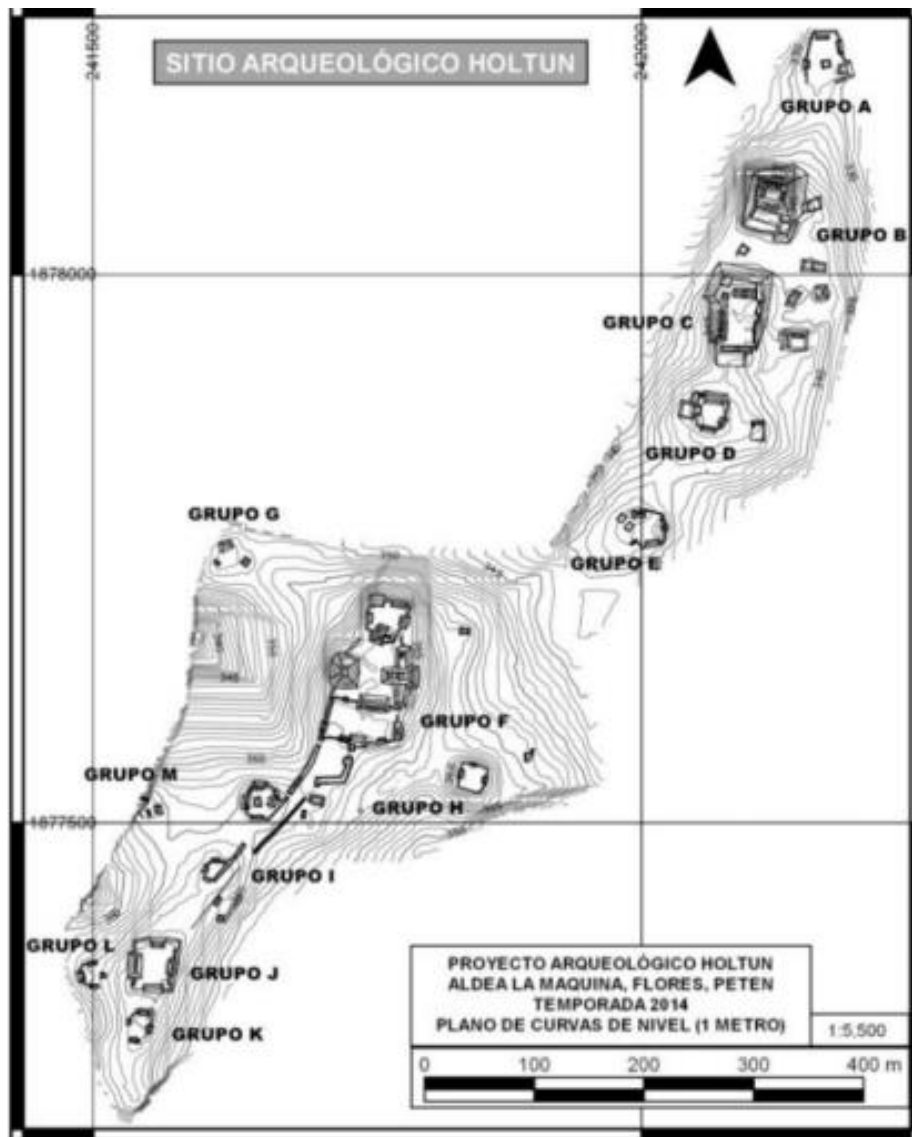


Figure 1: Map of Archaeological Site Holtun
R. Guzman 2015

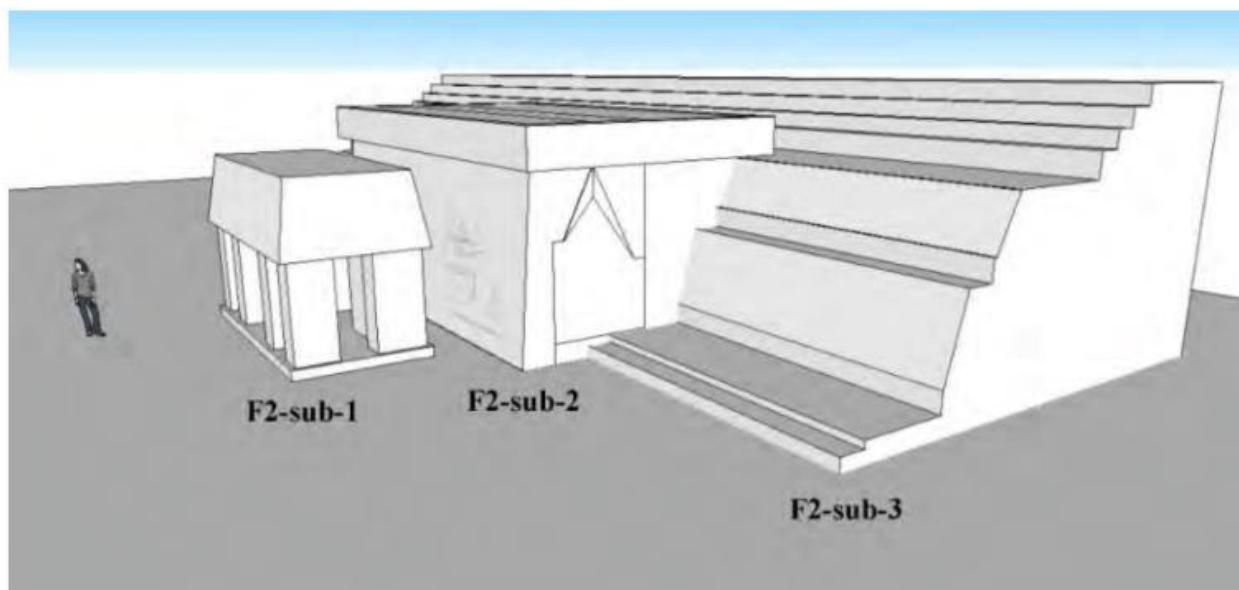


Figure 2: Reconstruction map of Structure F2 with all associated substructures
M. Clarke 2016

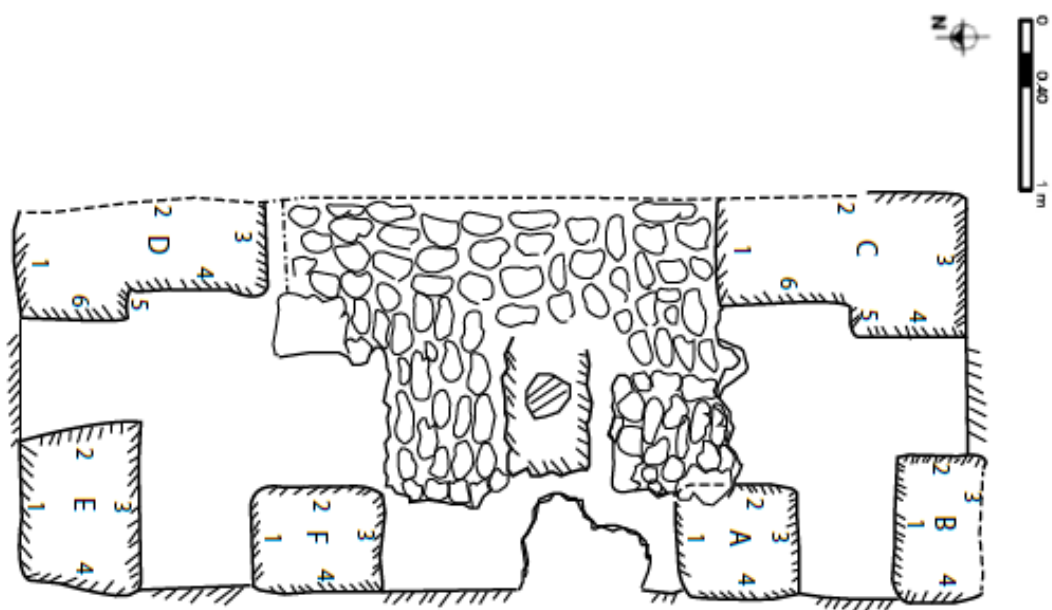


Figure 3: Plan drawing of Structure F2-Substructure 1
R. Gill 2017

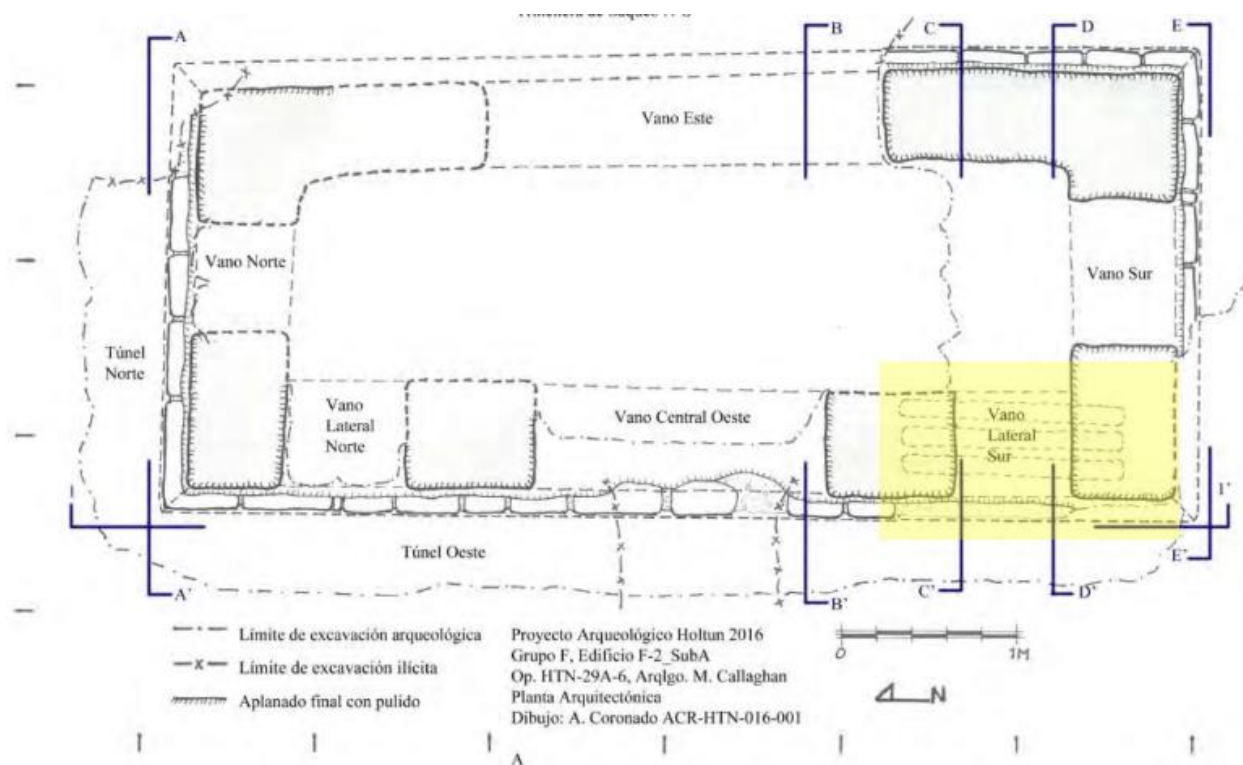
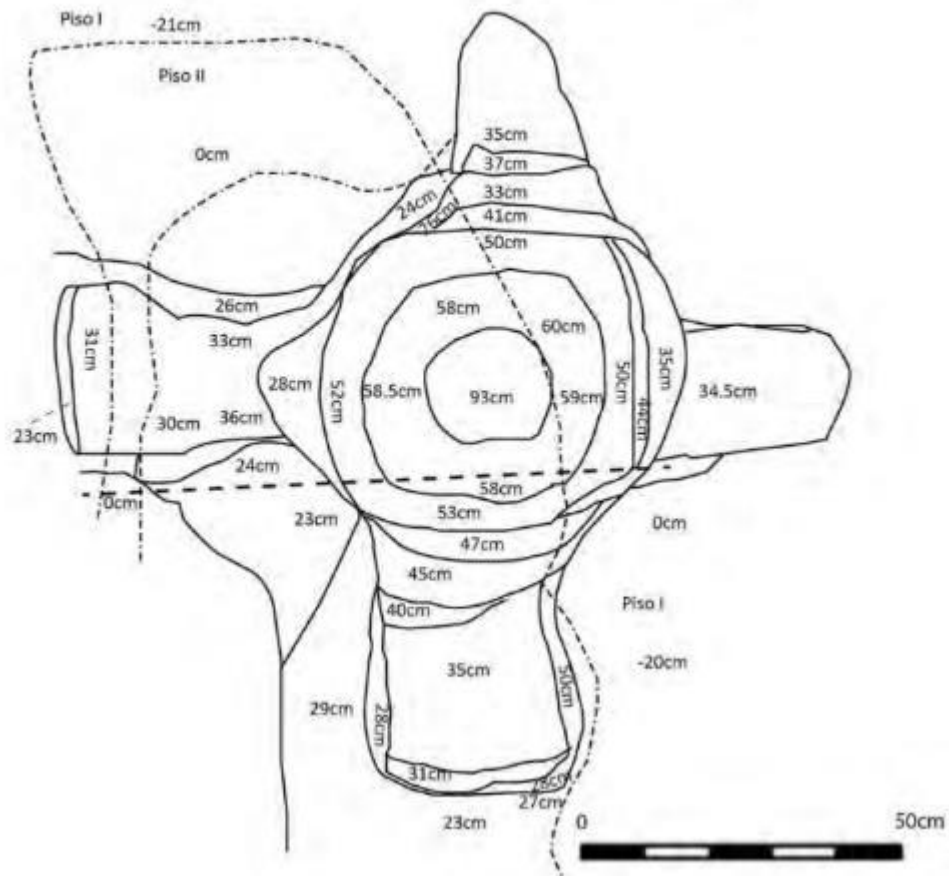
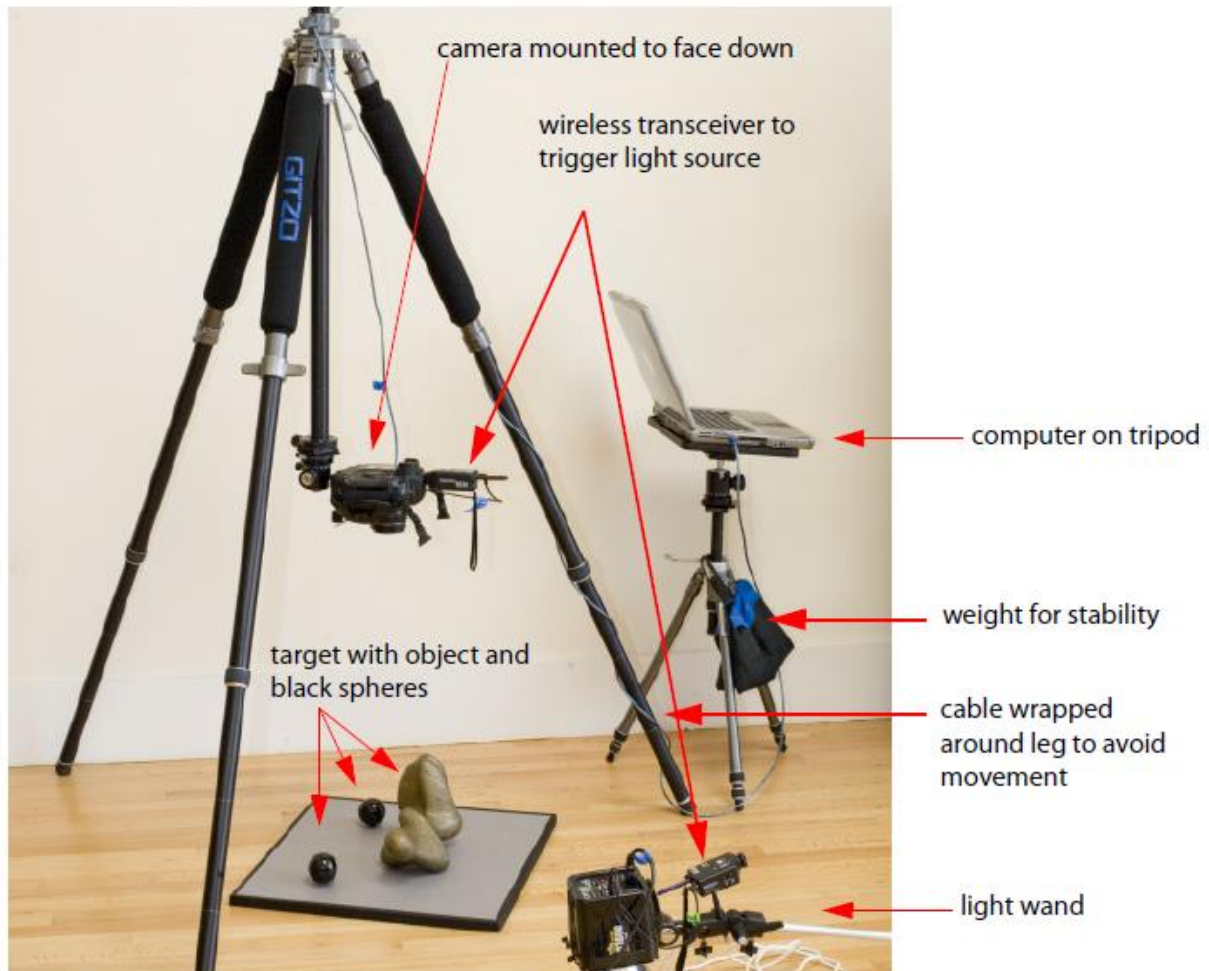


Figure 4: Original plan drawing of Structure F2-Sub 1 with postholes highlighted
A. Coronado 2016



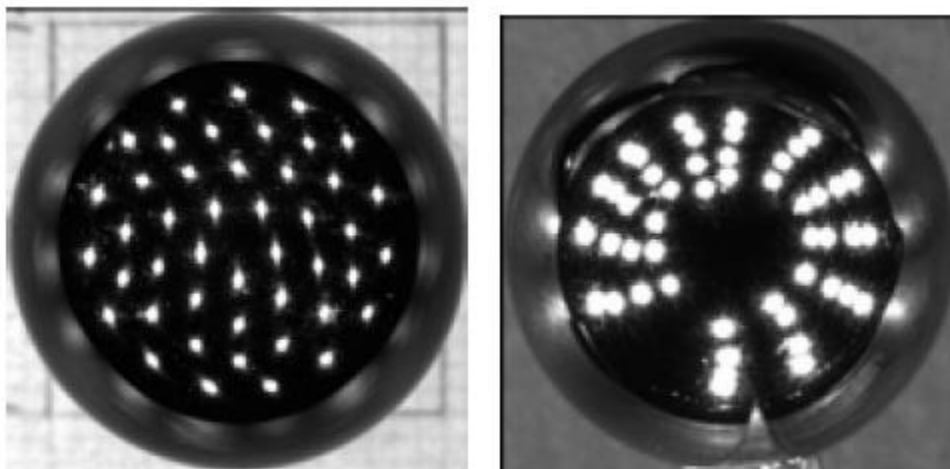
54



*Figure 6: Image depicting ideal RTI equipment set up with mounted camera and remote triggering system.
Cultural Heritage Imaging 2013*



*Figure 7: Image depicted ideal RTI capture session with analysts and light source
Cultural Heritage Imaging 2013*



*Figure 8: Image depicting ideal RTI light distribution and likely light distribution
Cultural Heritage Imaging 2013*



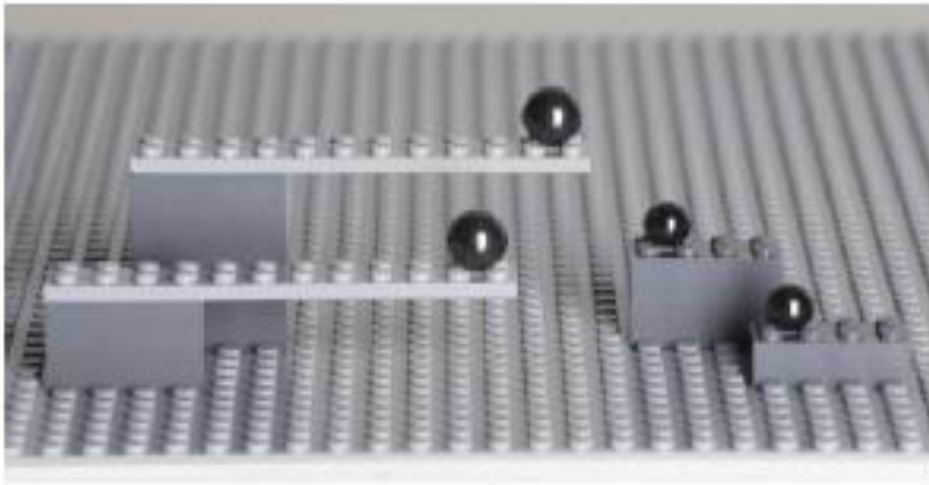
Figure 9: Flawed RTI attempt on Graffito A2-B



Figure 10: Corrected RTI attempt on Graffito A2-B



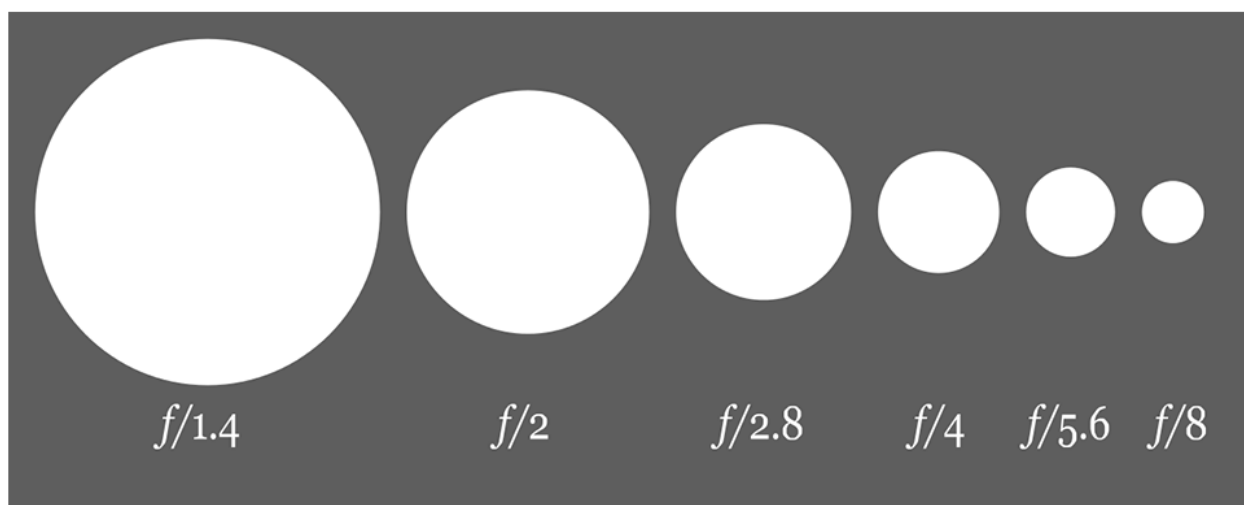
*Figure 11: Black reflective spheres glued to wooden dowels
Cultural Heritage Imaging 2013*



*Figure 12: Black reflective spheres propped up on Legos
Cultural Heritage Imaging 2013*



*Figure 13: Black reflective spheres stuck to double-sided sticky tape
Cultural Heritage Imaging 2013*



*Figure 14: Different apertures and their corresponding numbers
N. Mansurov 2018*

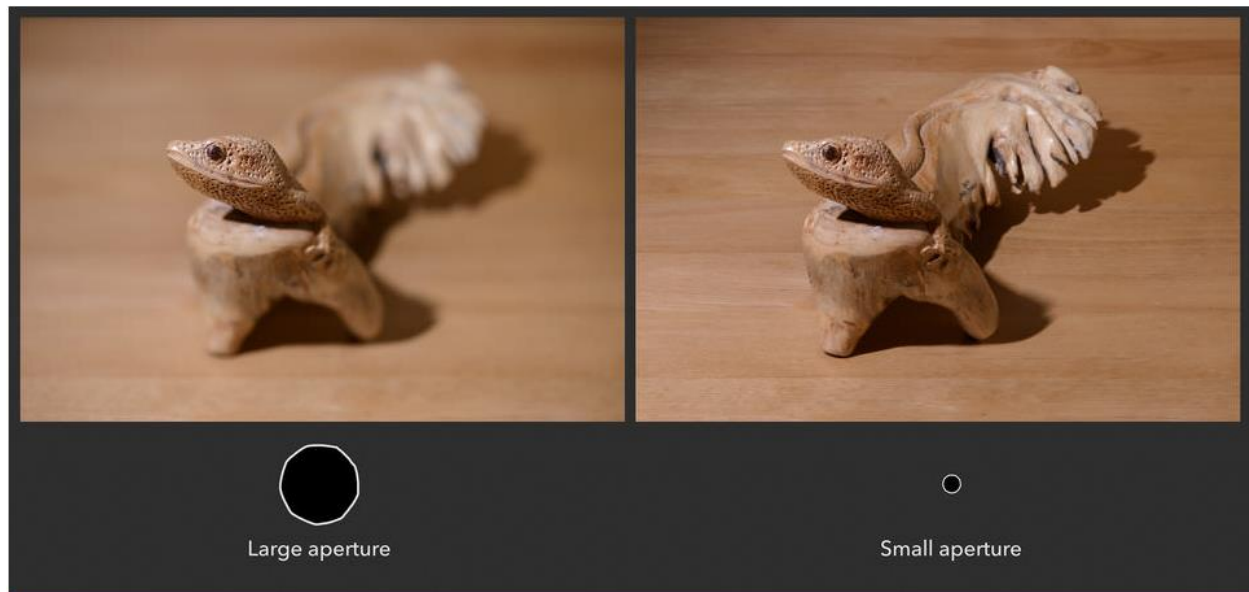


Figure 15: Examples of differing depth of field; on the left is a shallow depth of field and a larger aperture and on the right is a larger depth of field with a smaller aperture
N. Mansurov 2018

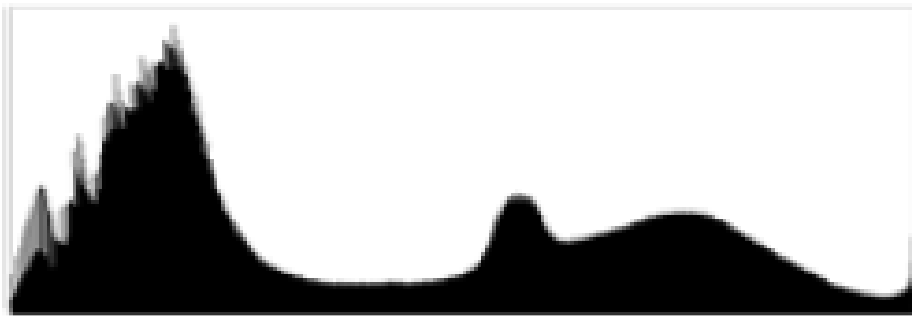


Figure 16: Example of ideal histogram shown on the camera for the brightest image in the RTI capture session
Cultural Heritage Imaging 2013



Figure 17 Example of ideal histogram shown on the camera for the darkest image in the RTI capture session
Cultural Heritage Imaging 2013



Figure 18: Photograph depicting the fill of the structure that was left in place to prevent tunnel collapse
R. Gill 2017

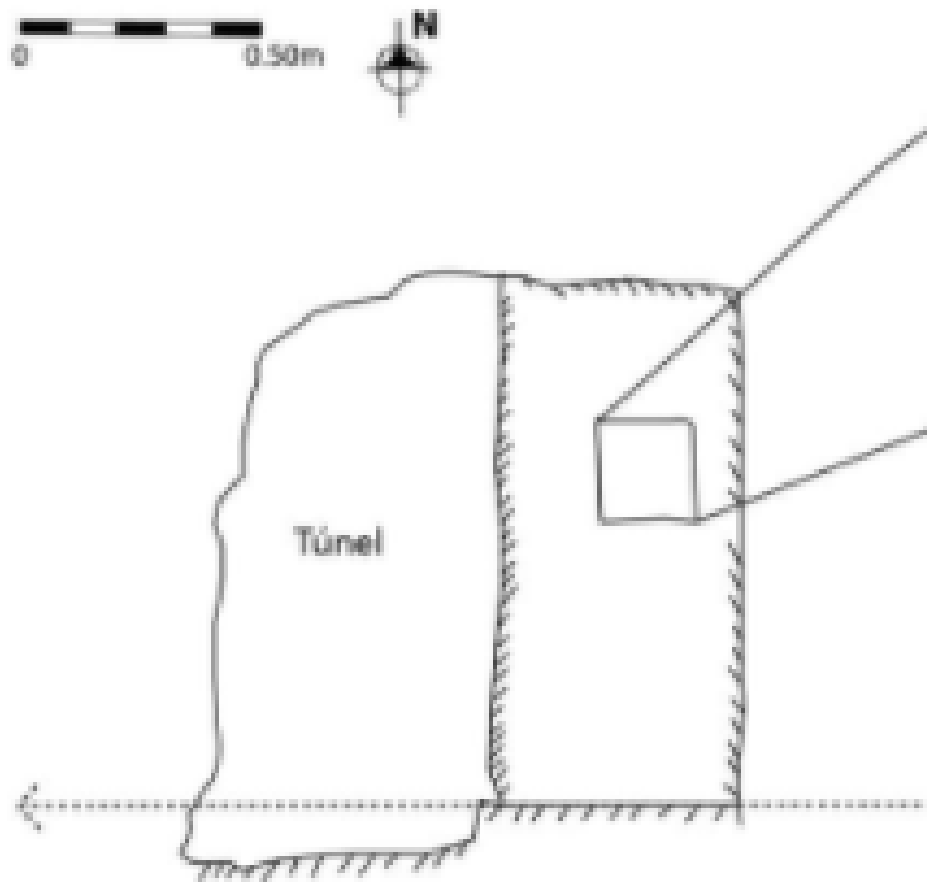


Figure 19: Line drawing of the smallest wall containing graffiti to show the minimum height of the tunnel ceiling
R. Gill 2017

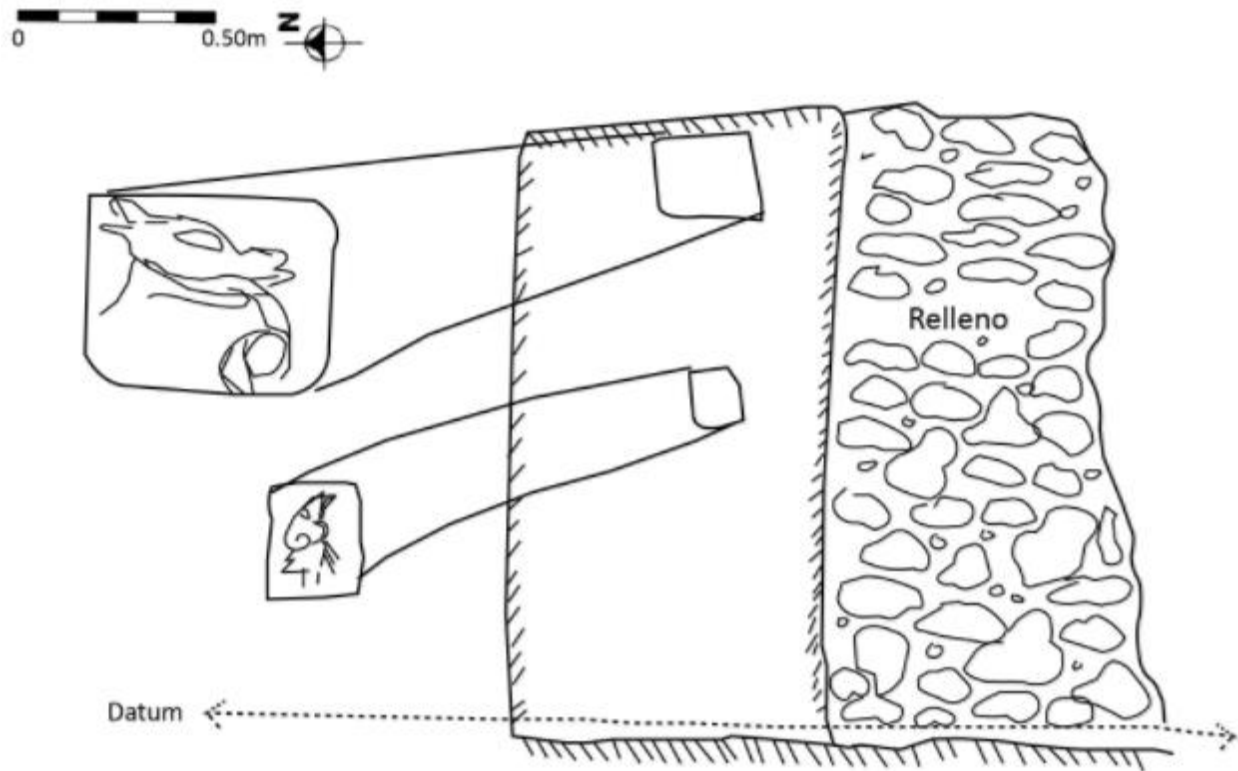


Figure 20: Line drawing of the tallest wall containing graffiti to show the maximum height of the tunnel ceiling
R. Gill 2017

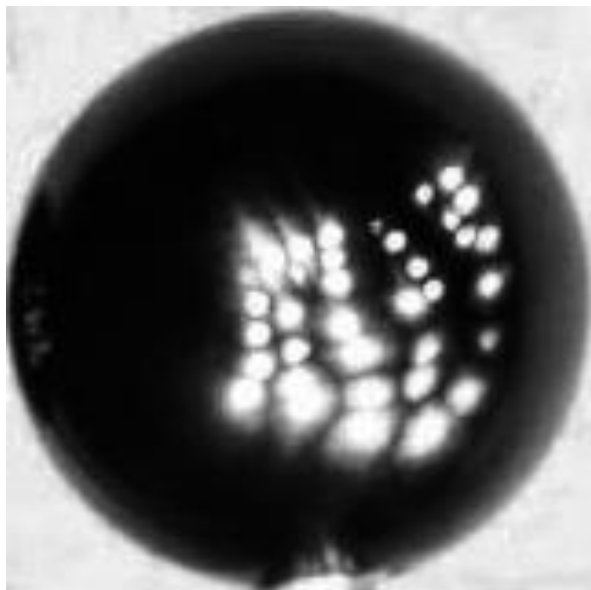


Figure 21: Composite highlights on the black sphere for the RTI capture session of Graffito C6-A
R. Gill 2017

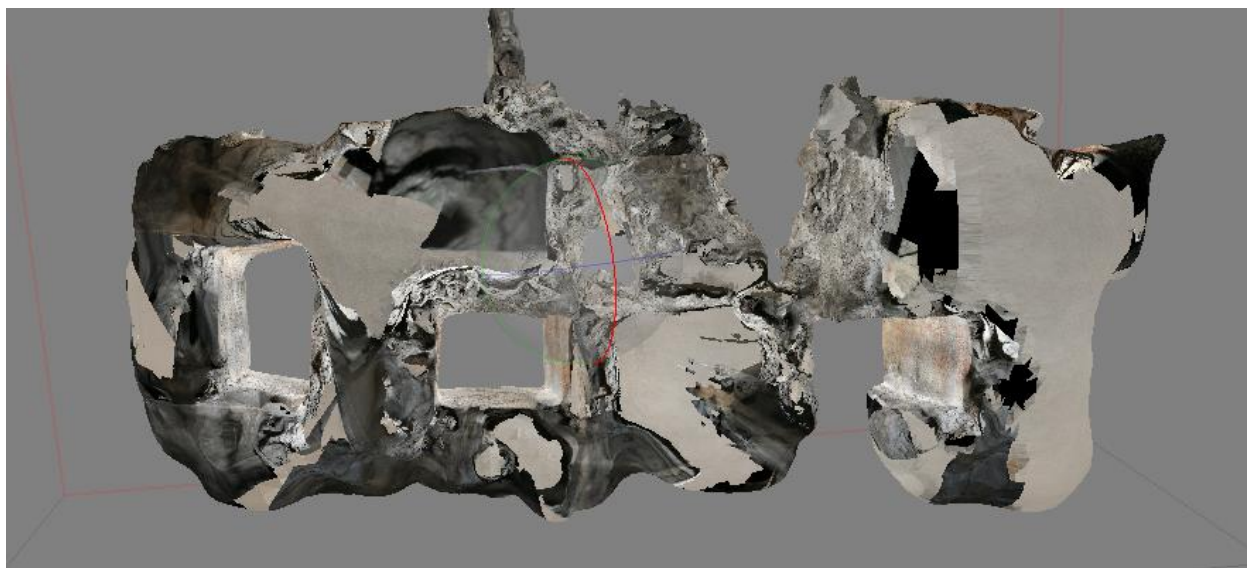


Figure 22: Final photogrammetry screen capture of structure F2-Sub1 taken from above
R. Gill 2017

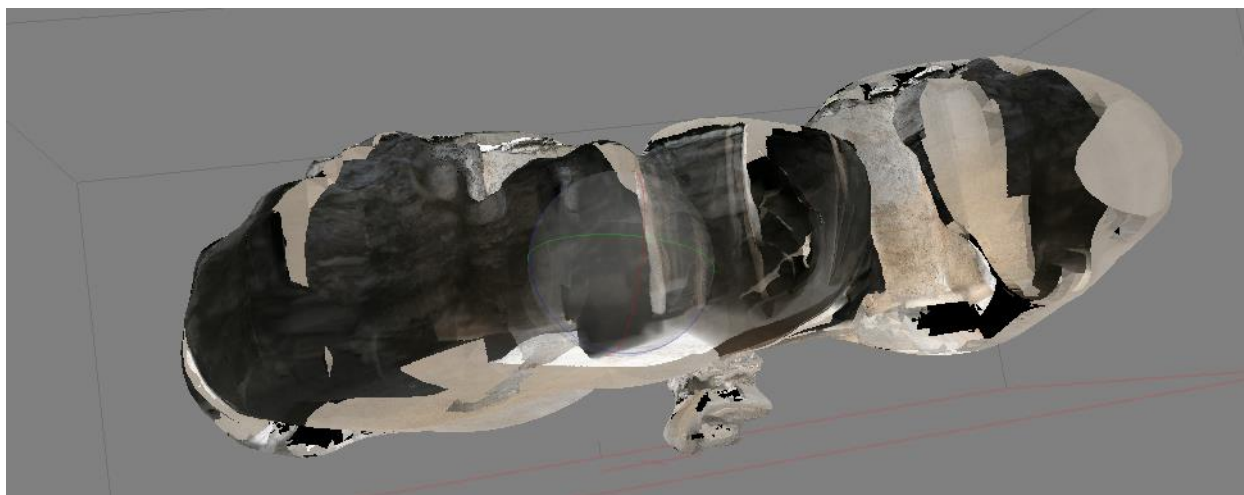


Figure 23: Final photogrammetry screen capture of Structure F2-Sub1 taken from the east side; the cruciform cut is visible below the main components of the structure
R. Gill 2017



Figure 24: Final photogrammetry screen capture of the interior of structure F2-Sub1 where one of the originally constructed columns as well as the structure fill left in as a retention wall
R. Gill 2017

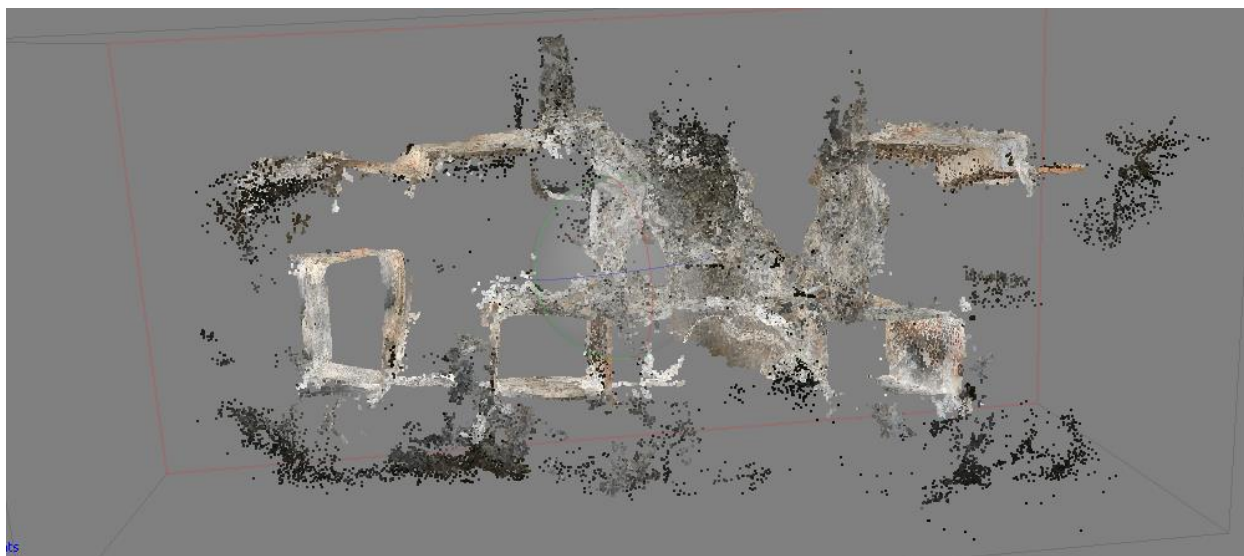


Figure 25: Dense point cloud of all points of commonality during the photogrammetry reconstruction of Structure F2-Sub1
R. Gill 2017

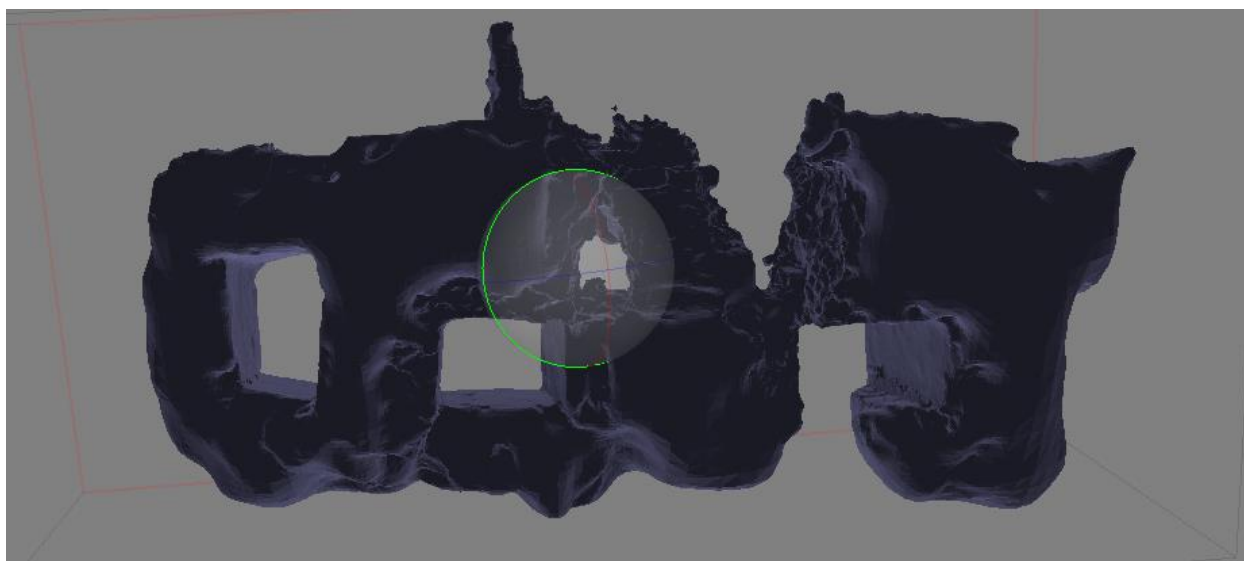


Figure 26: Wire frame of the photogrammetry reconstruction of Structure F2-Sub1 taken from above

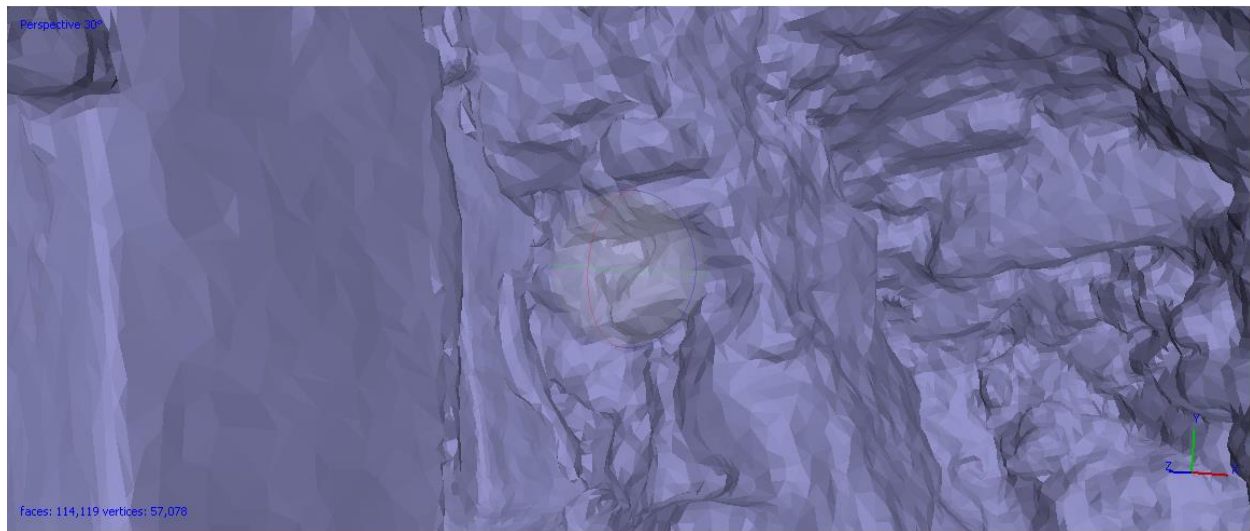
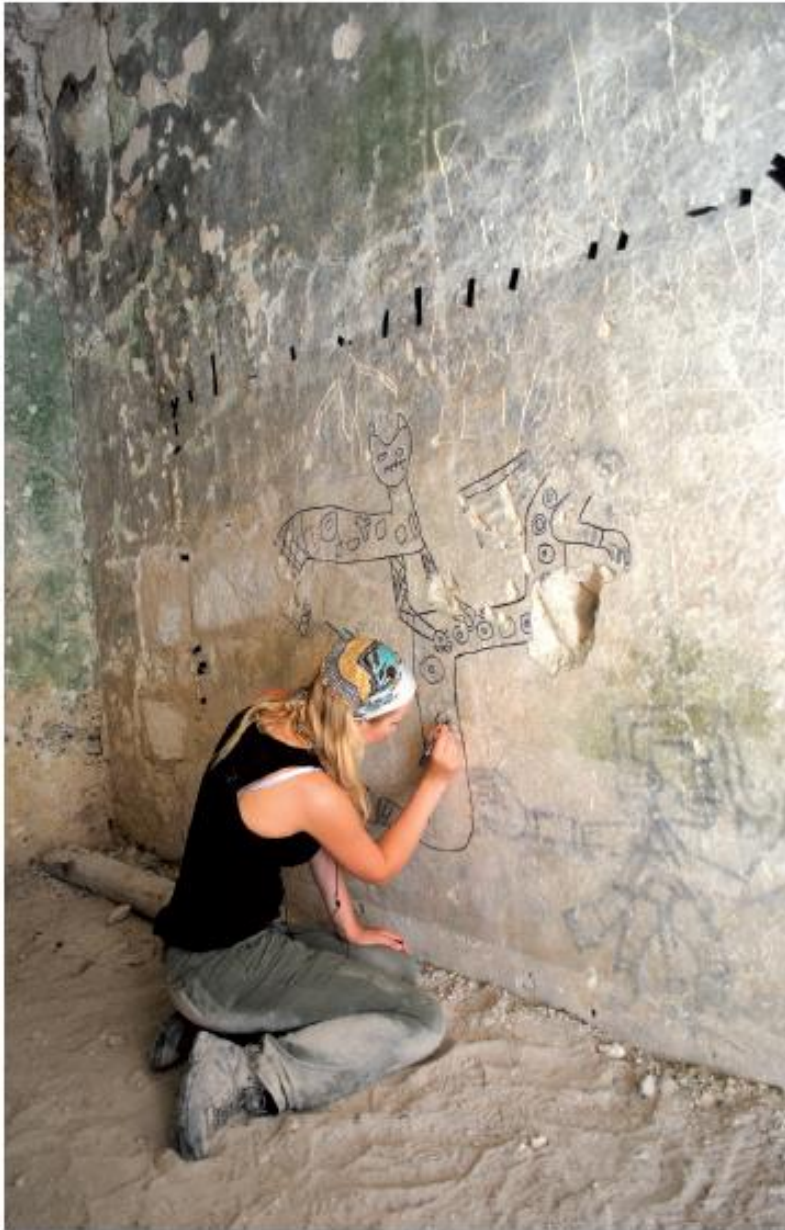


Figure 27: Wire frame of the photogrammetry reconstruction of Structure F2-Sub1 taken from the interior; on the left side of the image is the constructed column and on the right is the retention wall
R. Gill 2017



*Figure 28: Depiction of tracing incised graffiti at site of Nakum
Žralka 2014:98*



Figure 29: Depiction of archaeologist Henry Perez using a glass pane and PVC pipe to trace graffiti without touching the fragile stucco wall of the structure
R. Gill 2017



Figure 30: Comparison between Helen Trik and Michael Kampen's line drawings of graffiti from Tikal. In the top image, Trik heavily edits the lines that appear in the drawing based on what she believes are important. Kampen, in the bottom image, includes all the lines in his drawing, but the actual shapes of figures are muddled.
 Źralka 2014

APPENDIX B:
CHAPTERS THREE AND FOUR FIGURES

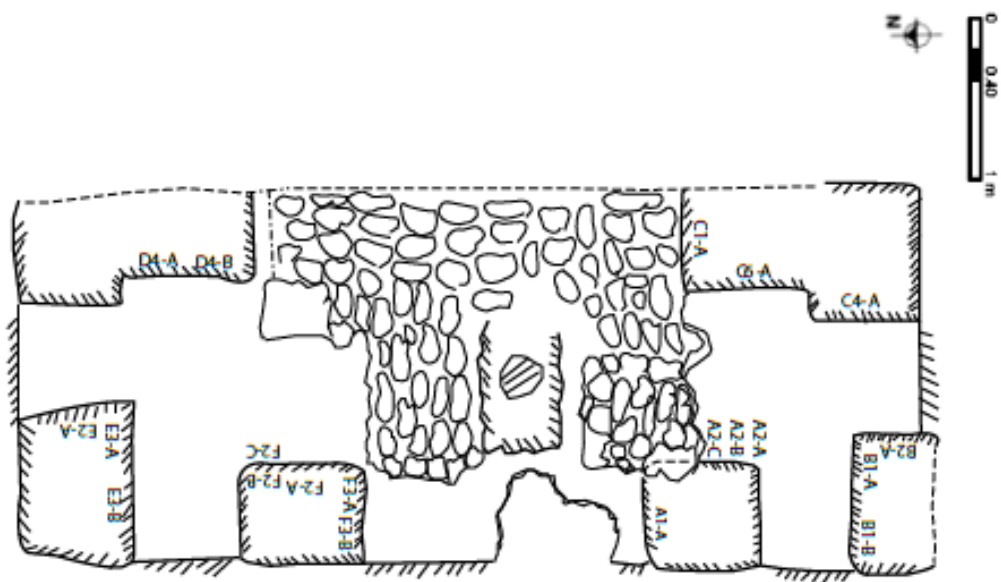
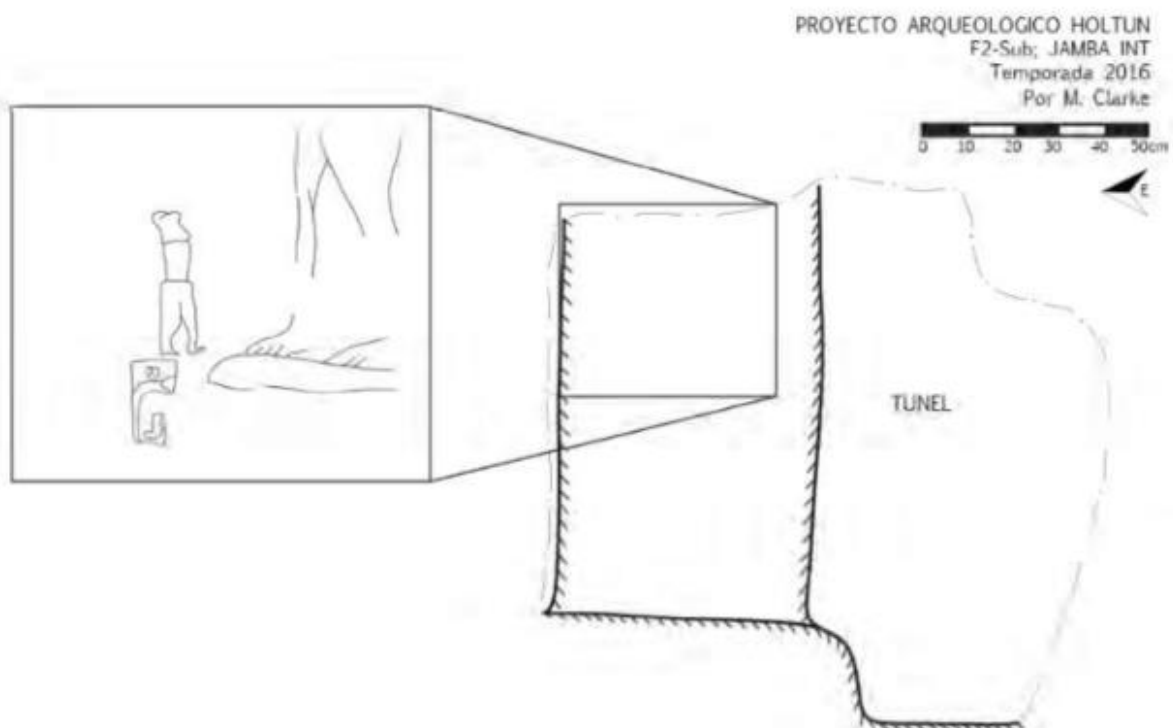


Figure 31: Plan drawing of structure F2-Sub1 indicating location of names of each specific and identified graffito
R. Gill 2017



*Figure 32: Line drawing of Graffito AI-A which a few anthropomorphic figures can be discerned.
M. Clarke 2016*



Figure 33: RTI screen capture with light source in the upper left-hand corner (-0.75 and 0.50) of Graffito A1-A



Figure 34: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito A1-A



Figure 35: RTI screen capture with light source in the lower left-hand corner (-0.50 and -0.75) of Graffito A1-A



Figure 36: RTI screen capture with light source in the lower right-hand corner (0.50 and -0.75) of Graffito A1-A



Figure 37: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffito A1-A (0.96 and 0.27)



Figure 38: Screen capture of the final photogrammetry reconstruction of wall A1 after the conservation work had been done on the structure.

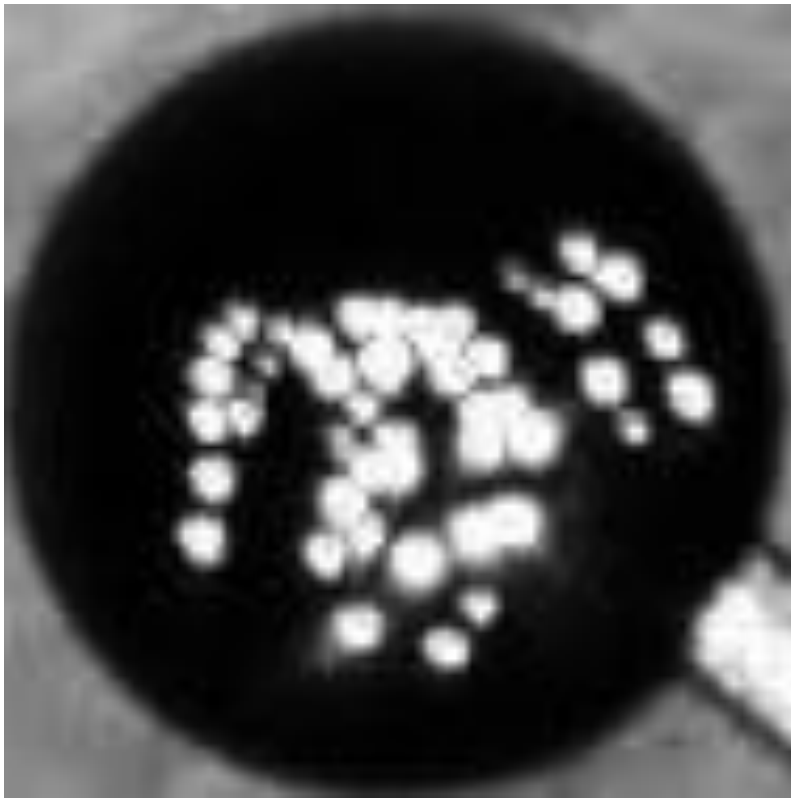


Figure 39: Composite highlights on the black sphere for the RTI capture session of Graffito A1-A



Figure 40: RTI screen capture with light source in the upper left-hand corner (-0.50 and 0.75) of Graffito A2-A



Figure 41: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito A2-A



Figure 42: RTI screen capture with light source in the lower left-hand corner (-0.50 and -0.75) of Graffito A2-A



Figure 43: RTI screen capture with light source in the lower right-hand corner (0.50 and -0.75) of Graffito A2-A



Figure 44: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffiti A2-A (0.92 and 0.11)

Proyecto Arqueológico Holtun
 Temporada del campo 2017
 Grupo F, Plaza B
 Dibujo del Grafitos A2-C, A2-B, y A2-A
 Dibujo: R. Gill
 Digitalizado: D. Crawford

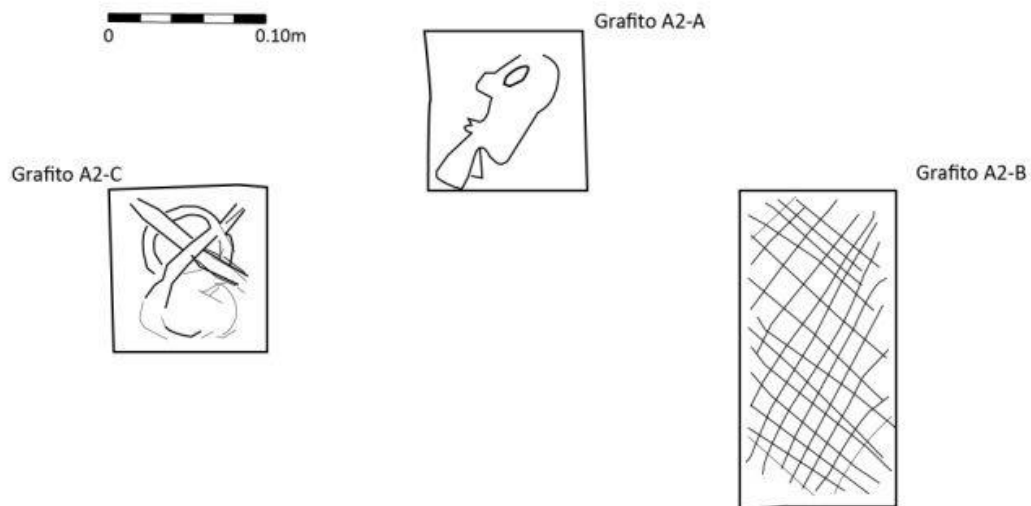
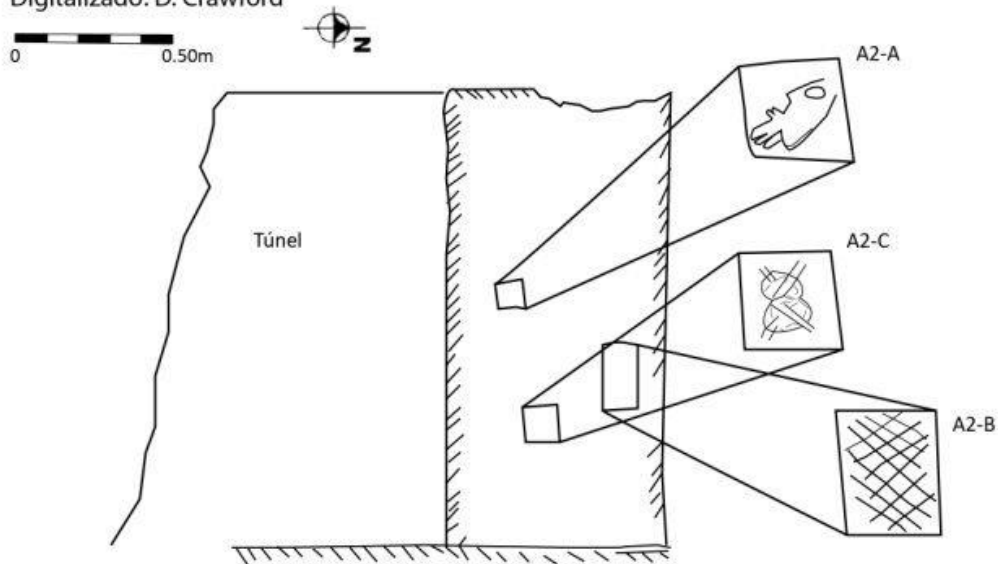


Figure 45: Line drawing of Graffiti A2-A, A2-B and A2-C, their location on wall A2 and their spatial relationships with each other
 R. Gill 2017

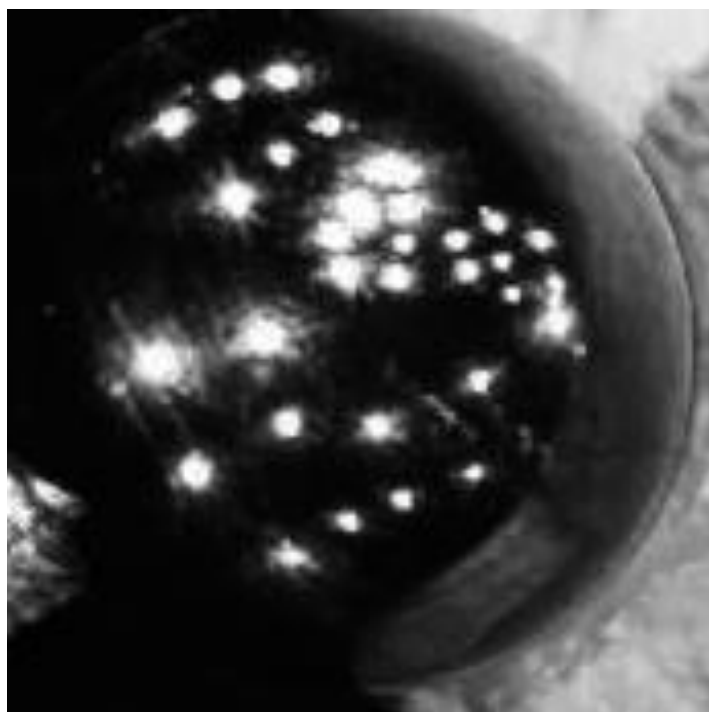


Figure 46: Composite highlights on the black sphere for the RTI capture session of Graffito A2-A



Figure 47: RTI screen capture with light source in the upper left-hand corner (-0.50 and 0.75) of Graffito A2-B

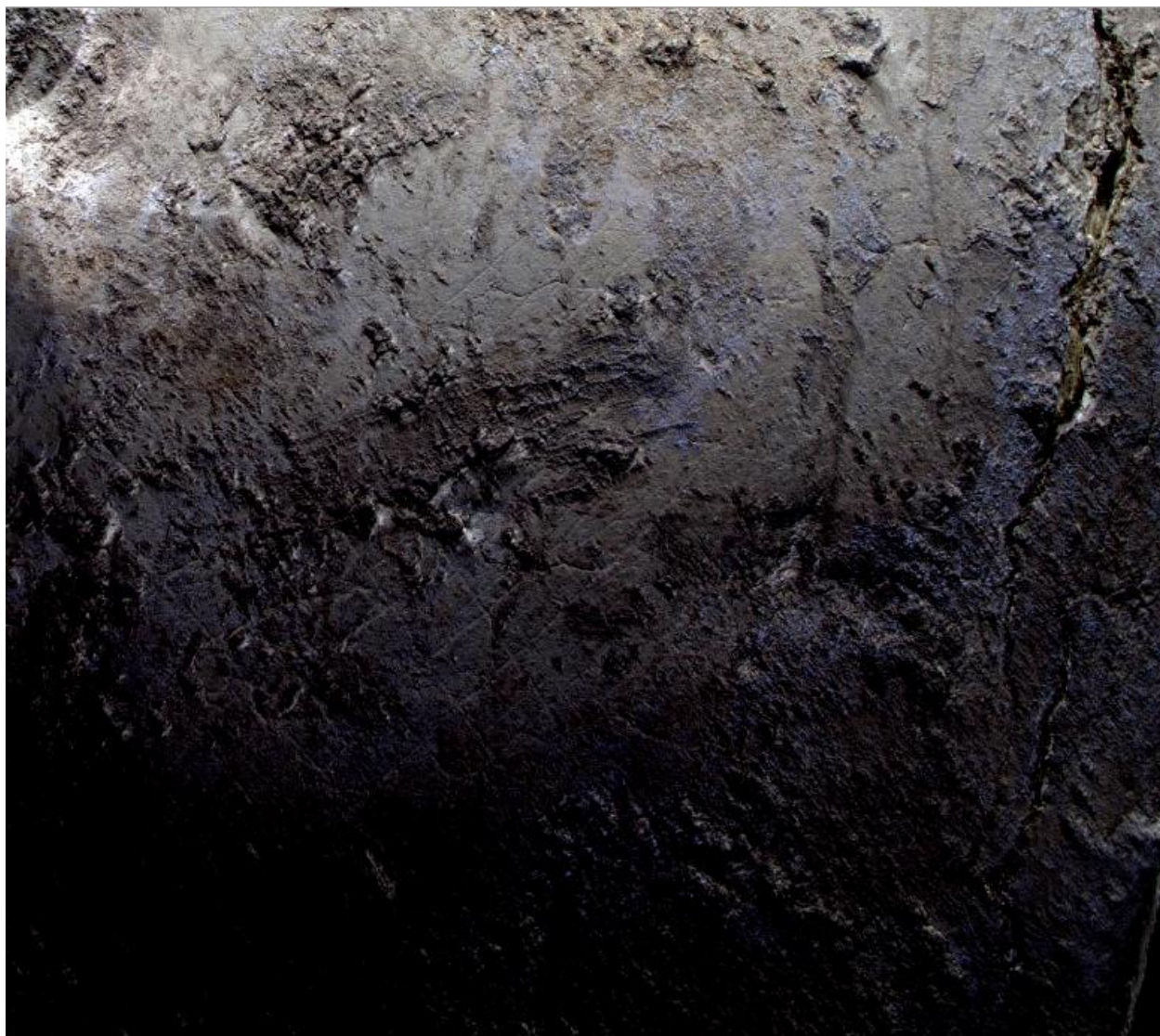


Figure 48: RTI screen capture with light source in the upper right-hand corner (0.50 and 0.75) of Graffito A2-B



Figure 49: RTI screen capture with light source in the lower left-hand corner (-0.75 and -0.50) of Graffito A2-B

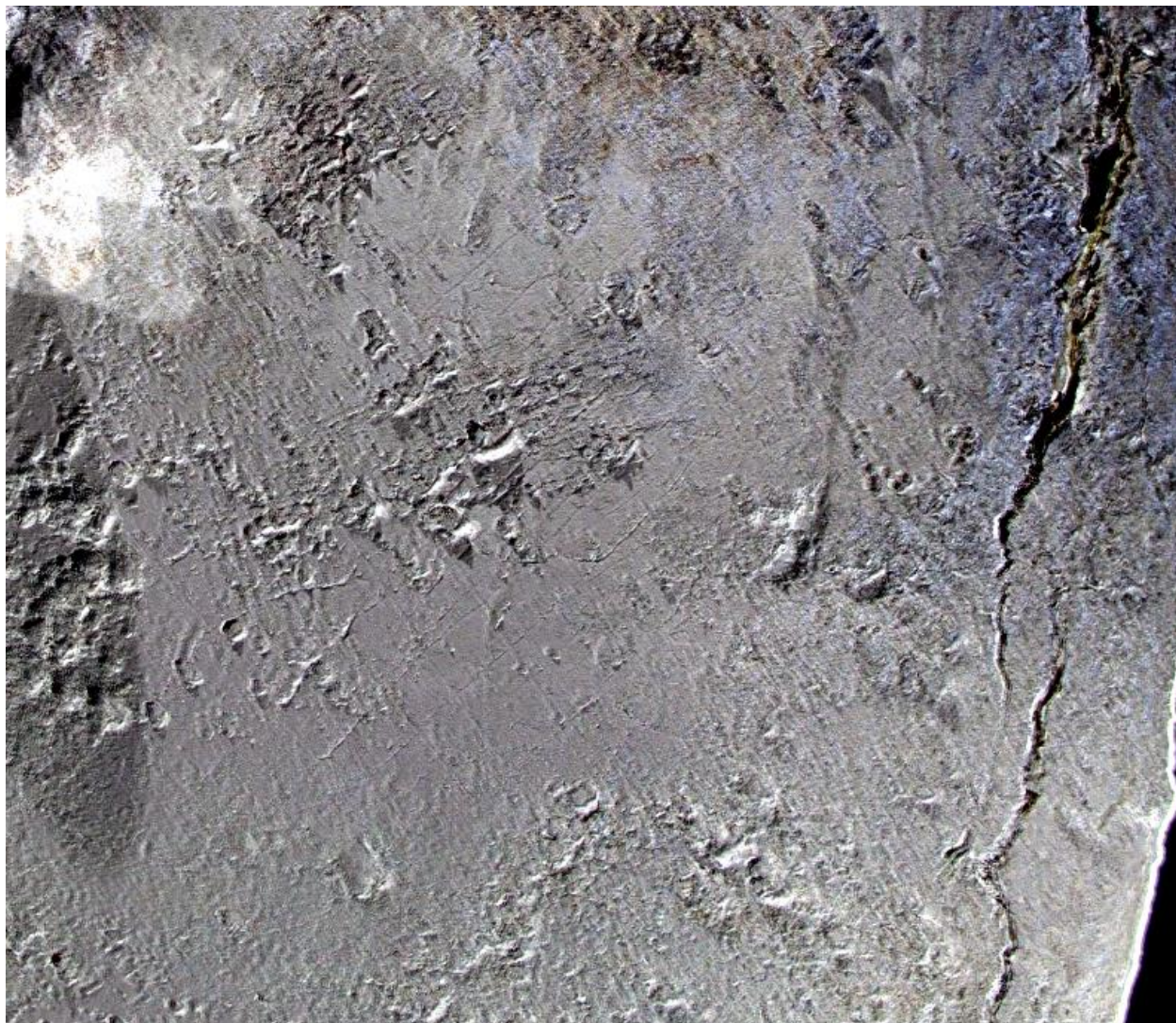


Figure 50: RTI screen capture with light source in the lower right-hand corner (MEASUREMENTS) of Graffito A2-B



Figure 51: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffiti A2-B (-0.64 and 0.77)

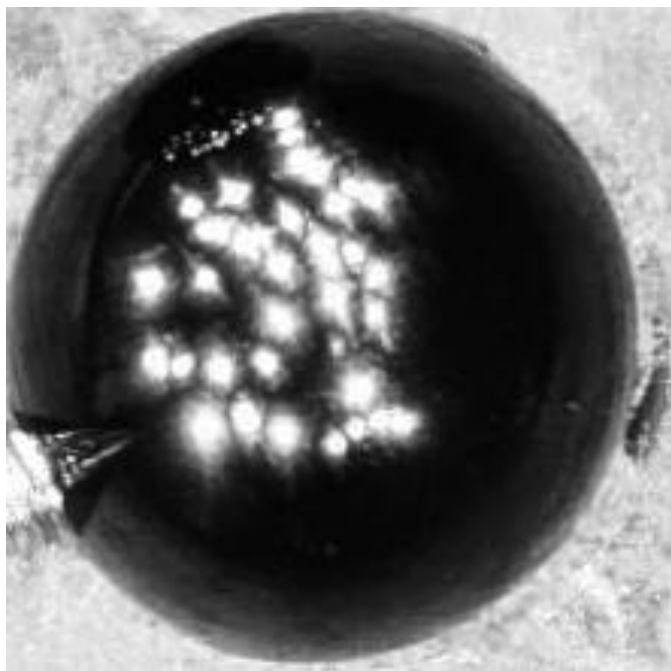


Figure 52: Composite highlights on the black sphere for the RTI capture session of Graffito A2-B



Figure 53: RTI screen capture with light source in the upper left-hand corner (-0.75 and 0.50) of Graffito A2-C



Figure 54: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito A2-C



Figure 55: RTI screen capture with light source in the lower left-hand corner (-0.75 and -0.50) of Graffito A2-C



Figure 56: RTI screen capture with light source in the lower right-hand corner (0.75 and -0.50) of Graffito A2-C



Figure 57: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffiti A2-C (-0.77 and 0.62)

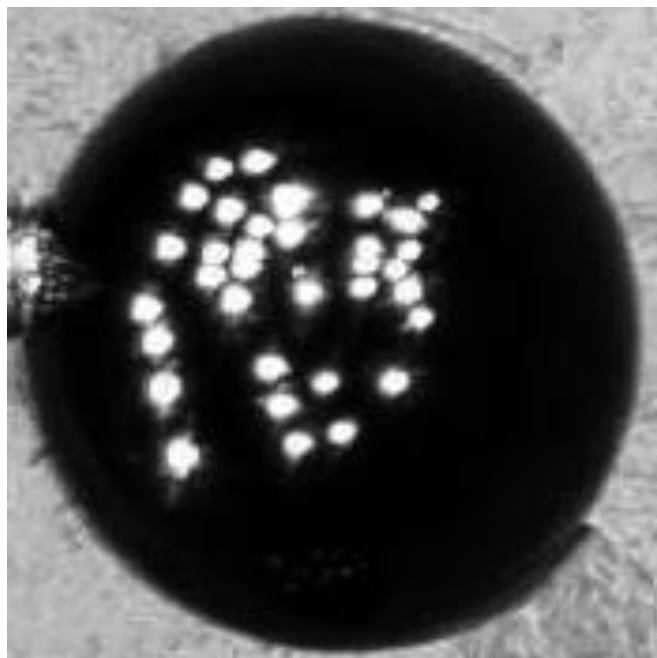


Figure 58: Composite highlights on the black sphere for the RTI capture session of Graffito A2-C



Figure 59: RTI screen capture of part one of Graffito B1-A with raking light from the right (1.00 and 0.00)



Figure 60: RTI screen capture of part two of Graffito B1-A with raking light from the right (1.00 and 0.00)

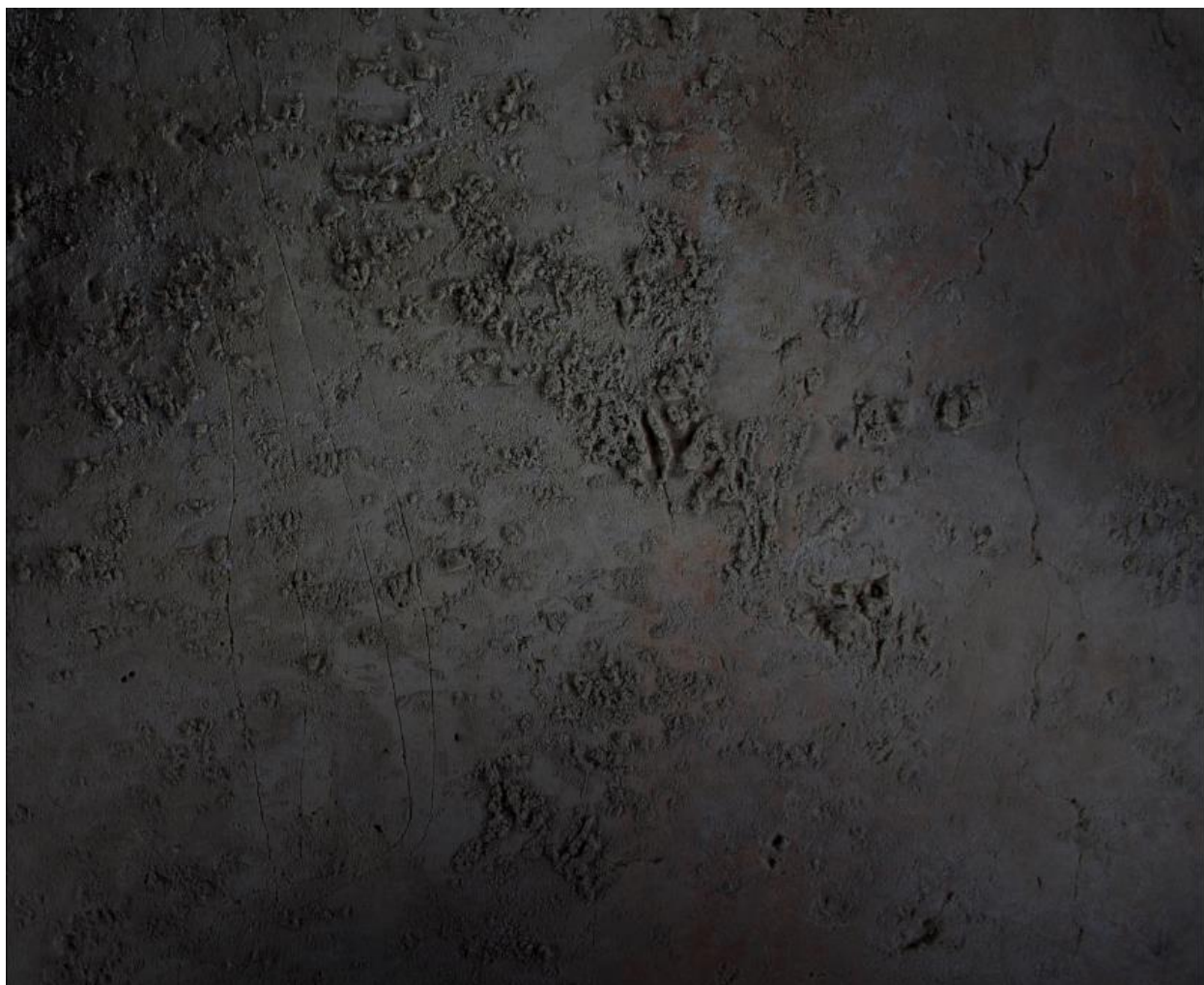


Figure 61: RTI screen capture of part three of Graffito B1-A with raking light from the right (1.00 and 0.00)

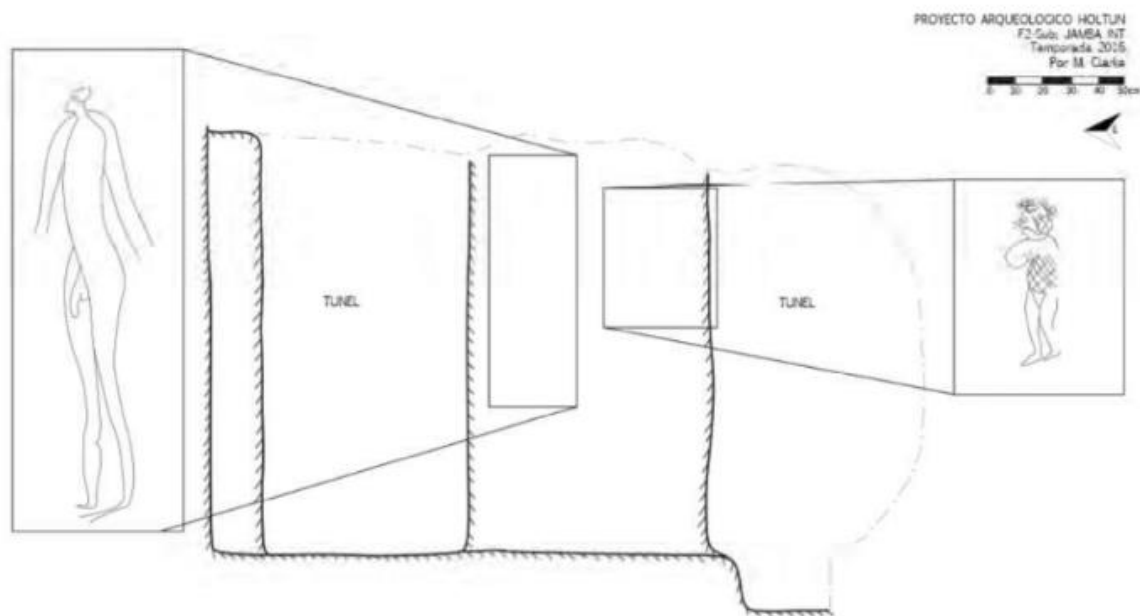


Figure 62: Line drawing of Graffito B1-A; on the left side of the image is Grafito B1-A and to the right is Graffito B1-B
M. Clarke 2016

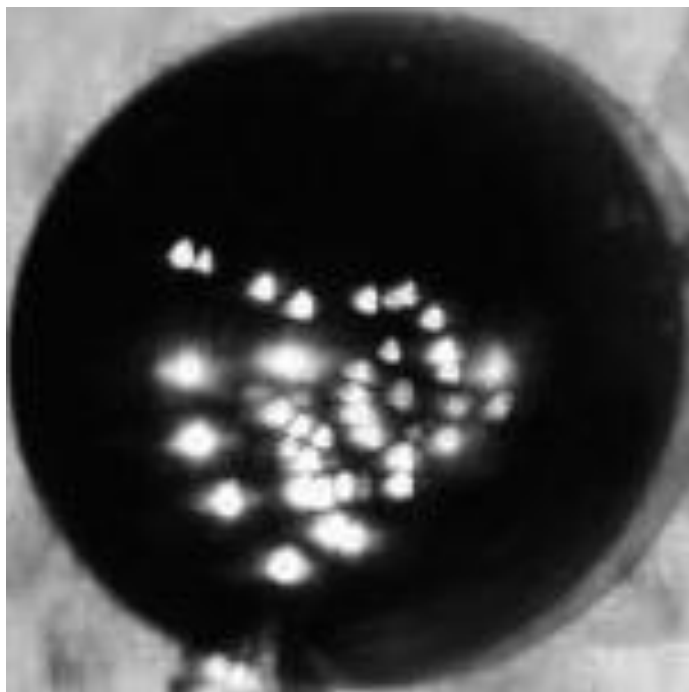


Figure 63: Composite highlights on the black sphere for part one of the RTI capture session of Graffito B1-A

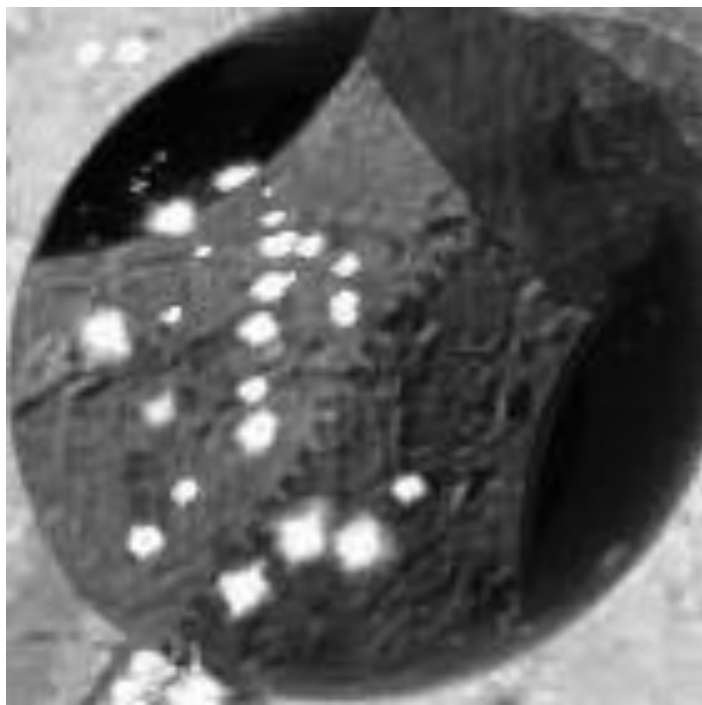


Figure 64: Composite highlights on the black sphere for part two of the RTI capture session of Graffito B1-A

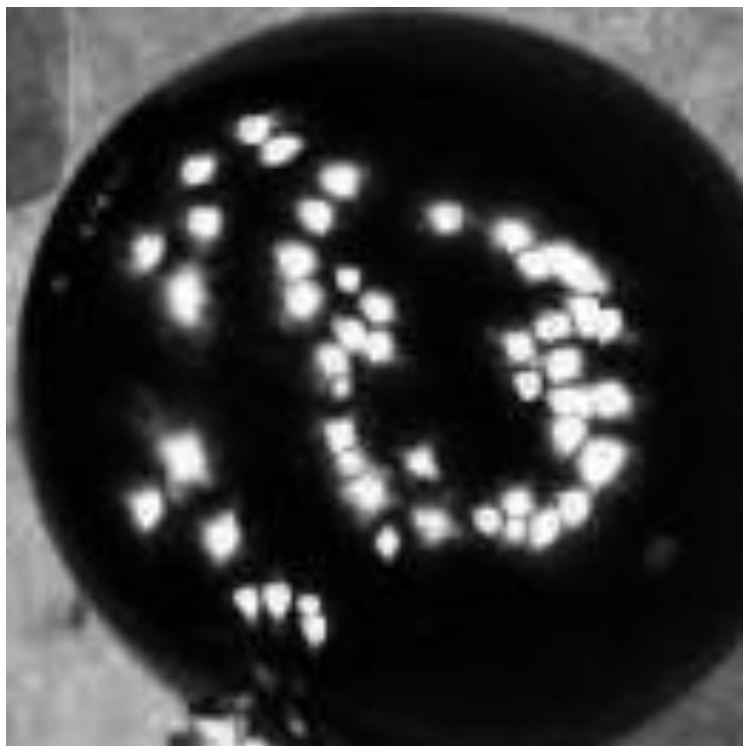


Figure 65: Composite highlights on the black sphere for part 3 RTI capture session of Graffito B1-A



Figure 66: RTI screen capture with light source in the upper left-hand corner (-0.75 and 0.50) of Graffito B1-B

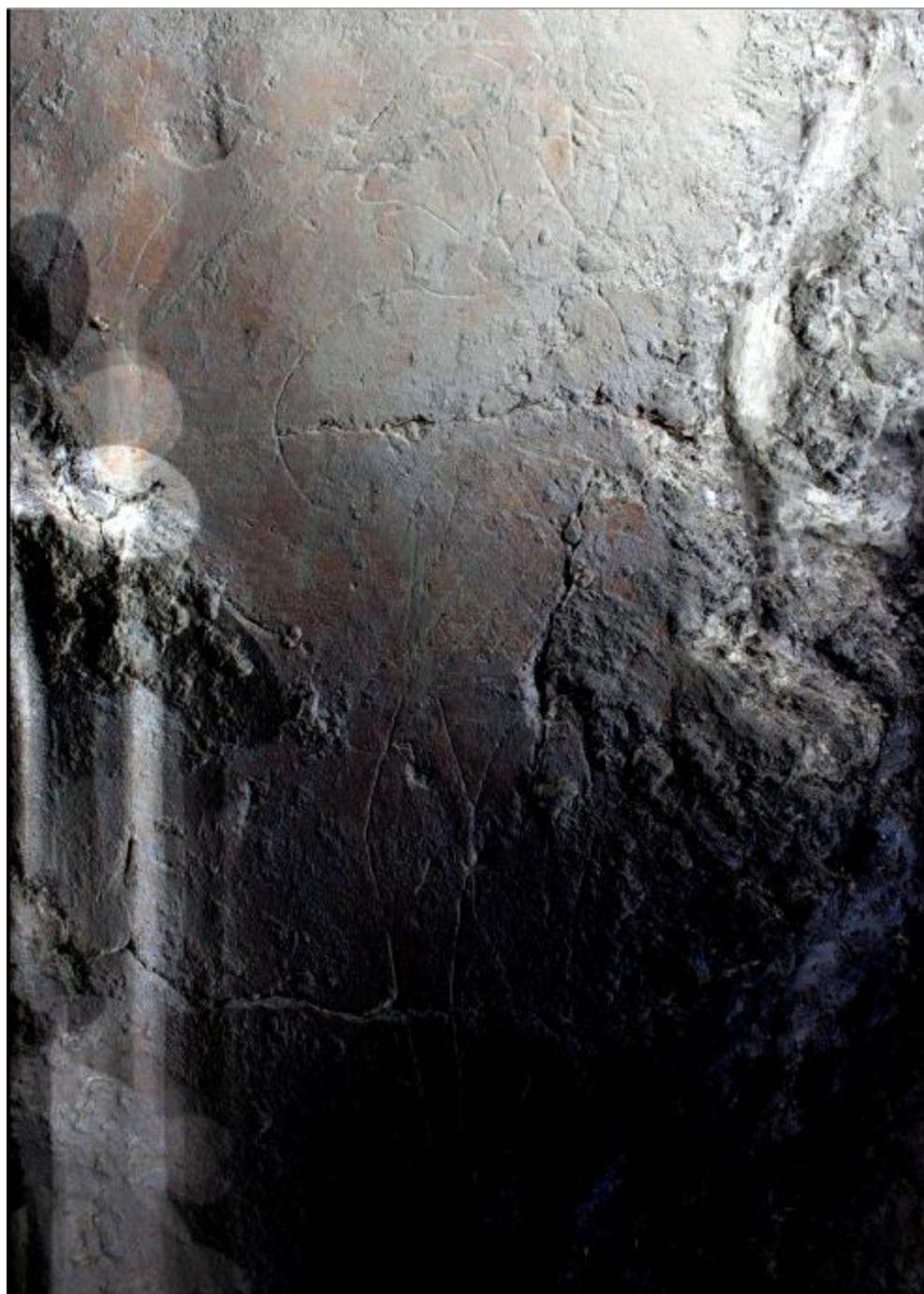


Figure 67: RTI screen capture with light source in the upper right-hand corner (-0.75 and 0.50) of Graffito B1-B



Figure 68: RTI screen capture with light source in the lower left-hand corner (0.75 and 0.50) of Graffito B1-B



Figure 69: RTI screen capture with light source in the lower right-hand corner (0.75 and -0.50) of Graffito B1-B



Figure 70: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffiti B1-B (-0.59 and 0.80)

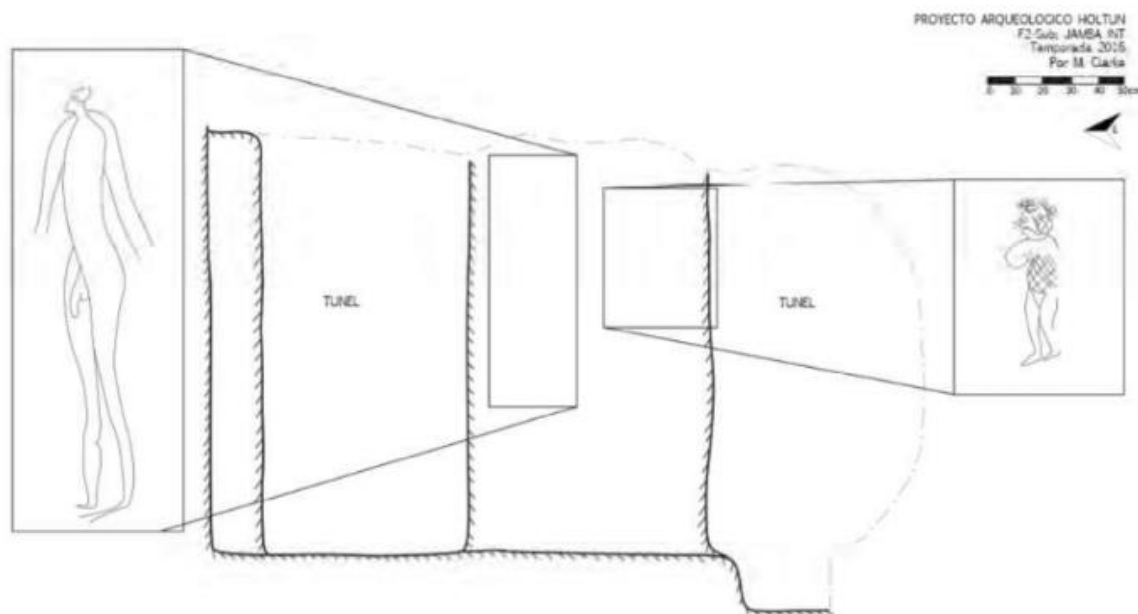


Figure 71: Line drawing of Graffito B1-B; on the left side of the image is Graffito B1-A and to the right is Graffito B1-B
M. Clarke 2016

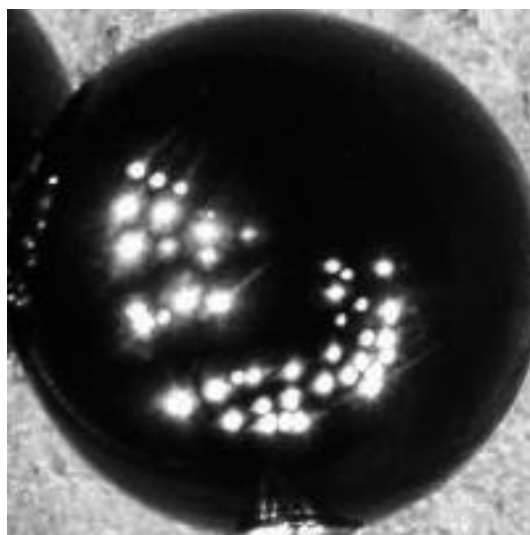


Figure 72: Composite highlights on the black sphere for the RTI capture session of Graffito B1-B



Figure 73: RTI screen capture with light source in the upper left-hand corner (-0.75 and 0.50) of Graffito B2-A

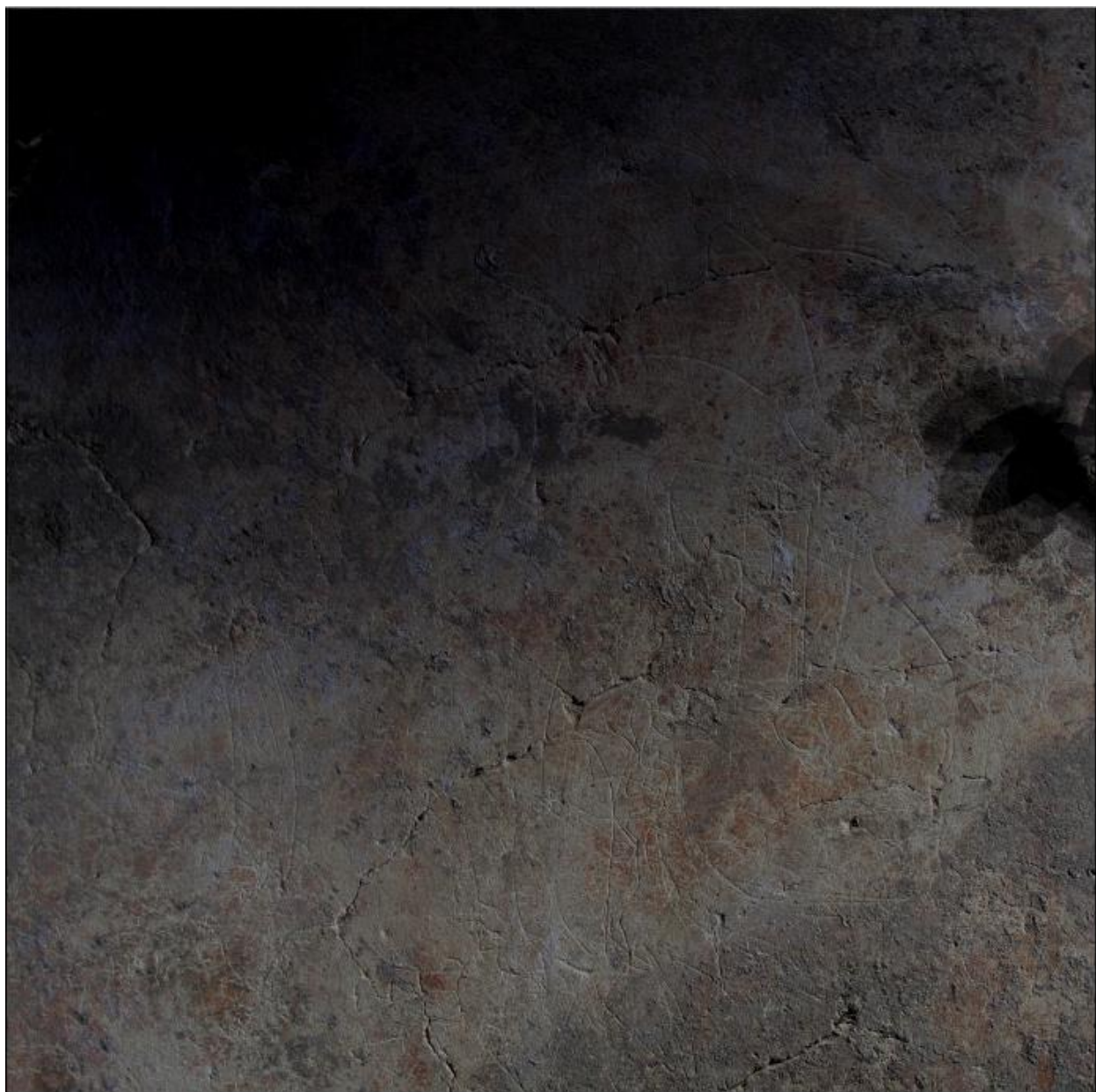


Figure 74: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito B2-A



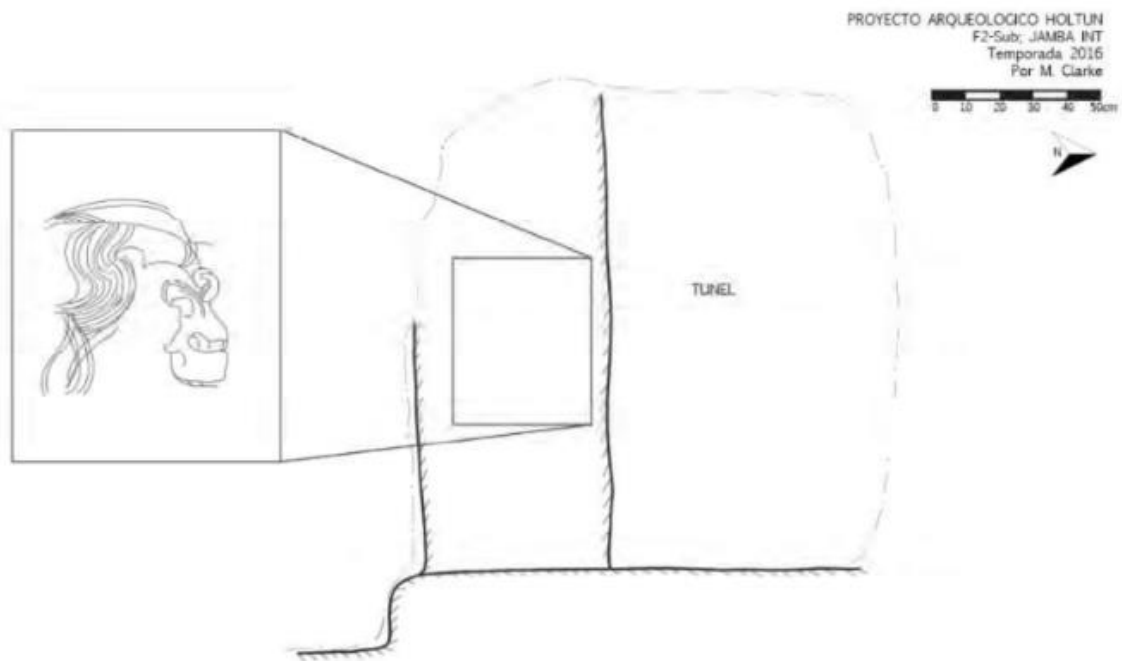
Figure 75: RTI screen capture with light source in the lower left-hand corner (-0.75 and -0.50) of Graffito B2-A



Figure 76: RTI screen capture with light source in the lower right-hand corner (0.75 and -0.50) of Graffito B2-A



Figure 77: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffiti B2-A (-0.87 and -0.22)



*Figure 78: Line drawing of Graffito B2-A
M. Clarke. 2016*

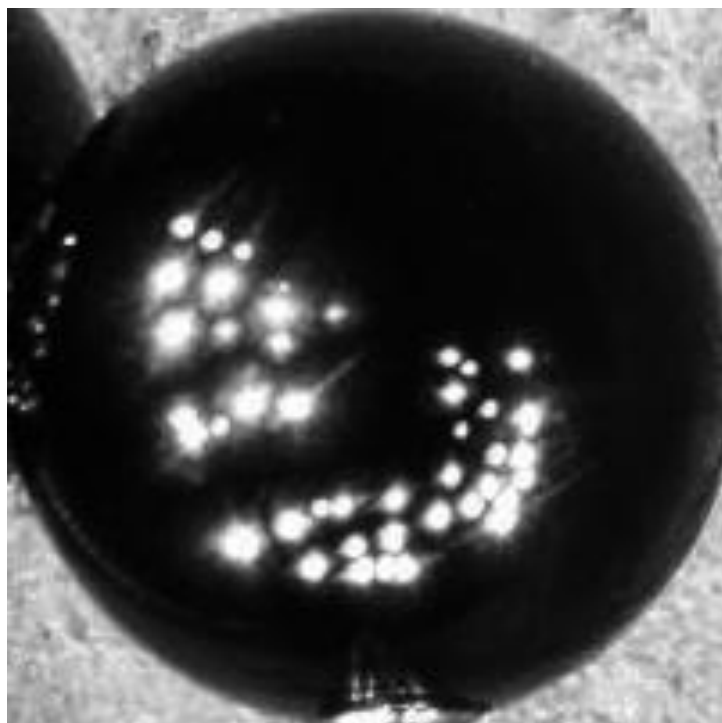
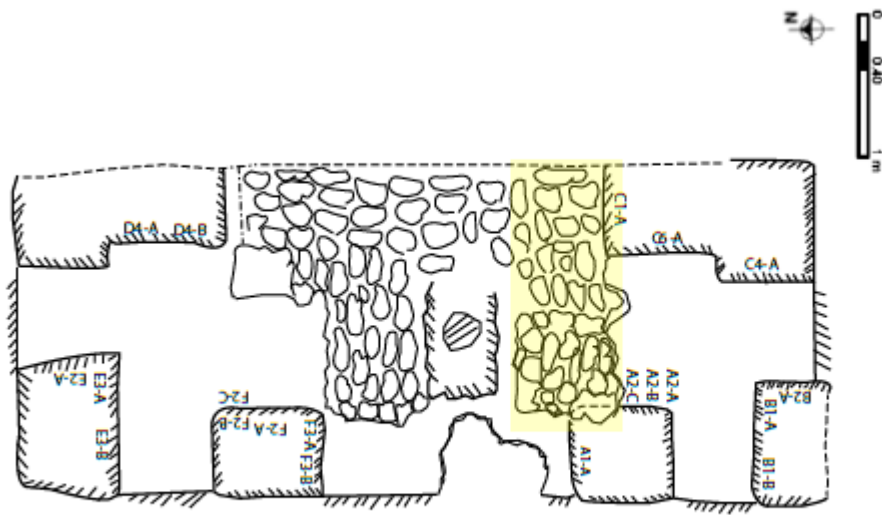


Figure 79: Composite highlights on the black sphere for the RTI capture session of Graffito B2-A



*Figure 80: Photograph of Graffito C1-A which, due to a retention wall, could not be photographed for this study
M. Callaghan 2016*



*Figure 81: Plan drawing of structure F2-Sub1 with the retention wall highlighted for clarity
R. Gill*



Figure 82: RTI screen capture with light source in the upper left-hand corner (-0.75 and 0.50) of Graffito C4-A

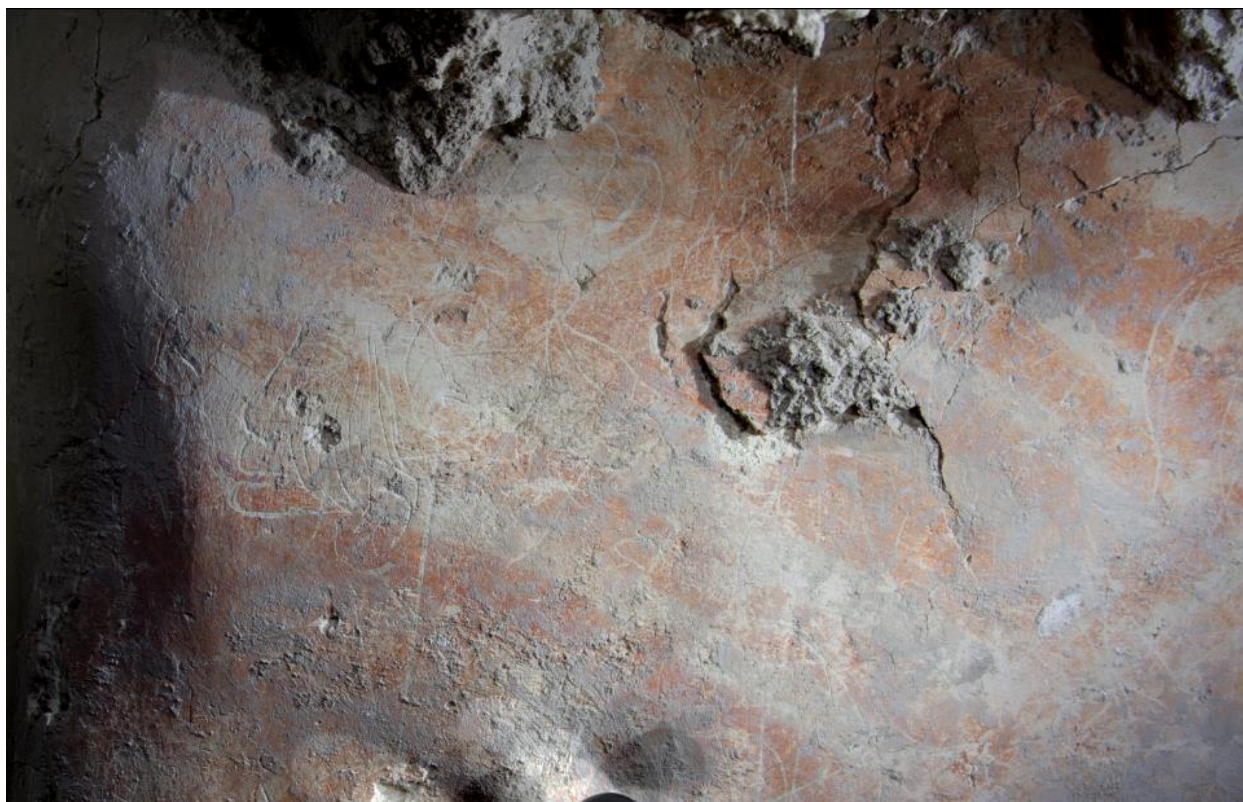


Figure 83: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito C4-A



Figure 84: RTI screen capture with light source in the lower left-hand corner (-0.75 and -0.50) of Graffito C4-A



Figure 85: RTI screen capture with light source in the lower right-hand corner (0.75 and -0.50) of Graffito C4-A



Figure 86: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffiti C4-A (-0.90 and 0.39)

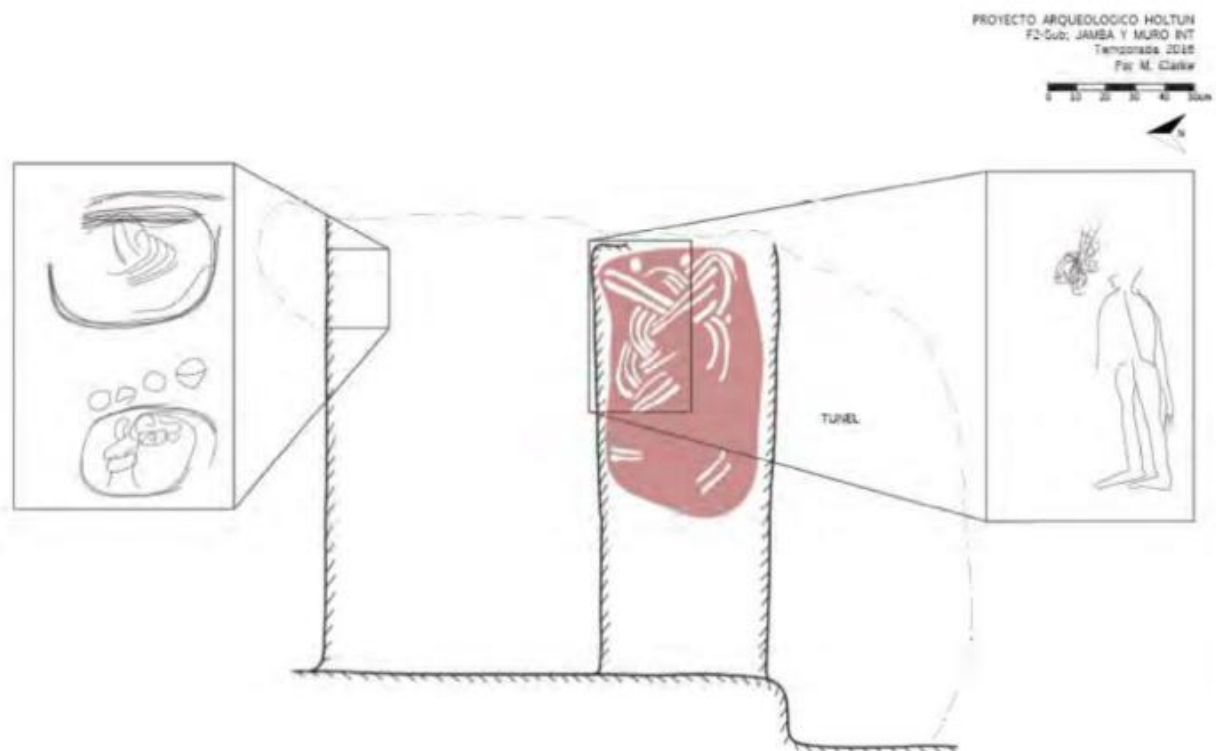


Figure 87: Line drawing of Graffito C4-A; on the left side of the image is Graffito C6-A and on the right side of the image is Graffito C4-A
M. Clarke 2016

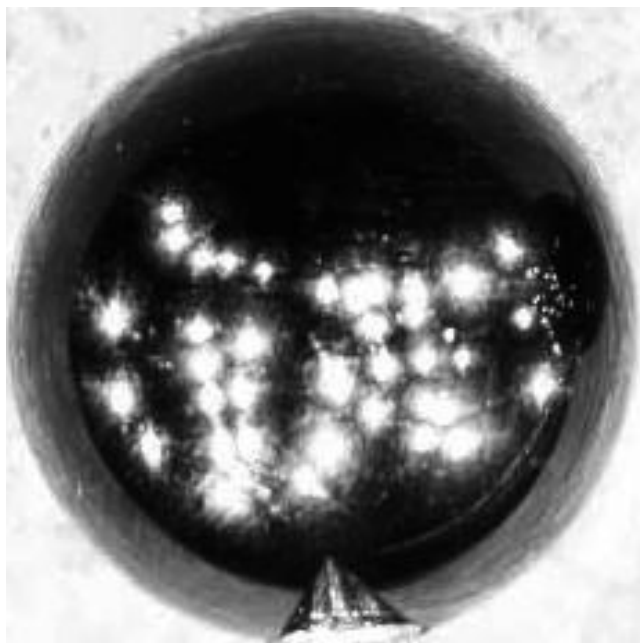


Figure 88: Composite highlights on the black sphere for the RTI capture session of Graffito C4-A



Figure 89: RTI screen capture with light source in the upper left-hand corner (-0.75 and 0.50) of Graffito C6-A



Figure 90: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito C6-A



Figure 91: RTI screen capture with light source in the lower left-hand corner (-0.75 and -0.50) of Graffito C6-A



Figure 92: RTI screen capture with light source in the lower right-hand corner (0.75 and -0.50) of Graffito C6-A



Figure 93: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffito C6-A (0.94 and -0.14)

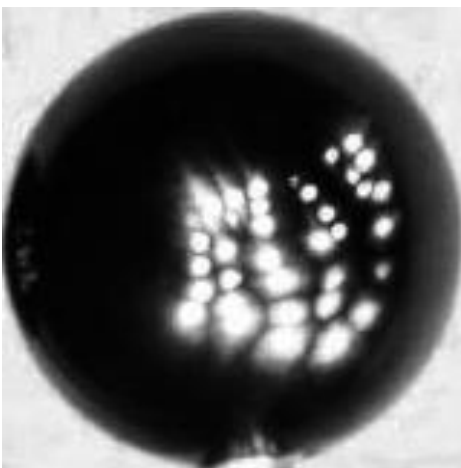


Figure 94: Composite highlights on the black sphere for the RTI capture session of Graffito C6-A



Figure 95: RTI screen capture with light source in the upper left-hand corner (-0.75 and 0.50) of Graffito D4-A



Figure 96: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito D4-A



Figure 97: RTI screen capture with light source in the lower left-hand corner (-0.75 and -0.50) of Graffito D4-A



Figure 98: RTI screen capture with light source in the lower right-hand corner (0.75 and -0.50) of Graffito D4-A



Figure 99: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffiti D4-A (0.93 and 0.36)

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 Temporada del campo 2017
 Grupo F, Plaza B
 Dibujo de Grafito D4-B y D4-A
 Dibujo: R. Gill
 Digitalizado: D. Crawford

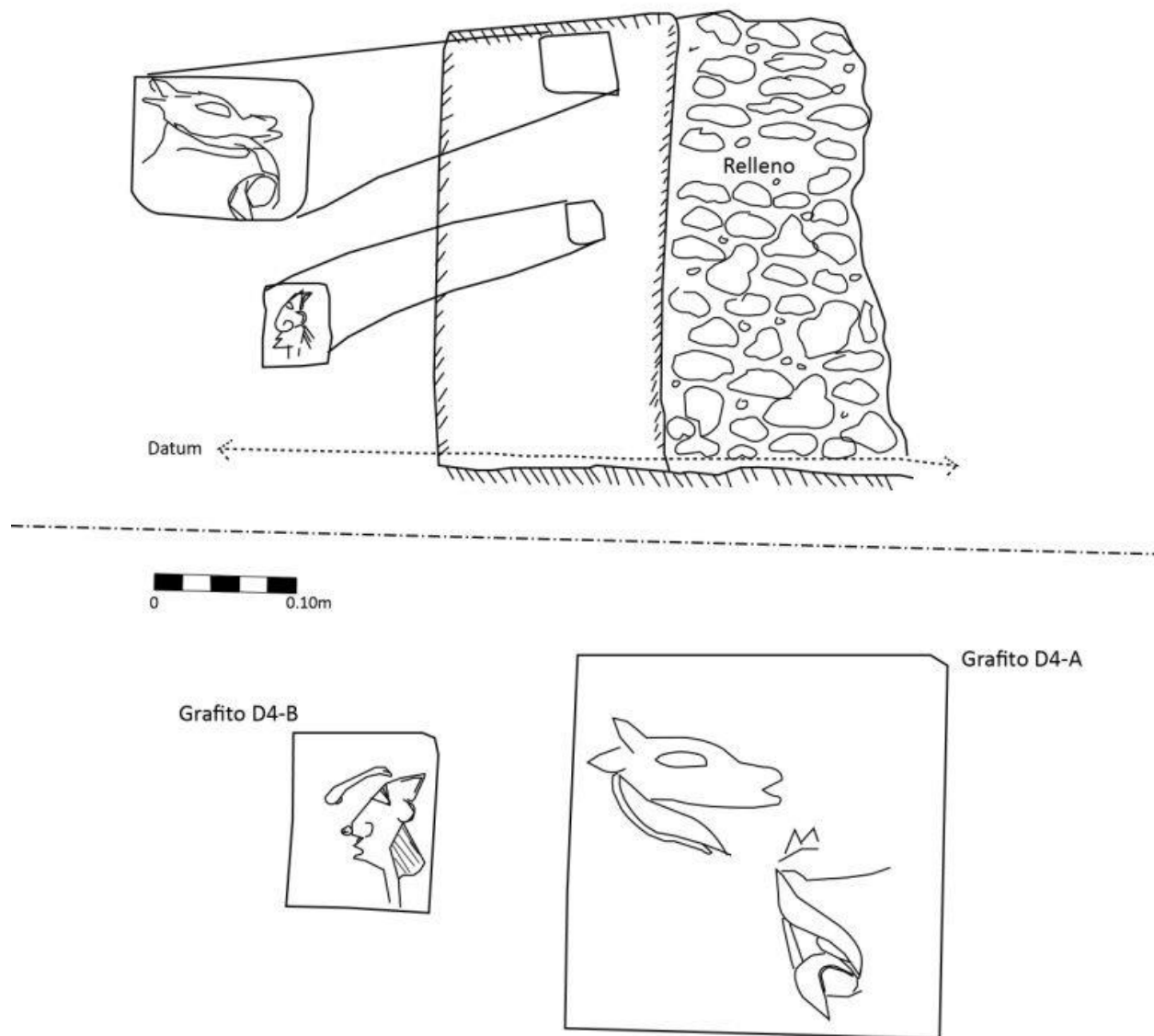


Figure 100: Line drawing of Graffiti D4-A and D4-B, their location on wall D4, and their spatial relationship with each other
 R. Gill 2017

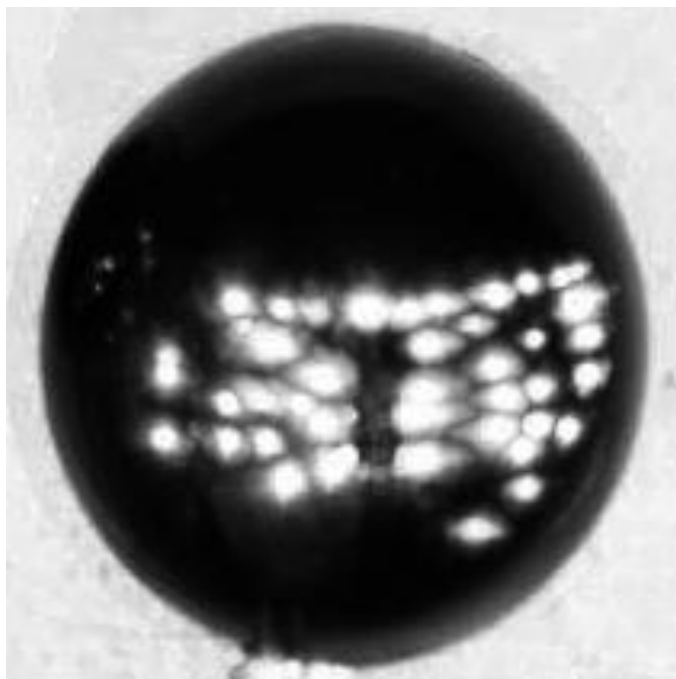


Figure 101: Composite highlights on the black sphere for the RTI capture session of Graffito D4-A



Figure 102: RTI screen capture with light source in the upper left-hand corner (-0.75 and 0.50) of Graffito D4-B

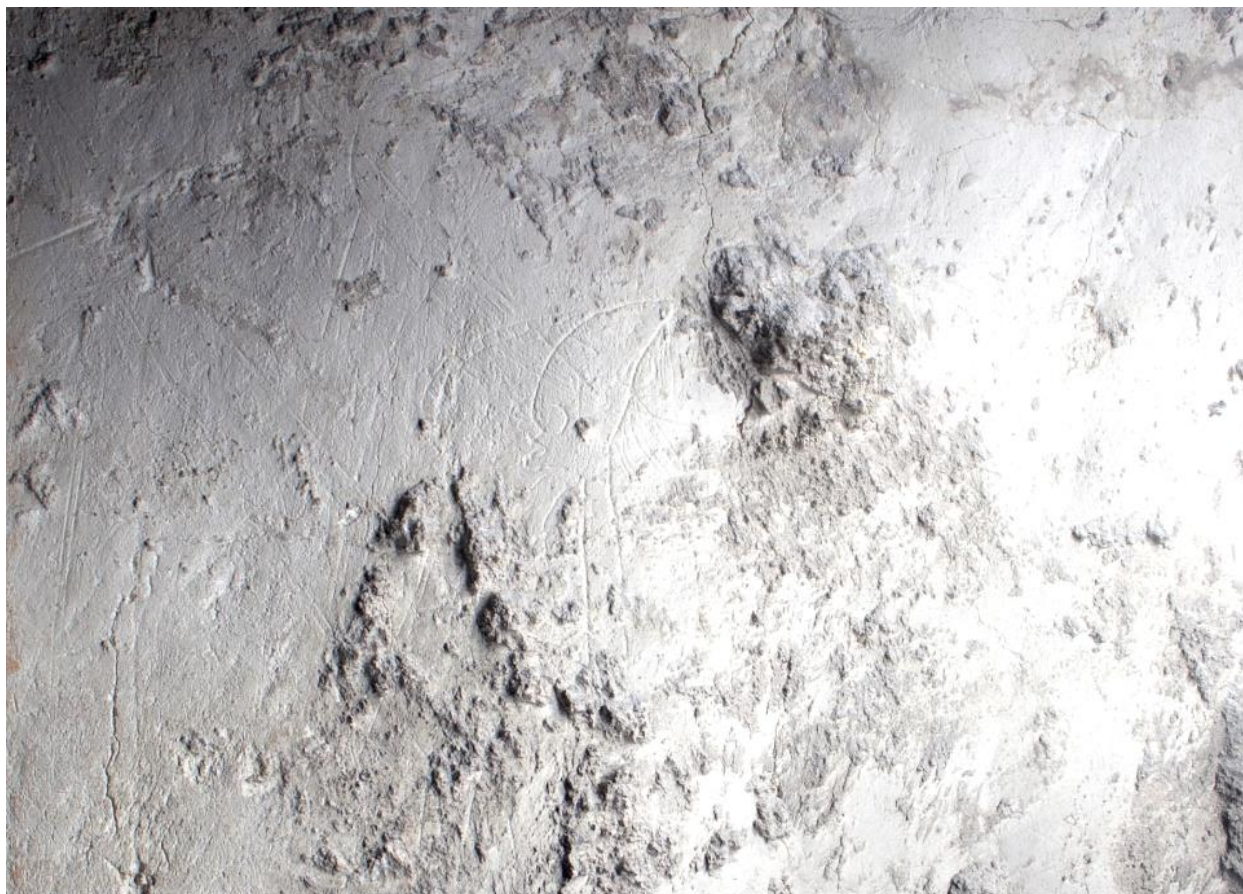


Figure 103: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito D4-B



Figure 104: RTI screen capture with light source in the lower left-hand corner (-0.75 and -0.50) of Graffito D4-B



Figure 105: RTI screen capture with light source in the lower right-hand corner (0.75 and -0.50) of Graffito D4-B



Figure 106: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffiti D4-B (-0.21 and -0.98)

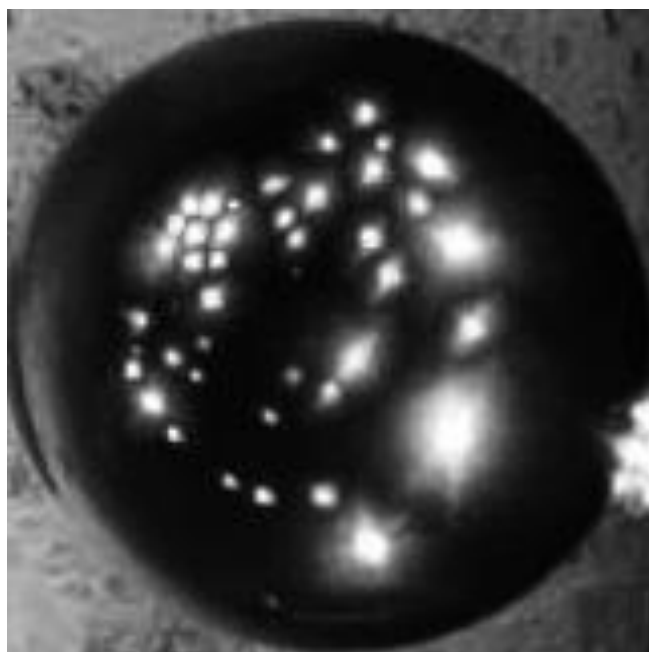


Figure 107: Composite highlights on the black sphere for the RTI capture session of Graffiti D4-B

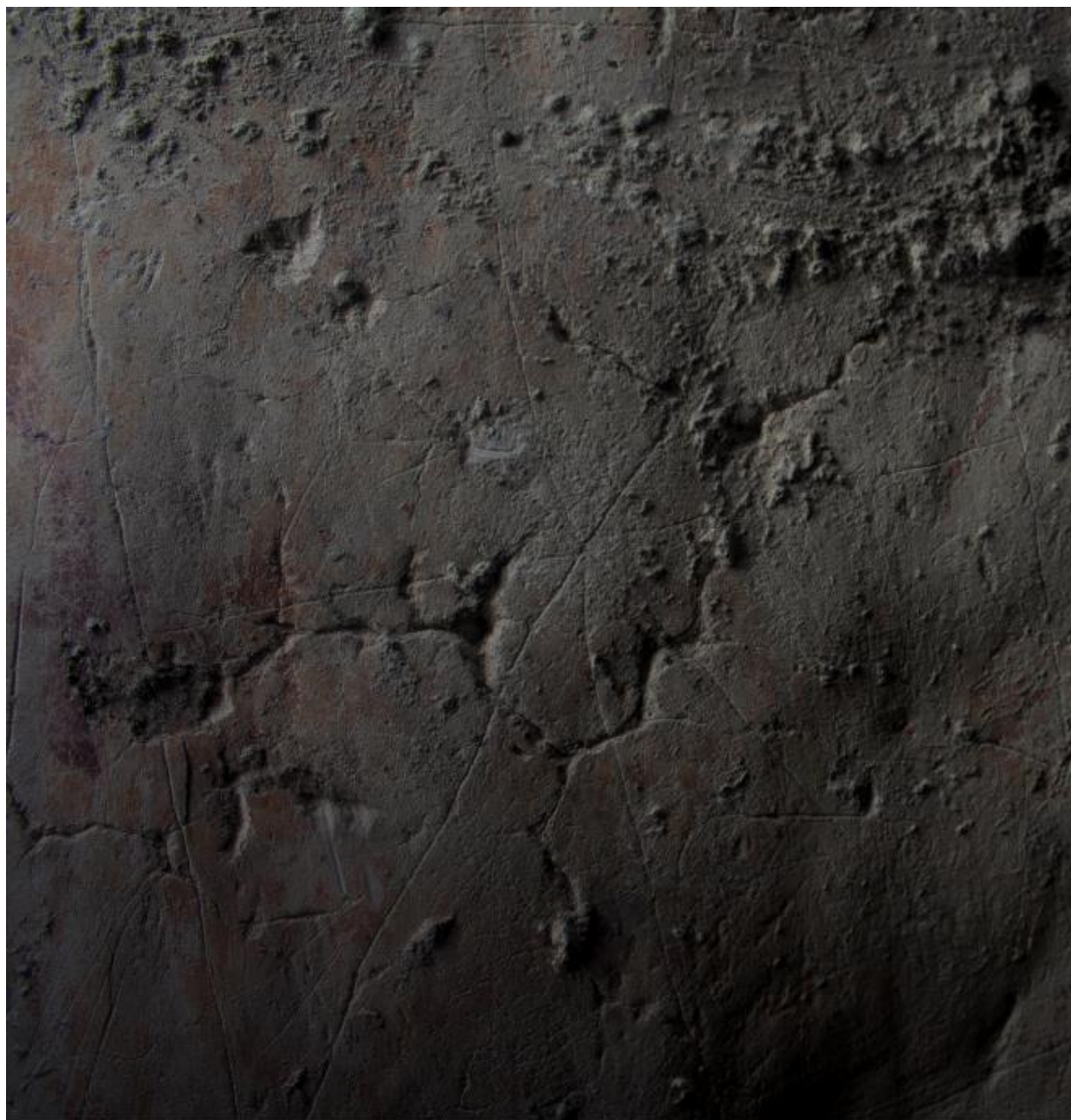


Figure 108: RTI screen capture with light source in the upper left-hand corner (-0.75 and 0.50) of Graffito E2-A



Figure 109: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito E2-A

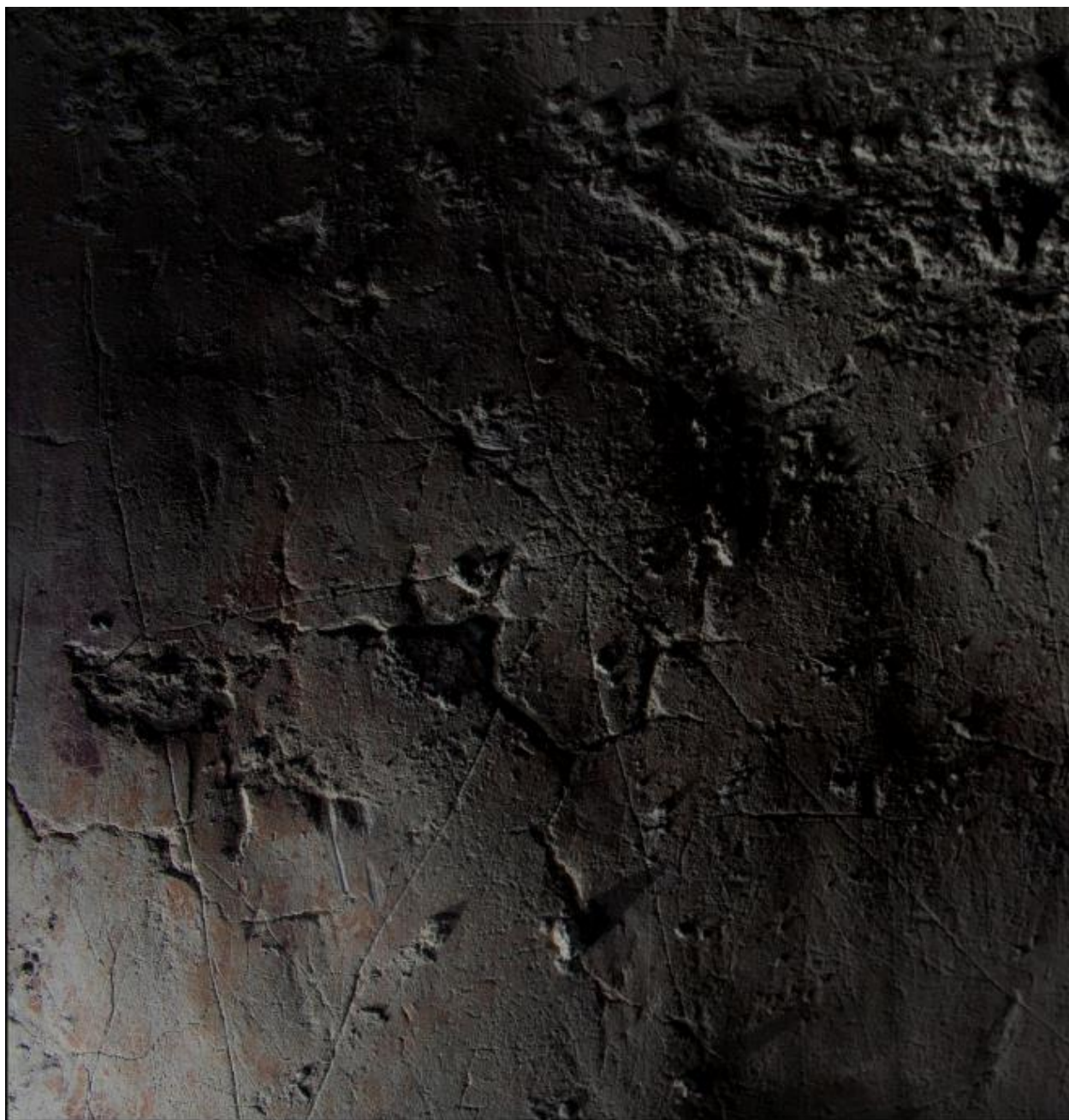


Figure 110: RTI screen capture with light source in the lower left-hand corner (-0.75 and -0.50) of Graffito E2-A



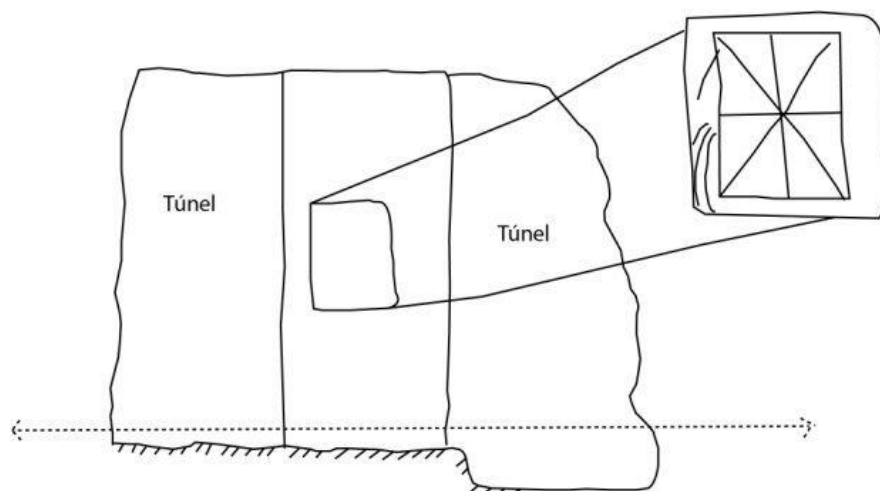
Figure 111: RTI screen capture with light source in the lower right-hand corner (0.75 ad -0.50) of Graffito E2-A



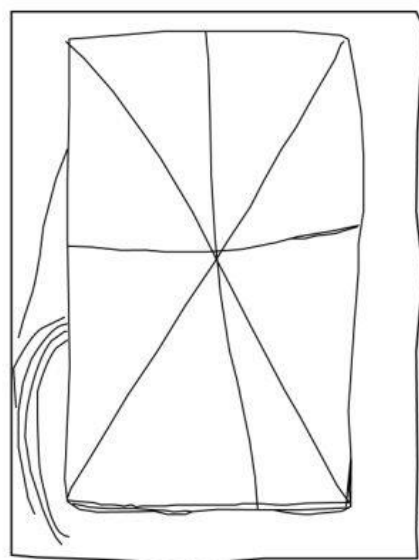
Figure 112: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffito E2-A (-0.81 and 0.22)

Proyecto Arqueológico Holtun
 Temporada del campo 2017
 Grupo F, Plaza B
 Dibujo del Grafito E2-A
 Dibujo: R. Gill
 Digitalizado: D. Crawford

0 0.50m



0 0.10m



Grafito E2-A

Figure 113: Line drawing of Grafito E2-A
 R. Gill 2017

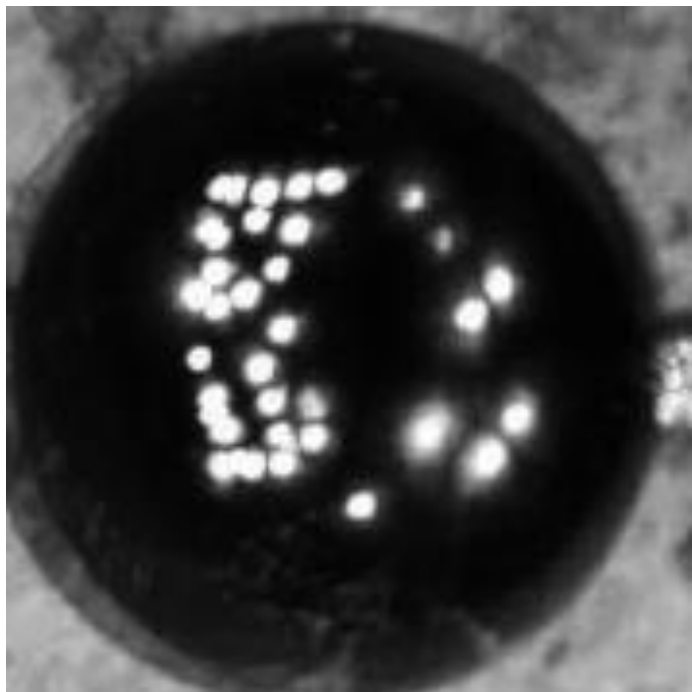


Figure 114: Composite highlights on the black sphere for the RTI capture session of Graffito E2-A



Figure 115: RTI screen capture with light source in the upper left-hand corner (-0.75 and 0.50) of Graffito E3-A



Figure 116: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito E3-A



Figure 117: RTI screen capture with light source in the lower left-hand corner (-0.75 and -0.50) of Graffito E3-A



Figure 118: RTI screen capture with light source in the lower right-hand corner (0.75 and 0.50) of Graffito E3-A



Figure 119: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffiti E3-A (-0.93 and 0.29)

Proyecto Arqueologico Holtun
Temporada del campo 2017
Grupo F, Plaza B
Dibujo de Grafito E3-A
Dibujo: R. Gill
Digitalizado: D. Crawford



Figure 120: Line drawing of Graffito E3-A
R. Gill 2017

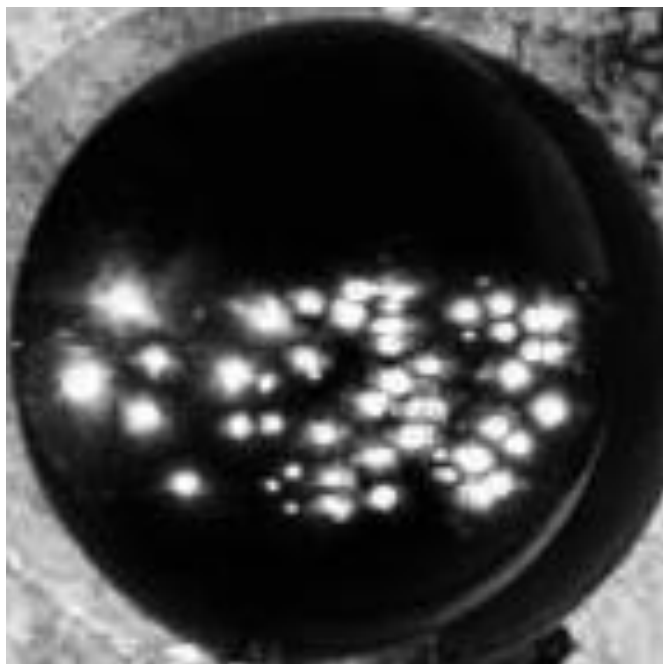


Figure 121: Composite highlights on the black sphere for the RTI capture session of Graffito E3-A



Figure 122: RTI screen capture with light source in the upper left-hand corner (-0.75 and 0.50) of Graffito E3-B



Figure 123: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito E3-B



Figure 124: RTI screen capture with light source in the lower left-hand corner (-0.75 and -0.50) of Graffito E3-B



Figure 125: RTI screen capture with light source in the lower right-hand corner (0.75 and -0.50) of Graffito E3-B



Figure 126: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffito E3-B (-1.00 and -0.08)

Proyecto Arqueológico Holtun
Temporada del campo 2017
Grupo F, Plaza B
Dibujo de Grafito E3-B
Dibujo: R. Gill
Digitilizado: D. Crawford

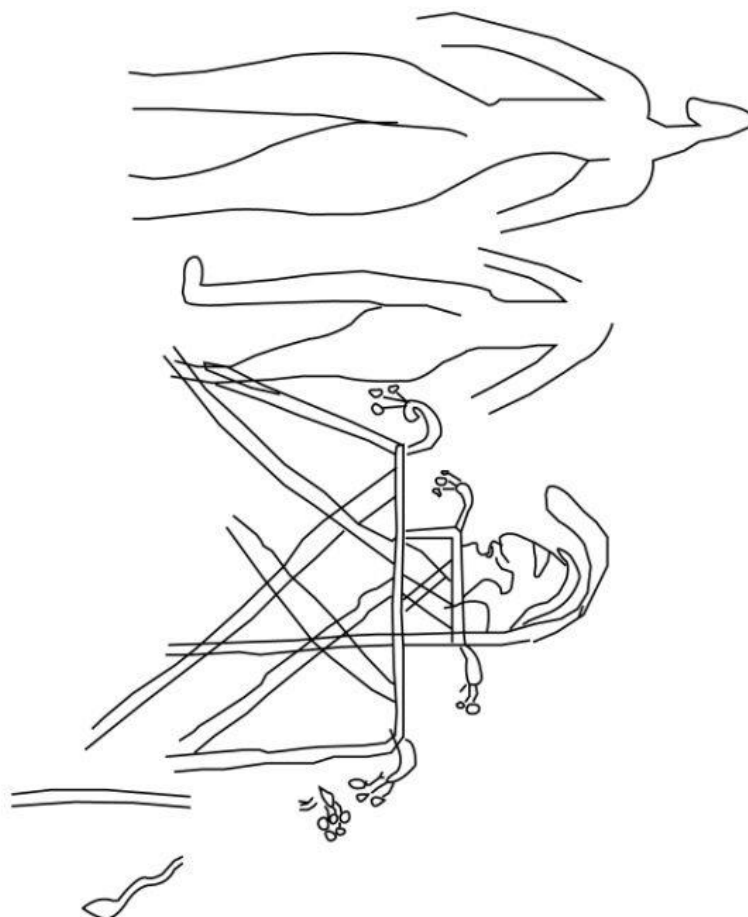


Figure 127: Line drawing of Graffito E3-B
R. Gill 2017

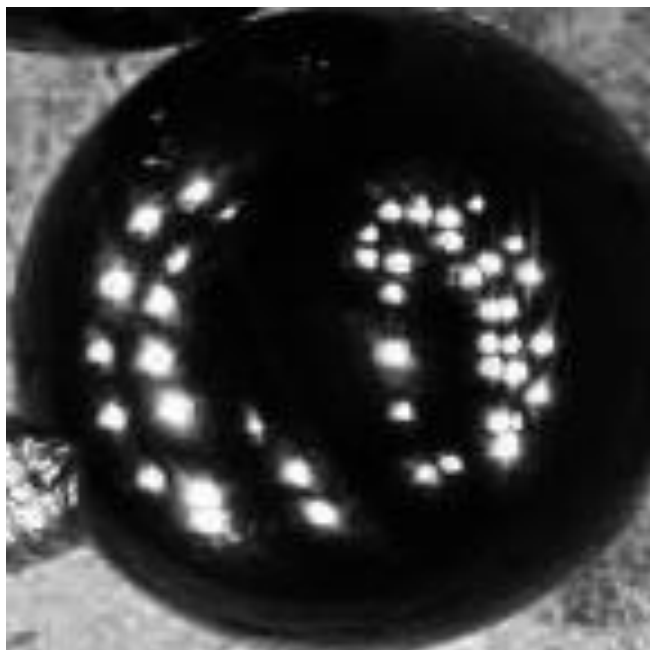


Figure 128: Composite highlights on the black sphere for the RTI capture session of Graffiti E3-B

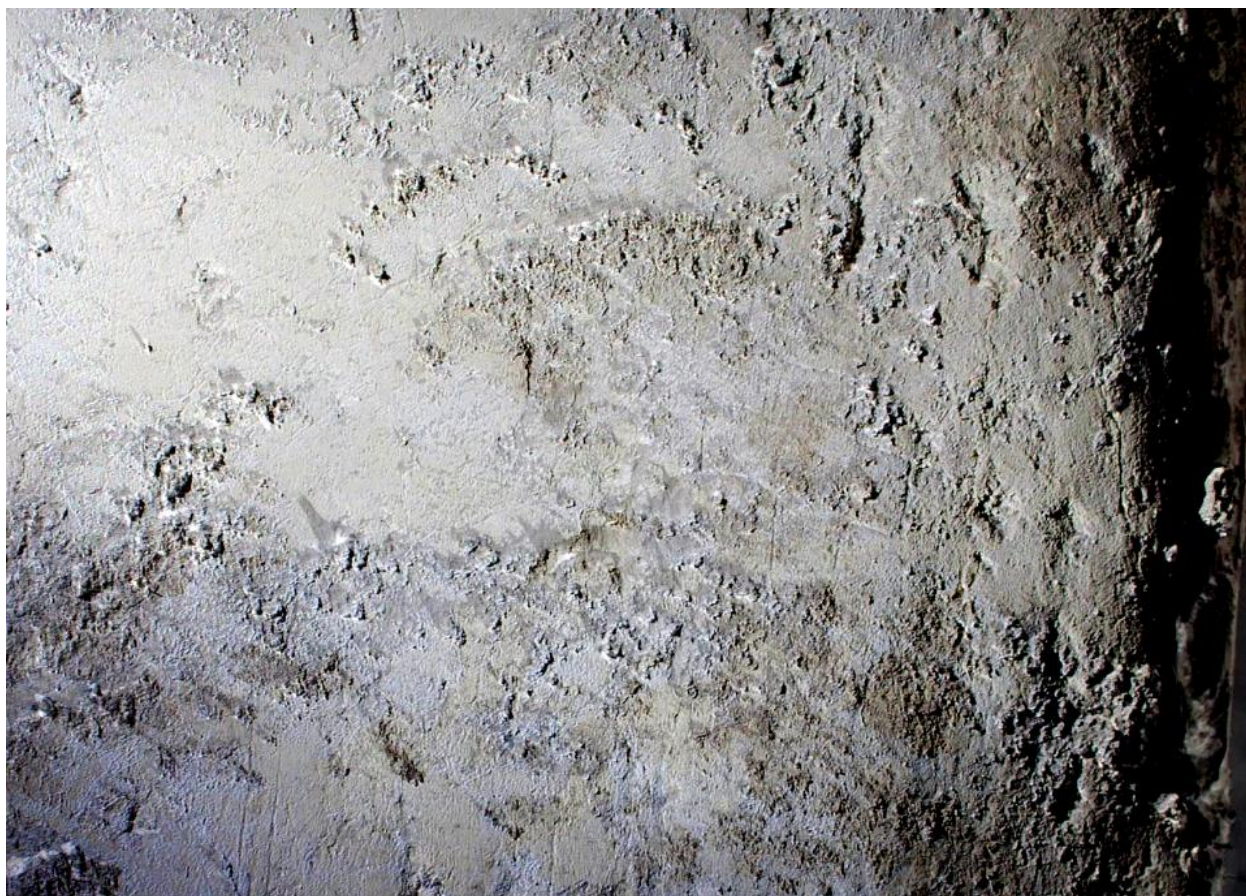


Figure 129: RTI screen capture with light source in the upper left-hand corner (-0.75 and 0.50) of Graffito F2-A



Figure 130: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito F2-A

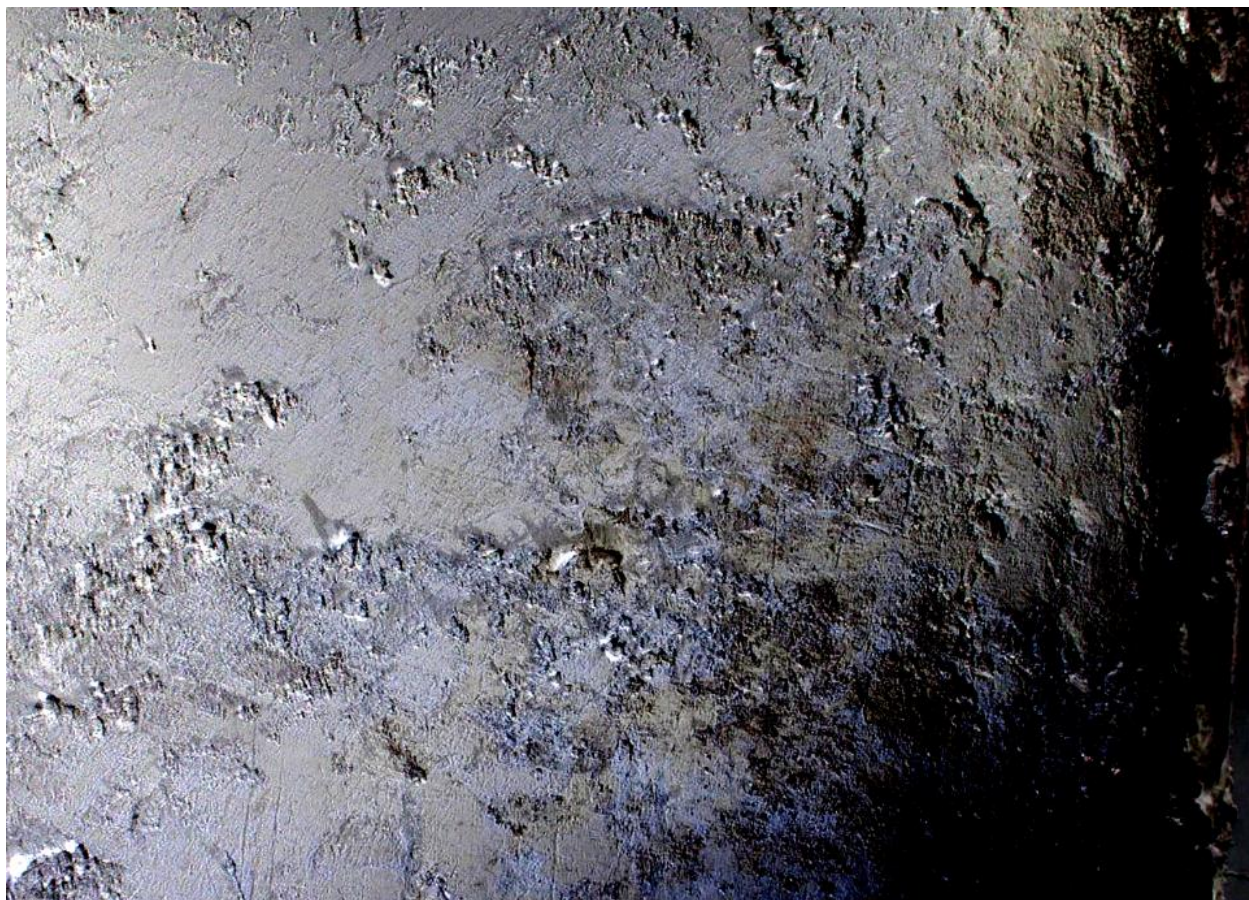


Figure 131: RTI screen capture with light source in the lower left-hand corner (-0.75 and 0.50) of Graffito F2-A



Figure 132: RTI screen capture with light source in the lower right-hand corner (0.75 and -0.50) of Graffito F2-A



Figure 133: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffiti F2-A (-0.11 and -0.93)

Proyecto Arqueológico Holtun
 Temporada del campo 2017
 Grupo F, Plaza B
 Dibujo del Grafitos F2-A, F2-B, F2-C
 Dibujo: R. Gill
 Digitalizado: D. Crawford

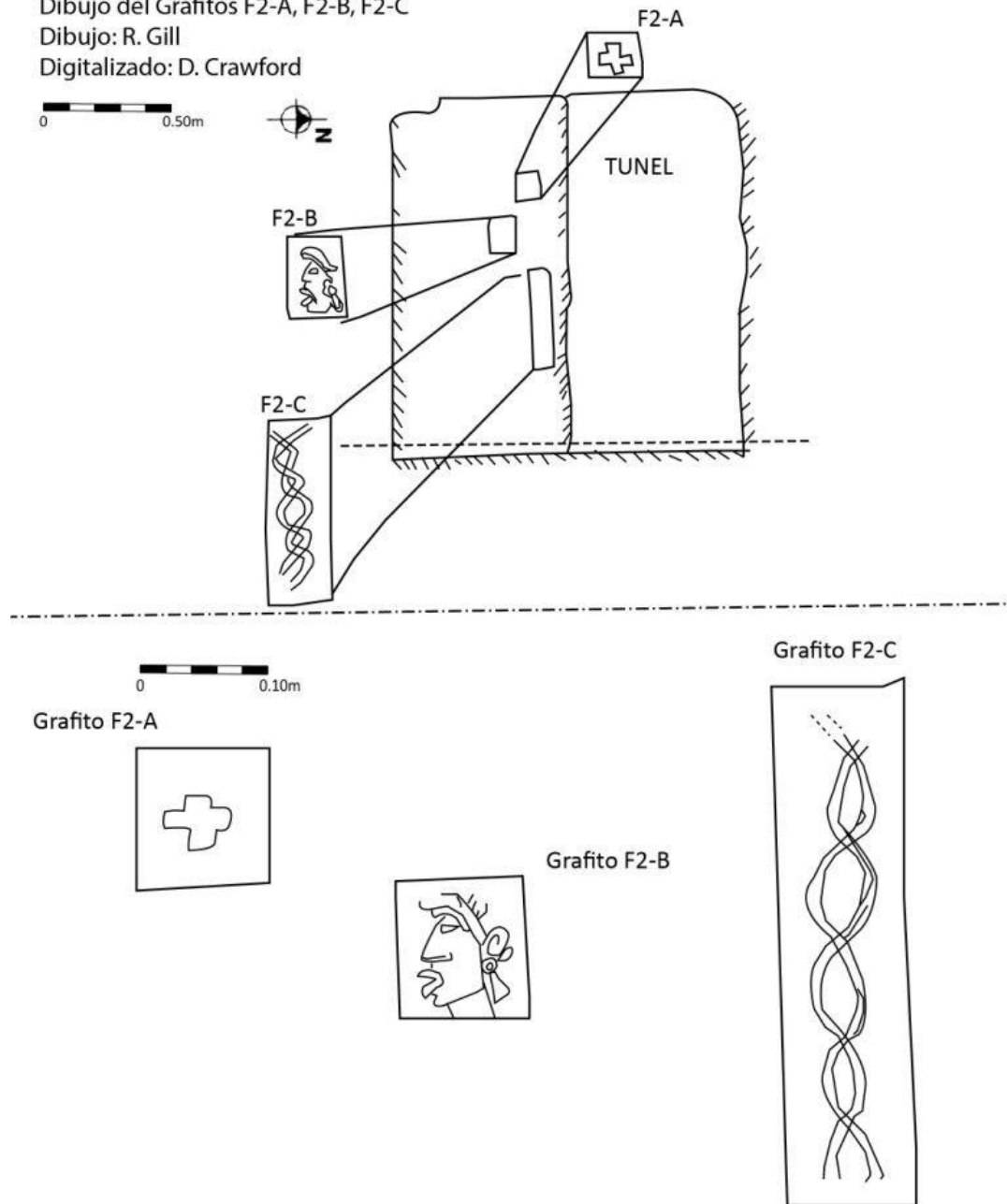


Figure 134: Line drawing of Graffiti F2-A, F2-B, and F2-C their location on wall F2 and their spatial relationship with each other
 R. Gill 2017

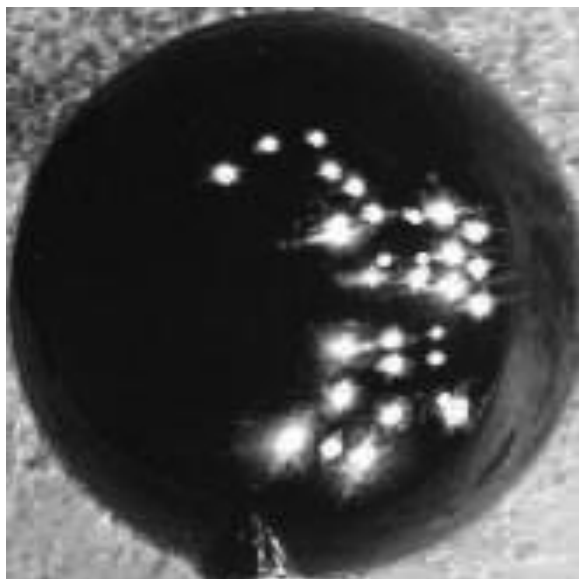


Figure 135: Composite highlights on the black sphere for the RTI capture session of Graffito F2-A



Figure 136: RTI screen capture with light source in the upper left-hand corner (-0.75 and 0.50) of Graffito F2-B



Figure 137: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito F2-B

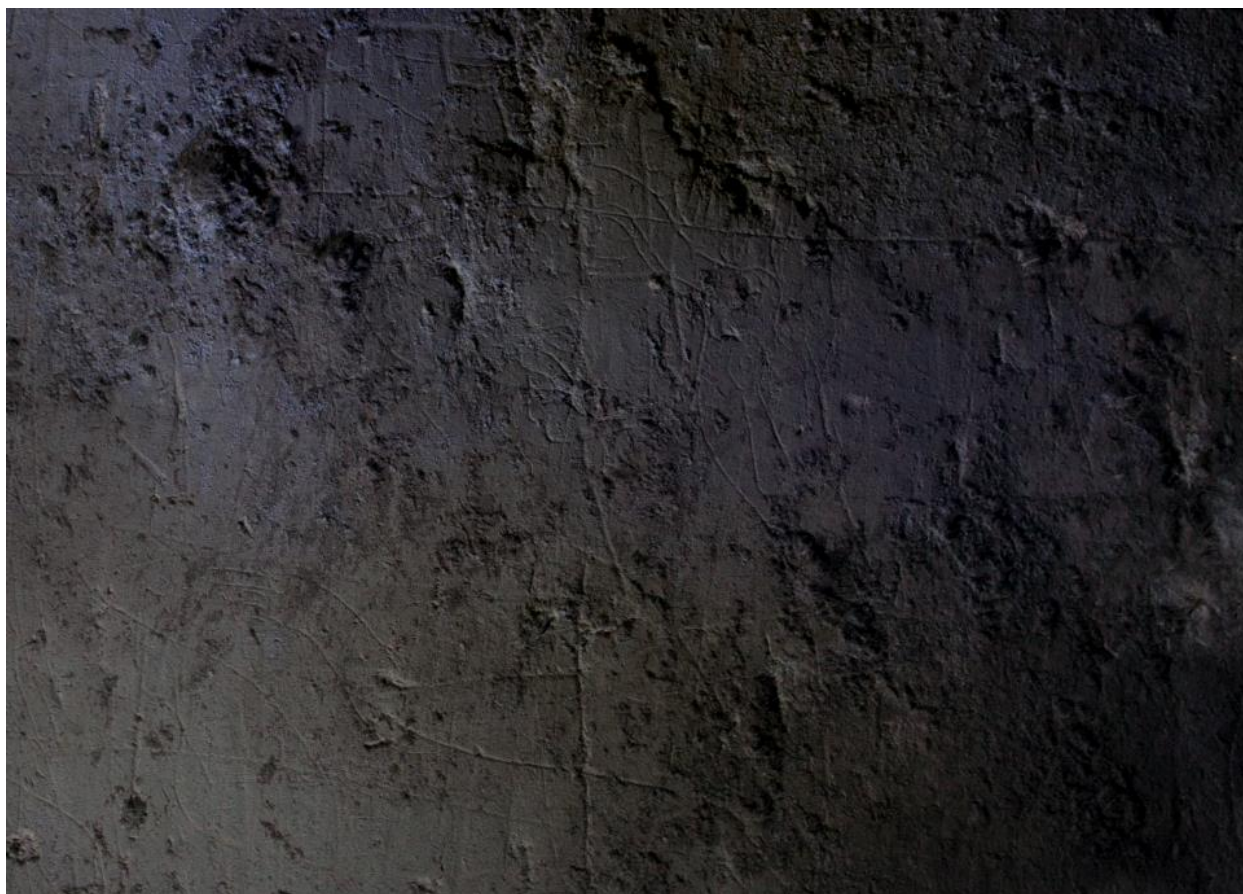


Figure 138: RTI screen capture with light source in the lower left-hand corner (-0.75 and -0.50) of Graffito F2-B



Figure 139: RTI screen capture with light source in the lower right-hand corner (0.75 and -0.50) of Graffito F2-B

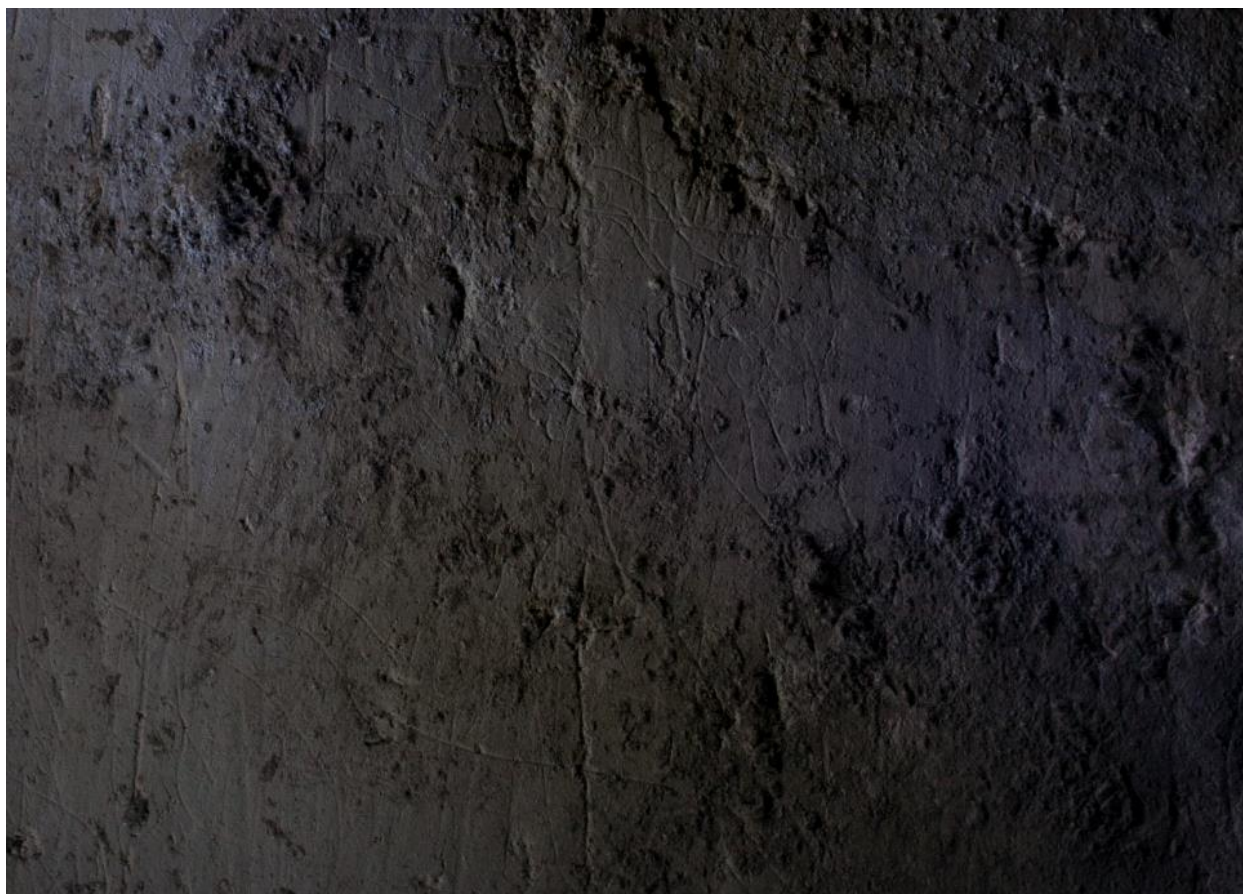


Figure 140: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffiti F2-B (-0.89 and -0.11)

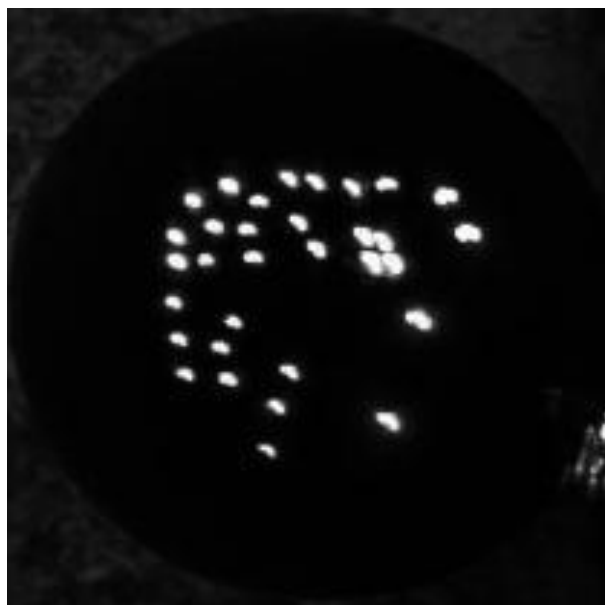


Figure 141: Composite highlights on the black sphere for the RTI capture session of Graffito F2-B



Figure 142: RTI screen capture with light source in the upper left-hand corner (-0.75 and 0.50) of Graffito F2-C



Figure 143: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito F2-C



Figure 144: RTI screen capture with light source in the lower left-hand corner (-0.75 and -0.50) of Graffito F2-C



Figure 145: RTI screen capture with light source in the lower right-hand corner (0.75 and -0.50) of Graffito F2-C



Figure 146: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffito F2-C (-0.78 and 0.58)

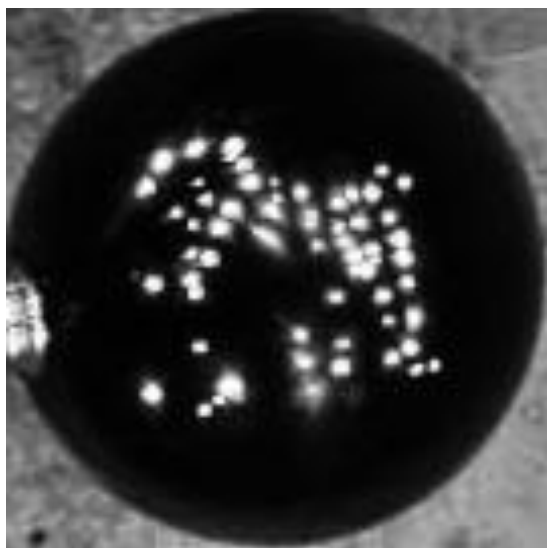


Figure 147: Composite highlights on the black sphere for the RTI capture session of Graffito F2-C

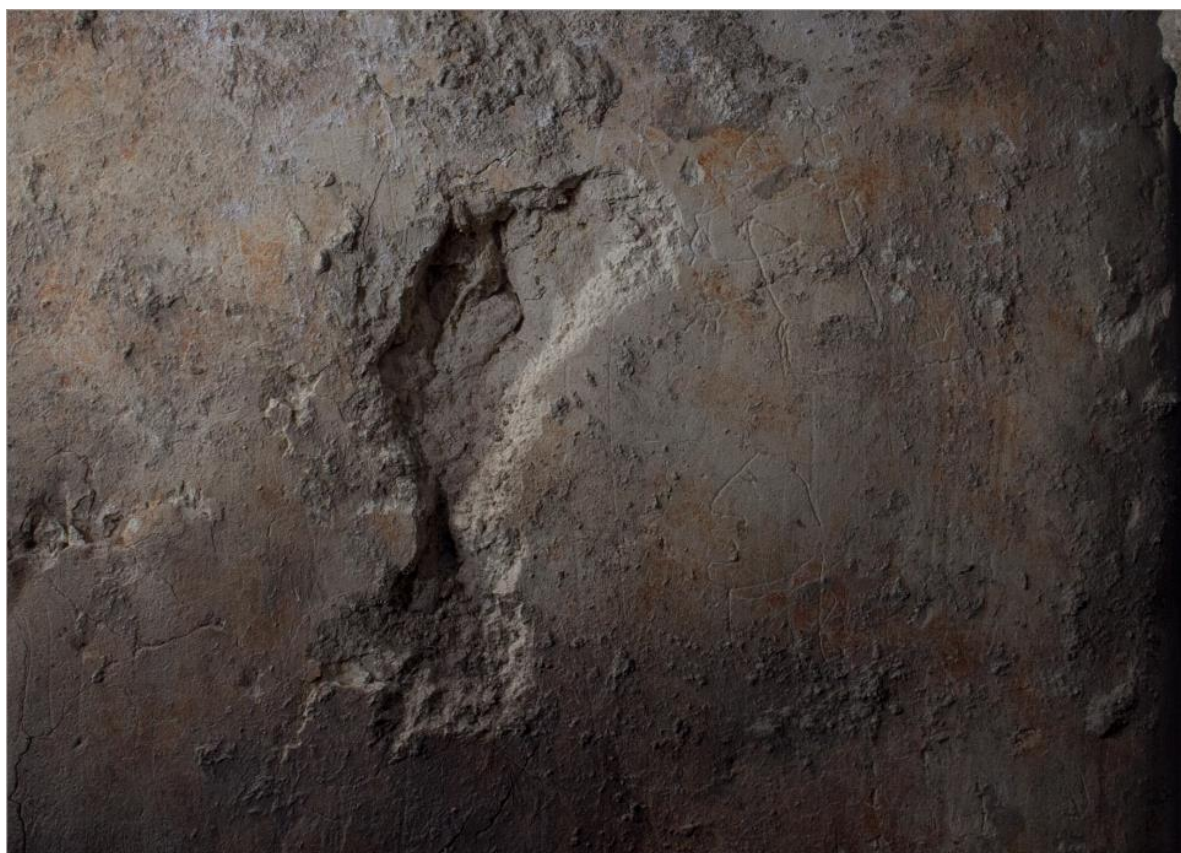


Figure 148: RTI screen capture with light source in the upper left-hand corner (0.75 and -0.50) of Graffito F3-A



Figure 149: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito F3-A



Figure 150: RTI screen capture with light source in the lower left-hand corner (-0.75 and -0.50) of Graffito F3-A



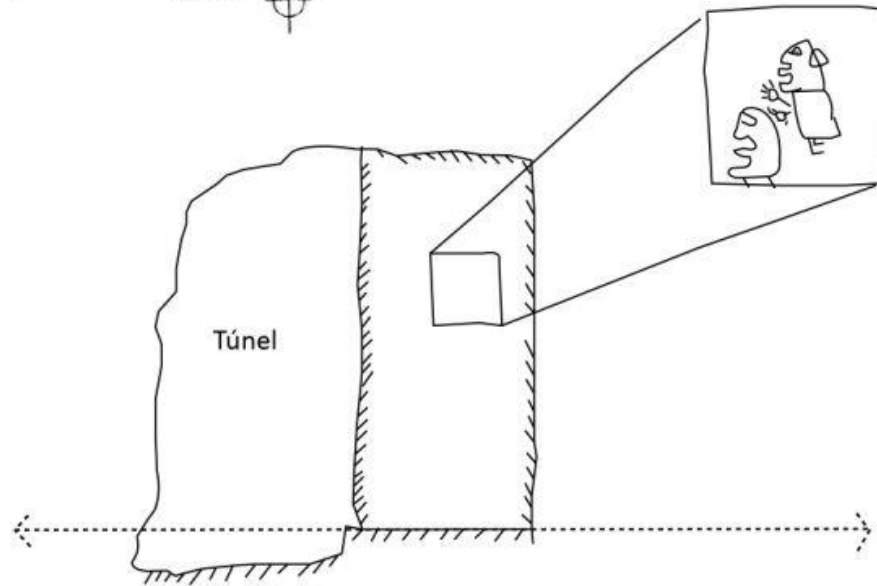
Figure 151: RTI screen capture with light source in the lower right-hand corner (0.75 and -0.50) of Graffito F3-A



Figure 152: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffiti F3-A (-0.20 and -0.98)

Proyecto Arqueológico Holtun
 Temporada del campo 2017
 Grupo F, Plaza B
 Dibujo de Grafito F3-A
 Dibujo: R. Gill
 Digitalizado: D. Crawford

0 0.50m



Grafito F3-A

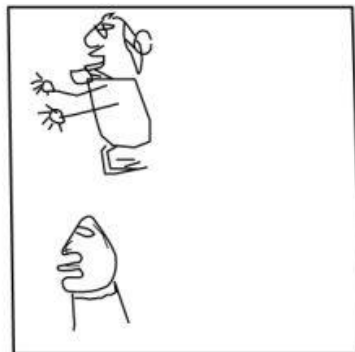


Figure 153: Line drawing of Grafito F3-A
 R. Gill 2017

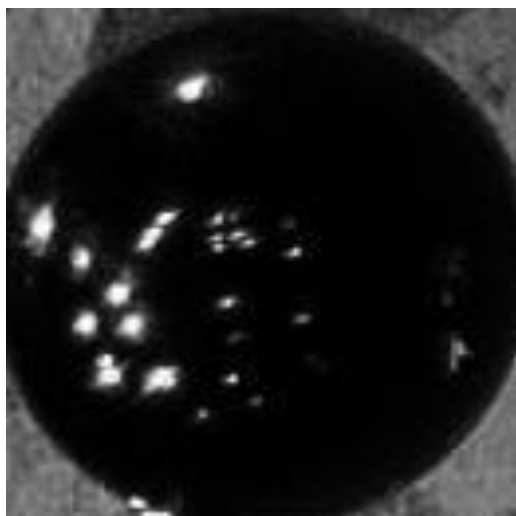


Figure 154: Composite highlights on the black sphere for the RTI capture session of Graffito F3-A



Figure 155: RTI screen capture with light source in the upper left-hand corner (-0.75 and 0.50) of Graffito F3-B

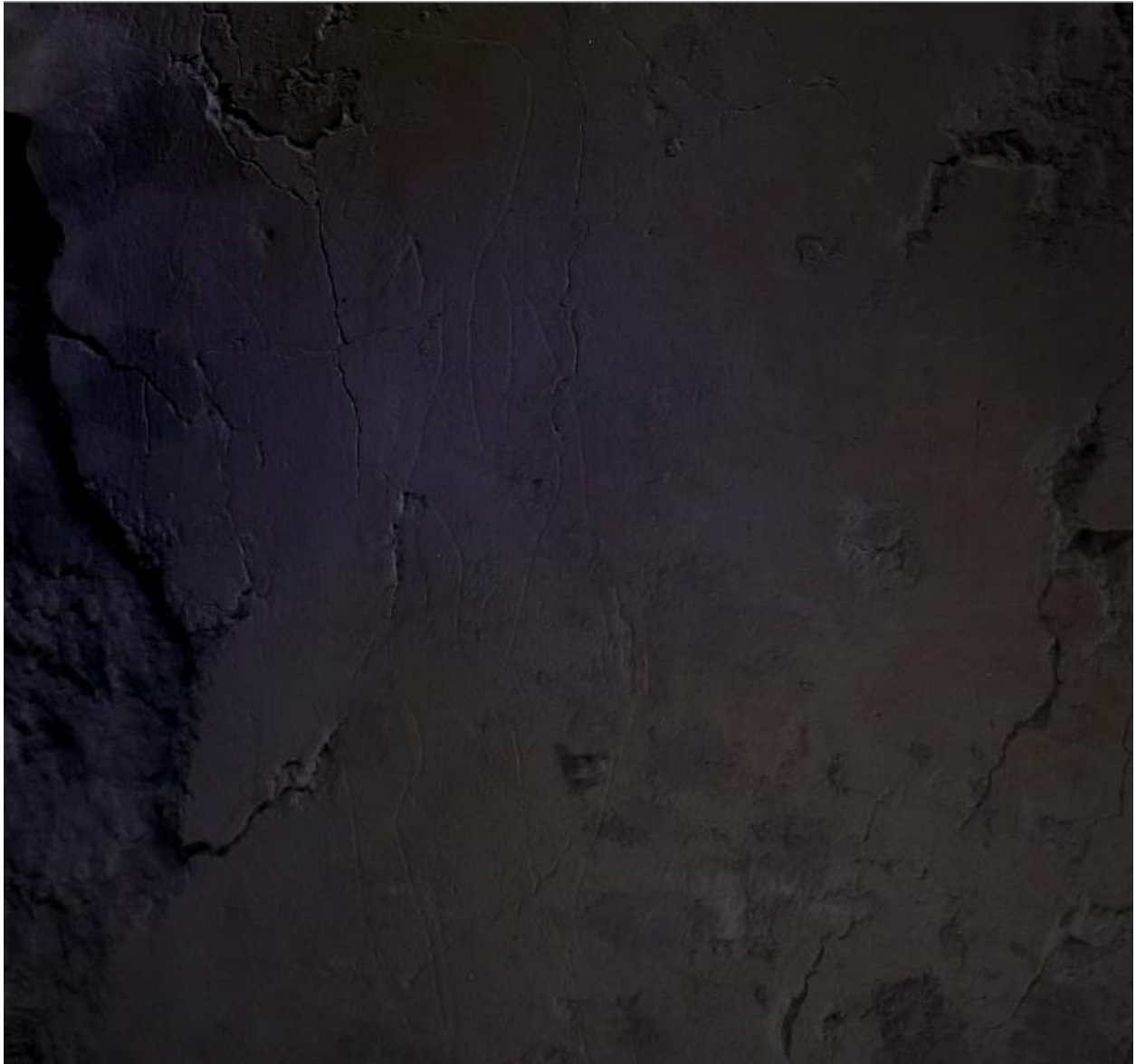


Figure 156: RTI screen capture with light source in the upper right-hand corner (0.75 and 0.50) of Graffito F3-B



Figure 157: RTI screen capture with light source in the lower left-hand corner (-0.75 and -0.50) of Graffito F3-B

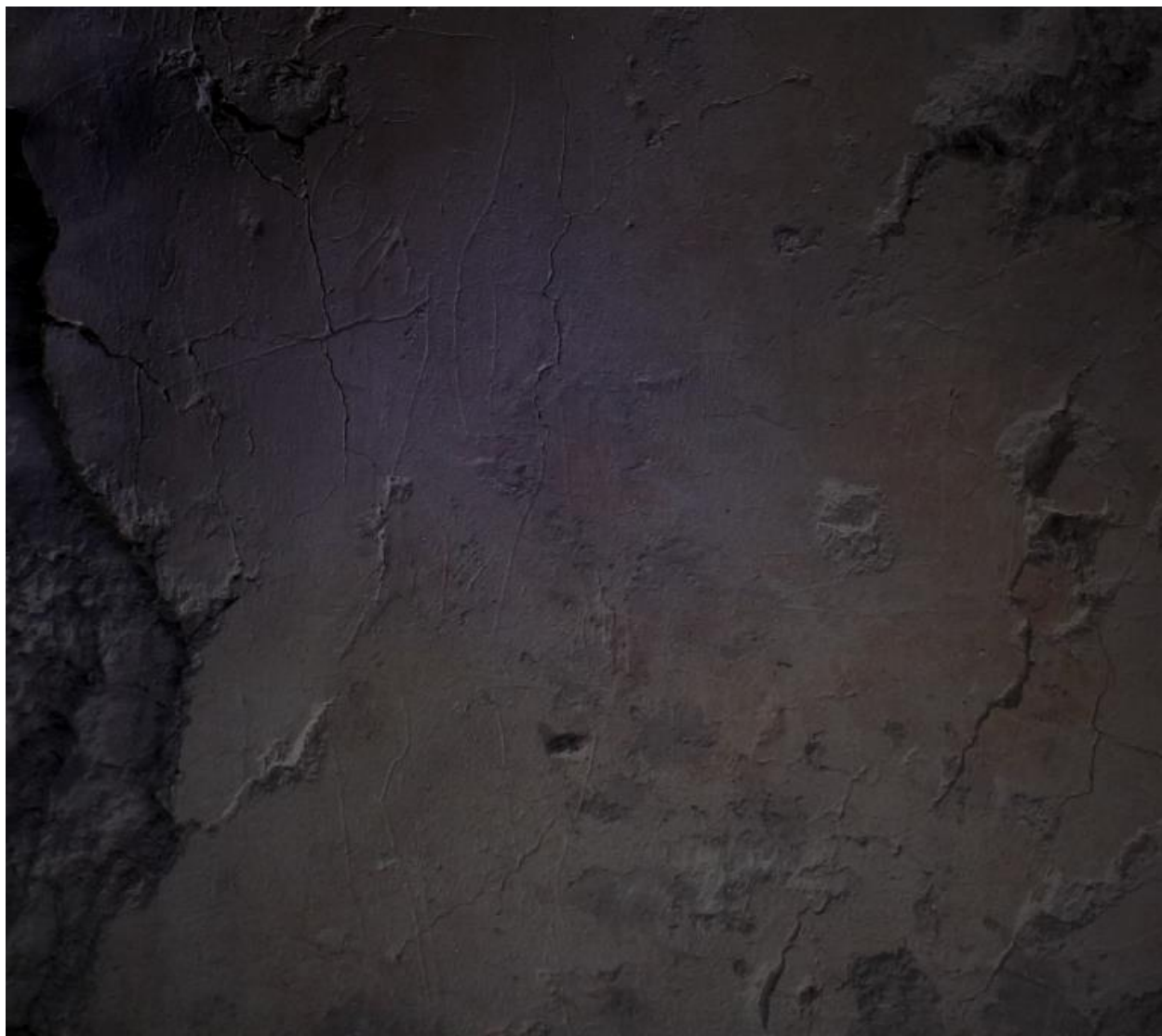
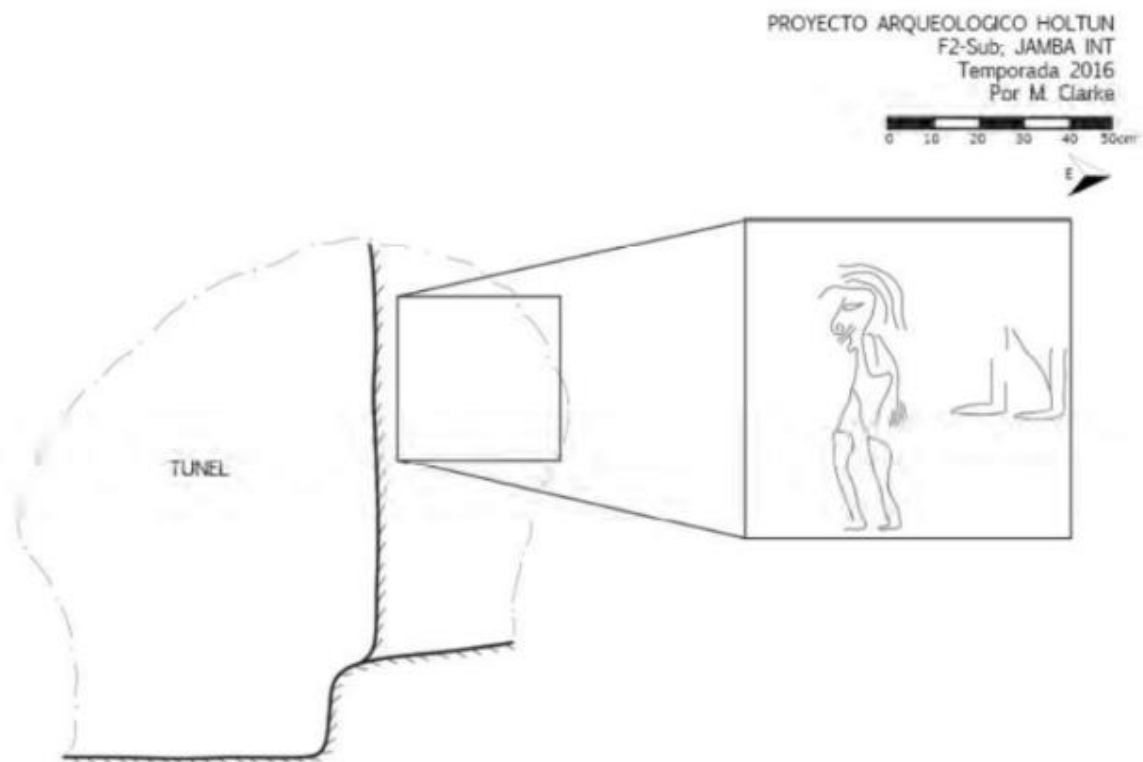


Figure 158: RTI screen capture with light source in the lower right-hand corner (0.75 and -0.50) of Graffito F3-B



Figure 159: RTI screen capture chosen directly by the analyst that best showcases the content of incised Graffiti F3-B (0.79 and -0.11)



*Figure 160: Line drawing of Graffito F3-B
M. Clarke 2016*

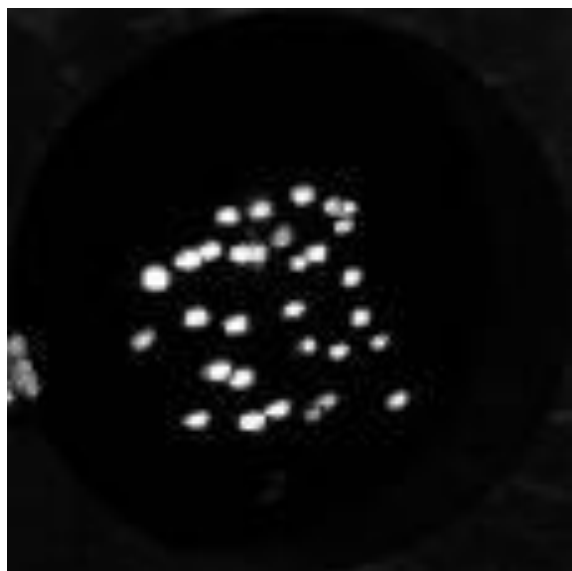


Figure 161: Composite highlights on the black sphere for the RTI capture session of Graffito F3-B

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