Report of the

Cochuah Regional Archaeological Survey

Field Season 2022 and Laboratory Analysis 2023-2025

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Cover illustration: Structure N1W3-1 of Sisal, photogrammetry by Alberto G. Flores Colin

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Acknowledgments

The 2022 field season was sponsored by the Selz Foundation and the Rust Family Foundation. The 2019 season was funded by the Selz Foundation and the Mellon/Faculty Fellowship from the American Council of Learned Societies awarded to Justine Shaw. The 2018 field season was funded by the Selz Foundation and the Rust Family Foundation. The field seasons of 2014 and 2012 were funded by the Selz Foundation.

The 2010 field season was also funded by the Selz Foundation, with additional support provided by the Swedish International Development Cooperation Agency (SIDA) and the Swedish Research Council (VR). The 2008 field season was funded by the Selz Foundation and the Antiqua Foundation. The CRAS field seasons of 2003, 2004, and 2005 were funded by the Antiqua Foundation, as was our 2002 season in Yo'okop. The Stiftelsen Lars Hiertas minne provided additional support for Johan Normark's participation during the 2005 field season. The 2001 Yo'okop season was made possible thanks to a grant from the Selz Foundation.We greatly appreciate the support and encouragement that Bernard Selz has continued to provide us over the years.

The 2000 season was funded by the H. John Heinz III Fund of the Heinz Family Foundation (reference number H1305) and the Foundation for the Advancement of Mesoamerican Studies Inc. (FAMSI project number 99016).In previous seasons of the CRAS Project, Johan Normark received financial support for fieldwork from Den Adlerbertska forskningsstiftelsen. These agencies have allowed Johan to conduct research before and after the fieldwork: Foundation Mary von Sydow, née Wijk, donation fund, Helge Ax:son Johnson Foundation, Gunvor and Josef Anér Foundation, Wilhelm and Martina Lundgren Science Fund, and Birgit and Gad Rausing Foundation for Humanities Research. Adam Kaeding received funding from the Boston University Overseas Research Grant. Without all this funding, our research in the region would not have been possible.

We would also like to thank our colleagues from the United States, Canada, Sweden, and Mexico, including INAH-QR and INAH-National, for helping us with our research season. The delegates and staff of INAH-Quintana Roo have been incredibly kind in helping us continue our research in the Cochuah region.
In addition to the above, the members of the Project wish to thank our family and friends who have been very patient and supportive in helping us continue with our research.

Finally, and most importantly, we would like to thank the people of Huay Max, Ichmul, Sacalaca, Saban, San Felipe, Tabasco, and Xquerol who have kindly allowed us to live and work in their ejidos during our seasons. In addition to the community members who work with us (see following pages), we received countless archaeological (and survival) tips and assistance from many individuals in all the mentioned ejidos.

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Esther Cahum

Part 1: Introduction to the CRAS 2022 Field Season

Chapter 1: Objectives and Background of the 2022 Field Season

Justine M. Shaw and Alberto G. Flores Colin

The 2020 season of the Cochuah Region Archaeological Project was designed to further the project's long-term goals, including the continuous documentation of sites in the Cochuah region and the excavation of test pits at mapped locations to obtain chronological data on changes in the regional settlement pattern over time. This season continued with two research lines established in prior seasons: the documentation of sites via test pits and the excavation of four circular structures to enhance comprehension of the Terminal Classic's final period, which succeeded the decline of major sites and the depopulation of much of the region.

The excavation of the foundations of circular constructions aimed to enhance the understanding of this construction type, which is thought to originate from a period following the early occupancy of the Terminal Classic. The aforementioned aligns with the stratigraphic relationship between the circular constructions and the distinctive architecture of the Terminal Classic period. A hypothesis was posited that the final structures may signify post-classic residential occupants, which remain undocumented in the region; only those designated for ceremonial activities during this period have been located.

Nonetheless, prior excavations were unable to determine a distinct occupational phase due to the absence of ceramic type differentiation, but architecturally, two phases may be discerned: an early phase and a later phase during the Terminal Classic period.

Consequently, this season's excavations of foundation braces of perishable structures employed a 50 cm grid, and sediment samples were gathered to facilitate a more comprehensive investigation of the activities linked to these late occupants. Soil chemical analyses indicate diverse processes occurring within and around the structures, consistent with prior seasons.

In the ejido of Sacalaca, test pits were excavated in Group Kan Ni', San Isidro Yodzonot, and San Andres Norte Milpa, where other two foundations of perishable constructions were also investigated. This season in San Felipe, we concentrated solely on the Sisal site, where two foundations of perishable constructions were excavated. Despite the brevity of this field season compared to previous ones, the research in the area continues to produce interesting findings.

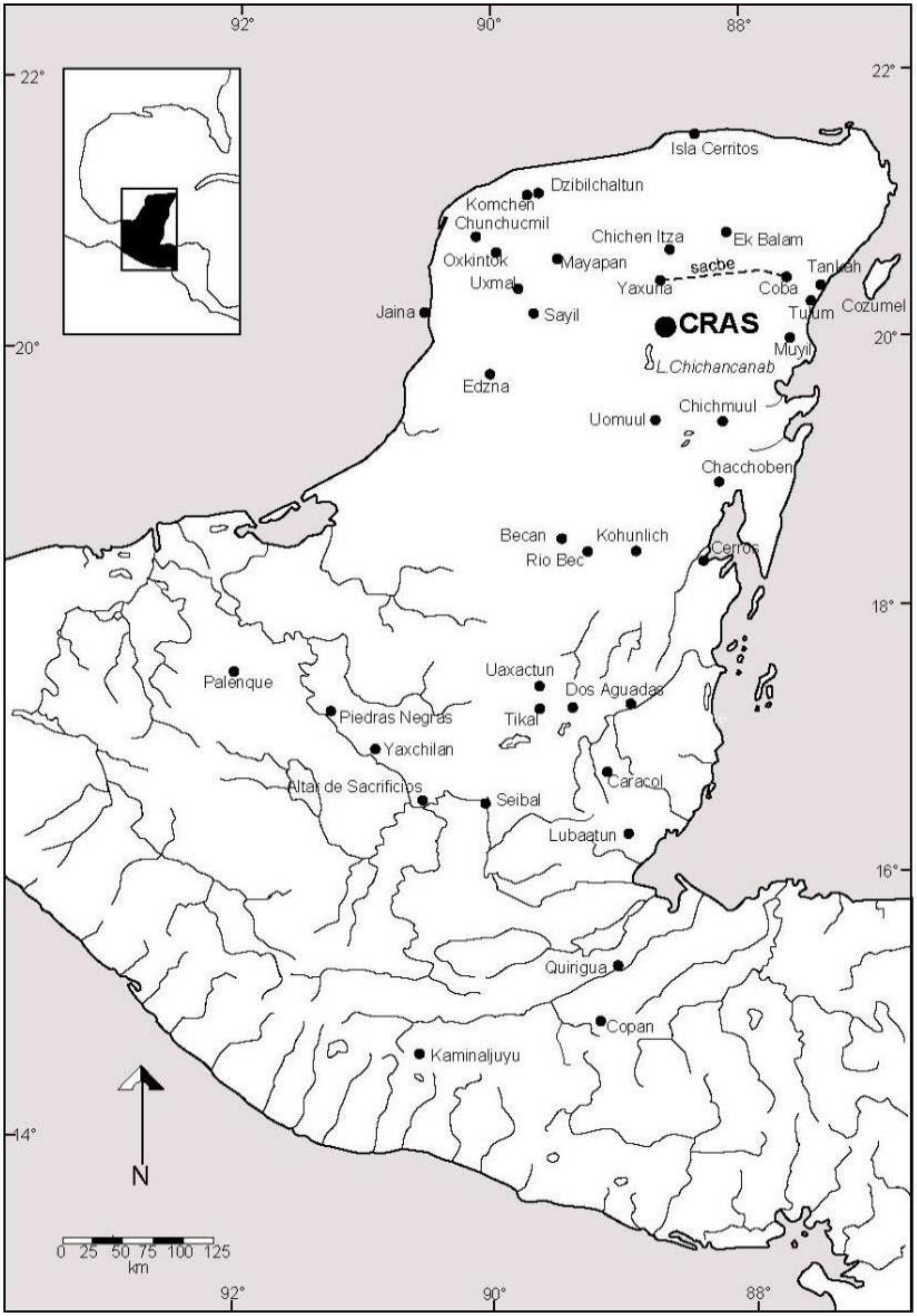


Figure 1. Location of the study area of the CRAS Project

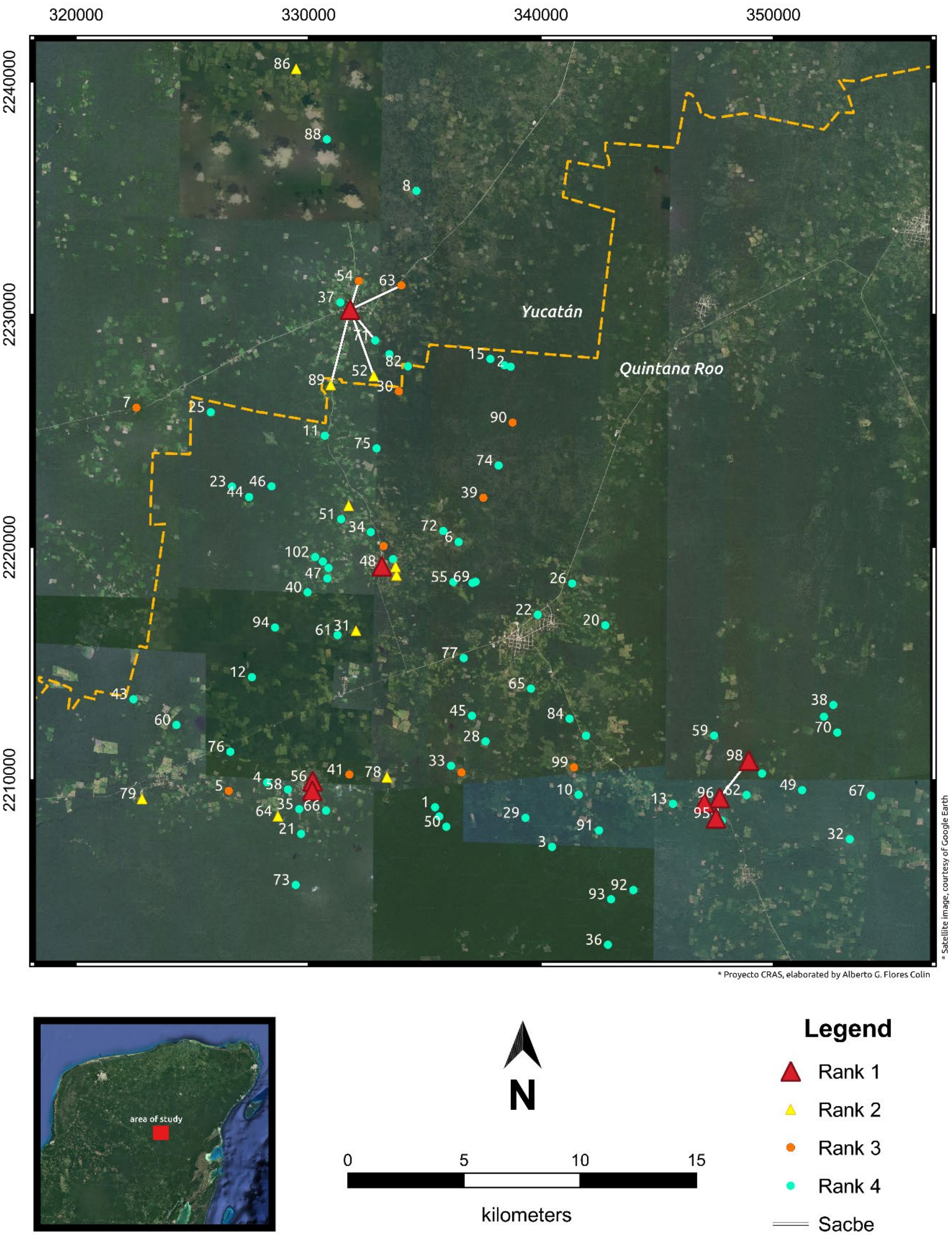


Figure 2. Sites within the study area of the CRAS Project
(key on page 4)

#	Site	Rank
1	Abuelos	4
2	Balche Prehispanico	4
3	Balche Saban	4
4	Benito Juárez	4
5	Candelaria	3
6	Chakal Ja'as	4
7	Chan Calotmul	3
8	Chan Mahas	4
9	Chumkatzin	4
10	Chumpich	4
11	Cortada	4
12	El Cedralito	4
13	Fortín de Yo'okop	4
14	Fuerte La Aguada	4
15	Fuerte de Balche	4
16	Grup K'an Ni'	2
17	Group Chultun	4
18	Group Noreste	3
19	Group Áak	2
20	Gruta del Alux	4
21	Hopemul	4
22	Huay Max	4
23	Ichbaquil	4
24	Ichmul	1
25	La Esperanza	4
26	La Gruta Huay Max	4
27	La Trinchera	4
28	Las Palmas	4
29	Nenela	4
30	Nohcacab	3
31	Noojol Yodzonot	2
32	Palomar	4
33	PWide VIlla	4
34	Parcela Escolar	4
35	Parcela escolar	4
36	Piimmul	4
37	Poxil	4
38	Ramonal (Saban)	4
39	Ramonal Este	3
40	Ramonal Poniente	4
41	Ramonal Quemado	3
42	RWide Balche	4
43	RWide Chankunai	4
44	RWide Guadalupe	4
45	RWide Rosales	4
46	RWide San Juan	4
47	RWide Yodzonot	4
48	Sacalaca	1
49	Sahkabch'en	4
50	Sak Chikin	4
51	San Andres	4

#	Site	Rank
52	San Andres Ichmul	2
53	San Andres Norte	2
54	San Cristóbal Ichmul	3
55	San Diego	4
56	San Felipe Group Norte	1
57	San Felipe Group Sur	1
58	San Fernando	4
59	San Francisco	4
60	San Francisco Tabasco	4
61	San Isidro	4
62	San Isidro (Saban)	4
63	San Juan Ichmul	3
64	San Lorenzo	2
65	San Manuel	4
66	San Nicólas	4
67	San Pablo	4
68	San Pablo	4
69	San Pedro	4
70	San Pedro (Saban)	4
71	San Pedro Ichmul	4
72	San Pedro Sacalaca	4
73	San Salvador	4
74	Santa Cruz	4
75	Santa Elena	4
76	Santa Elena Tabasco	4
77	Santa Rita	4
78	Sisal	2
79	Tabasquito	2
80	Trinchera Sacalaca	
81	Venadito	3
82	X-ma-Kabba	4
83	Xbequil	4
84	Xkanil	4
85	Xkansep	4
86	Xlapak	2
87	Xnicteil	4
88	Xnicteil	4
89	Xquerol	2
90	Xtojil	3
91	Yaxche 1	4
92	Yaxche 2	4
93	Yaxche 3	4
94	Yo'aktun	4
95	Yo'okop	1
96	Yo'okop Group B	1
97	Yo'okop Group D	1
98	Yo'okop GroupC	1
99	Yo'pila	3
100	Yodzonot	4
101	Yodzonot Este	4
102	Yodzonot Norte	4

Part 1: Introduction to the CRAS 2022 Field Season

Chapter 2: Research Methods of the CRAS Project

Justine M. Shaw

The Cochuah Regional Archaeological Survey Project (CRAS) included the archaeological investigation of the ejidos of Sacalaca and San Felipe. Methodologically, the project sought to continue the project methods that have been employed for several years and have yielded good results, while also introducing practices that would improve the quality and quantity of data obtained without significantly increasing costs.

Several 2x2 m test pits were conducted in the plaza(s) or open areas of several of the sites investigated this 2022 season. These excavations of the plaza area or open spaces aimed to provide ceramics from sealed contexts that could be used to date the construction sequence in a given area, as well as to determine the number and characteristics of construction phases and episodes of occupation. The test pits were excavated in natural or cultural levels and concluded in bedrock (unless otherwise indicated). The collected materials were separated according to the Operation / Level / Lot system. All the sediment or construction fill was removed with handpicks and trowels, transferred to buckets, and then sifted thru a 1 cm mesh.

Shaw or Flores monitored each excavation, which was under the immediate direction of one or more experienced archaeologists from the Project. From one to four members of the local staff assisted with the excavation and screening. All test pits were backfilled at the end of the excavation process, once they had been recorded and their elements consolidated. The project members completed standardized forms and sheets, which included basic contextual information such as depth, measurements, soil color in Munsell, soil texture, content, types of artifacts, GPS location, and a sketch for each excavated lot (Figure 3). This standardization in data collection provides the project with a more systematic written record in case an individual cannot personally complete the responsibilities of producing post-season reports.

The excavations of the San Andres Norte Milpa and Sisal structures were divided into suboperations of 50 x 50 cm using a grid of threads and stakes. Each excavated level was documented with photographs and a floor plan. Regarding the architectural elements that were exposed during our excavations, a consolidation process was carried out with the aim of ensuring their stability and preservation for the future. The materials used were lime, sascab, and local sediment. The first two were used to form a mixture in a 3 to 1 ratio, which was used to replace the degraded original mixture, as recommended in the consulted conservation literature (Cedillo 1993: 100–03; Cedillo et al. 1997).

This original mixture was removed with utmost care using fine spoons and brushes, trying not to damage the architectural elements. After the removal and replacement of the original mixture, the new mixture was painted with a combination of lime and sediment from the vicinity in equal proportions, although more water was added to create a more liquid mixture with which the joints of the consolidated stones were touched up to give them a more natural appearance.

Subsequent to this, and after the corresponding consolidation, the architectural elements and the adjacent excavated areas were backfilled to protect them. In the refilling process, the finest soil that was sifted thru the sieve during the excavation was first used, which was placed directly over the consolidated elements to ensure their preservation. After that, all the material that was extracted from the units was backfilled, all with utmost care to avoid damaging the excavated archeological contexts.

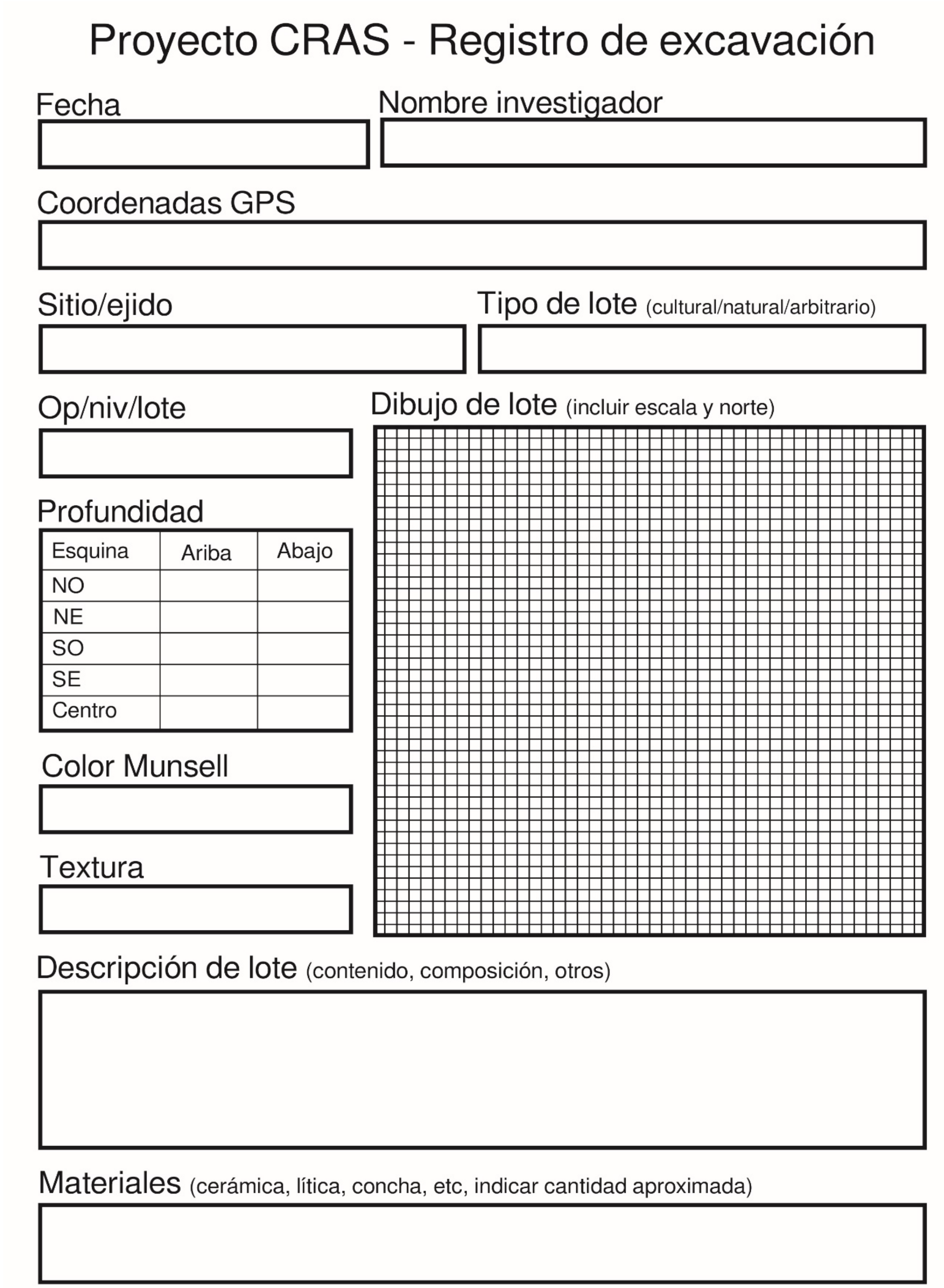
This season, soil samples were collected from all the excavated units, in a quantity of at least 100 ml for each Level and Lot. This collection was carried out following the recommendations by Barba (1986; 2007:441–42). The soil was extracted using a corer with the drill bit section or with a trowel, all previously washed with distilled water and rewashed after each collection. Each of the samples was placed in a plastic bag to be transported to the analysis laboratory.

In most cases, these samples are simply reserved for future studies that may be conducted. However, for the extensive excavations (foundations of perishable structures), the samples were taken to the soil analysis laboratory of the Center for Sustainable Development and Wildlife Utilization (CEDESU) at the Autonomous University of Campeche (UACAM), in the city of San Francisco de Campeche, where analyses were conducted, and the results are presented in Chapter 21 of this report.

The artifacts from the excavations and surface collections were washed and marked with the Site, Operation, Level, and lot. The Project used digital photographs, plan and profile maps, and extensive note-taking in addition to registration forms to document the visible remains on the surface and in the excavations.

At the end and/or at particularly important points in the excavation, a series of additional digital photographs were taken to enable photogrammetry (3-D virtual reconstruction) using Agisoft Photoscan Standard Edition (v. 1.4.2). Although the advantage of these reconstructions is primarily to facilitate the presentation and communication of the findings, they also allow for the analysis of excavations and features from various perspectives that can help understand spatial relationships and potential functions. Since the project backfilled all the excavations, this is the only means to revisit the excavations in the future to virtually examine particular components in situ.

The sherds were identified to the variety level whenever possible, using the type variety system (Smith et al. 1960). For the first time, each batch of ceramics was also weighed individually, in addition to identifying and counting sherds, in order to provide a better idea of the actual density and average size. The lithics were measured in terms of length, width, and thickness; identified by material and functional type; and then their Munsell colors were recorded. All the ceramic sherds and lithics were taken to INAH-QR in Chetumal to be stored after the corresponding analyzes were completed.



Proyecto CRAS - Registro de excavación

Fecha

Nombre investigador

Coordenadas GPS

Sitio/ejido

Tipo de lote (cultural/natural/arbitrario)

Op/niv/lote

Dibujo de lote (incluir escala y norte)

Profundidad

Esquina	Ariba	Abajo
NO		
NE		
SO		
SE		
Centro		

Color Munsell

Textura

Descripción de lote (contenido, composición, otros)

Materiales (cerámica, lítica, concha, etc, indicar cantidad aproximada)

Figure 3. Excavation Record Form for the CRAS Project

Part 2: Ejido of Sacalaca

Chapter 3: K’an Ni’, Operation 1

Thania E. Ibarra

Operation 1 at the K’an Ni’ site was a 2 × 2 m test pit situated adjacent to the northwest side of the platform, intended to establish a temporal sequence for it (Figure 4). In this side lies a potential ramp that extends from ground level to the platform level, oriented at 121º east of north. The identical axis was employed to align the test pit.

The excavation method was by cultural layers, and the soil was removed with a trowel. All the removed soil was sifted thru a sieve to recover archaeological material, and it was placed a few meters from the excavation. The area had recently been burned for agricultural use of the land, so the first step was to clear the burned and dry branches found in the work area (Figure 5). No ceramic material was recovered on the surface (Figure 6).

Excavation began at Level 1, Lot 1. It was a slightly sandy soil, Munsell 10YR 2/1 (black) in color, with a large amount of ash, a result of burning the land in preparation for planting. A large amount of gravel or *chich* was found, and ceramic material was recovered, and several soil sample were taken. The ceramic material belongs to the Late Terminal Classic.

Subsequently, Level 1, Lot 2 was dug, maybe representing the exterior of the access ramp to the platform in conjunction with Level 1, Lot 1. The soil's color and texture mirrored that of Lot 1, exhibiting a somewhat sandy consistency of Munsell 10YR 2/1 (black) and a significant ash concentration, resulting from anthropogenic fire for seedbed preparation. A significant quantity of gravel was discharged. A ceramic substance and a soil sample were recovered. Similar to Level 1, Lot 1, the ceramic material has been attributed to the Late-Terminal Classic period.

Level 1, Lot 3 may represent the ramp's interior, because of a potential alignment of the rocks. This lot closely resembled Lot 1 and Lot 2. A gravel surface was excavated, maybe serving as a component of the ramp. No pottery artifacts were recovered. A soil sample was collected. No rock alignment was detected, suggesting that it does not delineate the boundary of the access ramp to the platform (Figures 7 and 8).

Upon excavating the three lots of Level 1, we discerned that we were situated on the access ramp and had removed its surface layer. Consequently, to locate the border of the ramp and to build a chronological framework for the platform, it was determined to expand the pit 1.70 m southwestward. This extension was designated Operation 1B. The excavation reached the occupation surface, which was at the same elevation as Operation 1. It consisted of identical limestone rocks and gravel, likely comprising the fill and the ramp surface. The soil had a color of 10YR 2/1 (black) and possessed a slightly sandy texture interspersed with ash.

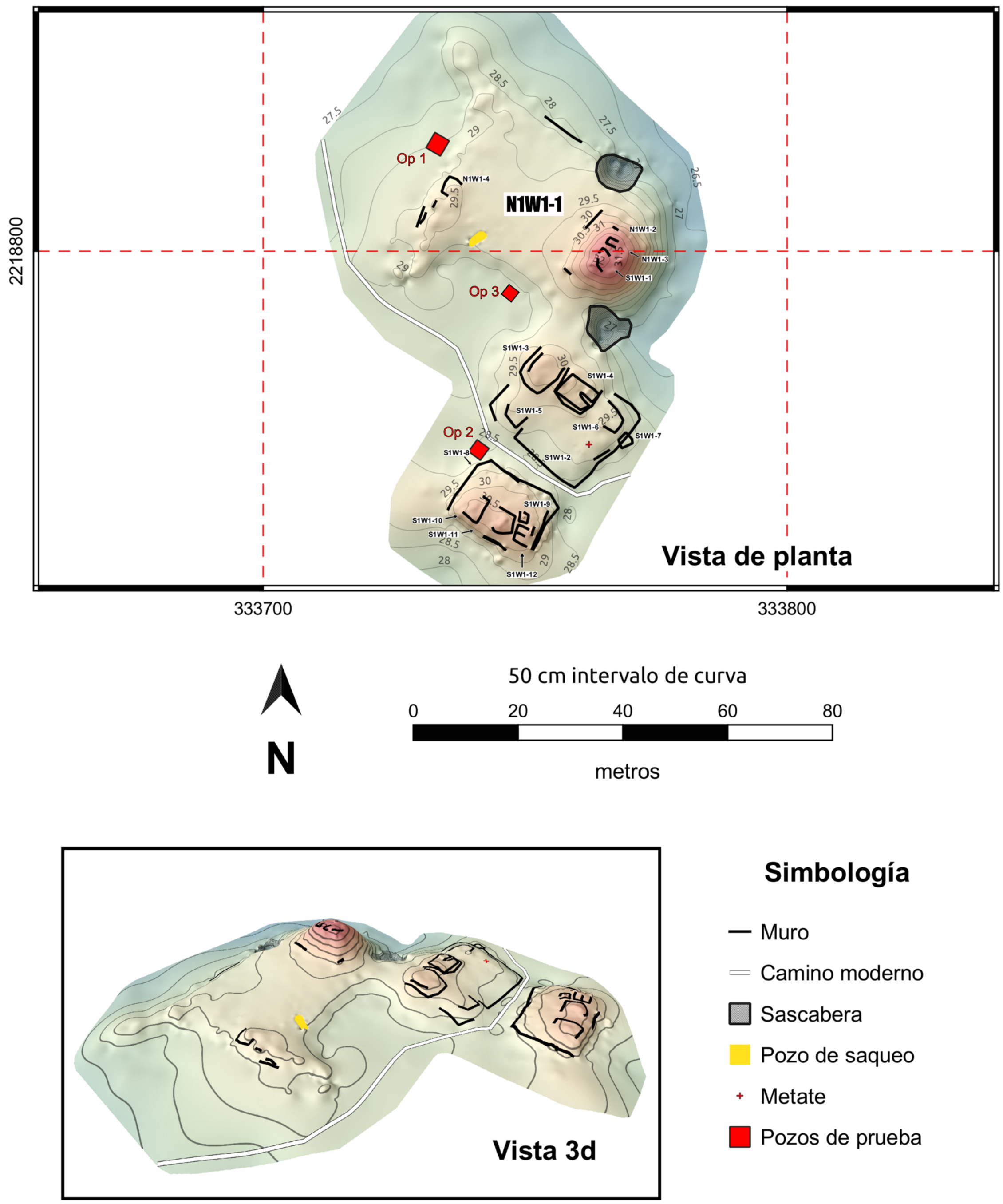


Figure 4. K’anNi’, Operations 1 and 2

No rock alignment was detected in this region, hence the ramp's edge was not located (Figure 9). Ceramic material was found and a soil sample was collected. The ceramic substance originates from the Late Terminal Classic and is attributed to the Muna and Chum groups. The excavation was completed (Figure 10), and the unit was backfilled with the excavated and screened soil (Figure 11).

Interpretation

The ramp's limit could not be identified or explored externally to determine the chronological sequence; nonetheless, ceramic artifacts were unearthed, dating to the Late-Terminal Classic, which at least indicates the platform's last occupation during this period. Certain stones outside the excavation exhibit a potential alignment, indicating they may delineate the bounds of the entrance ramp to the platform (Figures 12-14).

Figure 5. K’anNi’, Operation 1, clearing of the surface

Figure 6. K'anNi', Operation 1, surface

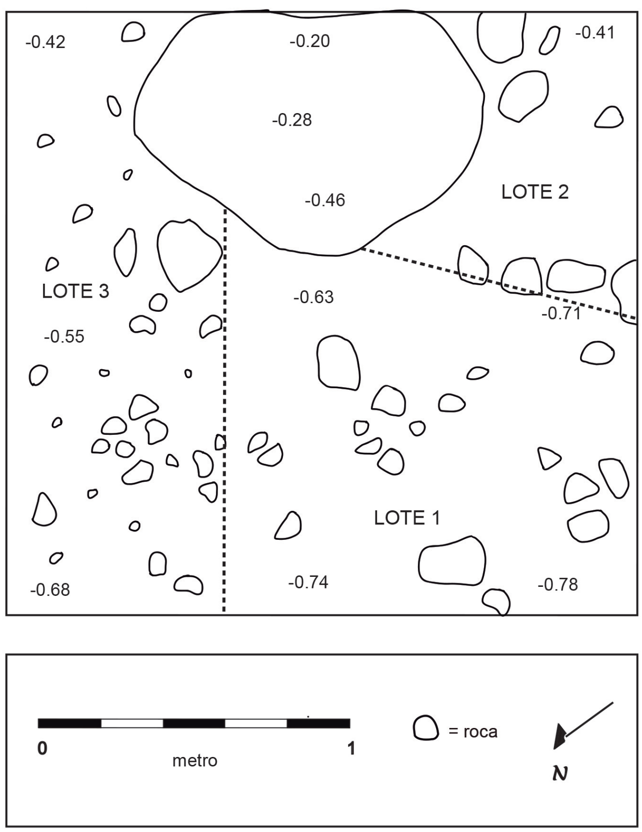


Figure 7. K'anNi', Operation 1, Lots 1-3

Figure 8. K’anNi’, end of excavation, Operation 1, Level 1, Lots 1, 2 and 3

Figure 9. K’anNi’, end of excavation, Operation 1b, Level 1, Lot 1

Figure 10. K’anNi’, end of excavation, Operation 1 and 1b, Level 1

Figure 11. K’anNi’, end of excavation, Operation 1 and 1b, backfilled

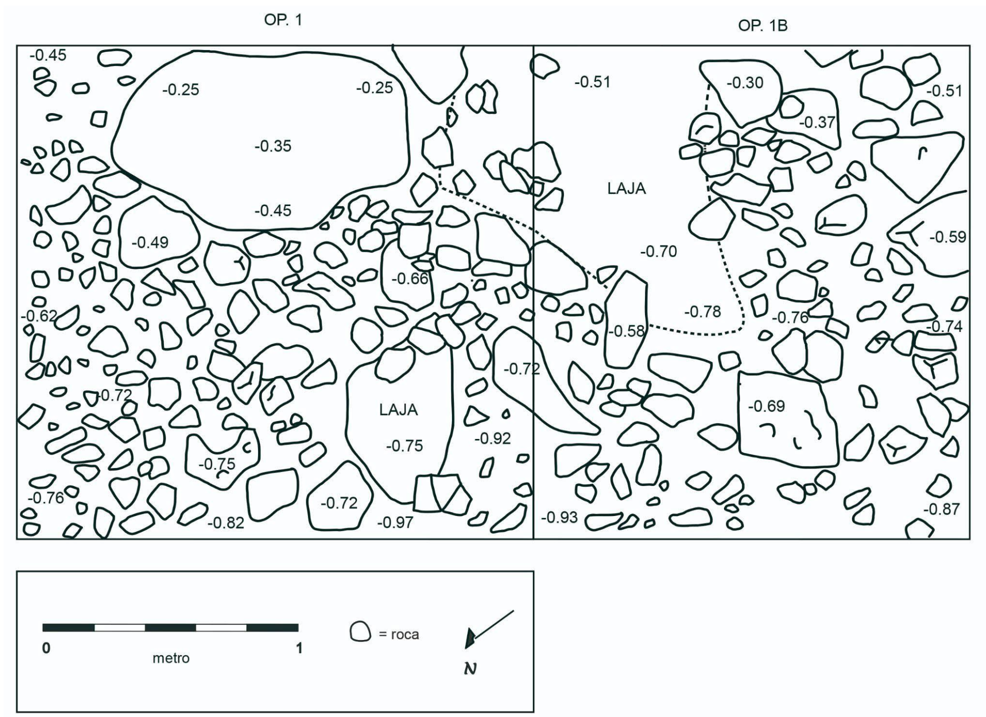


Figure 12. K'anNi', end of excavation, Operation 1 and 1b, Level 1, plan map

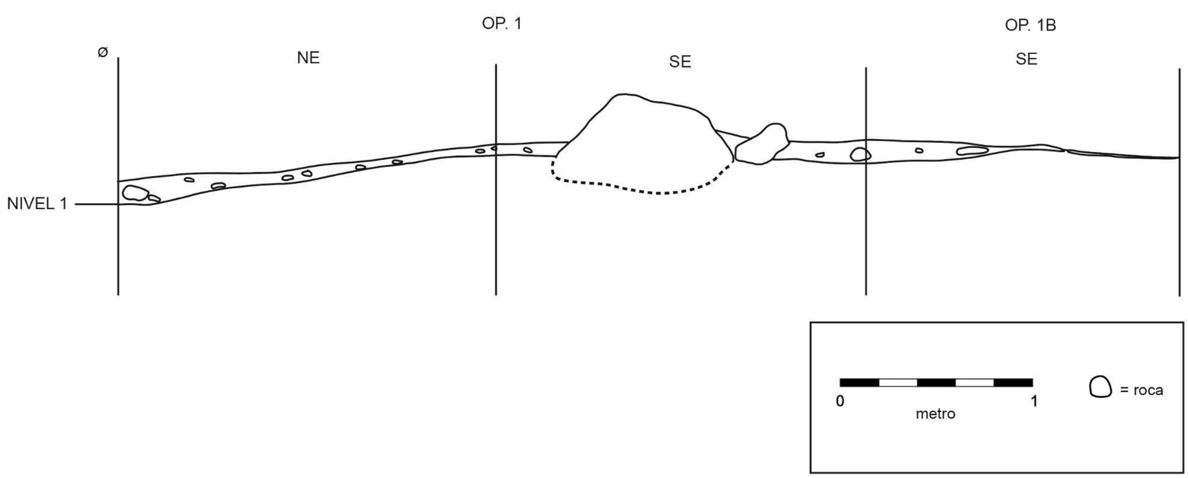


Figure 13. K'anNi', end of excavation, Operation 1 and 1b, profiles

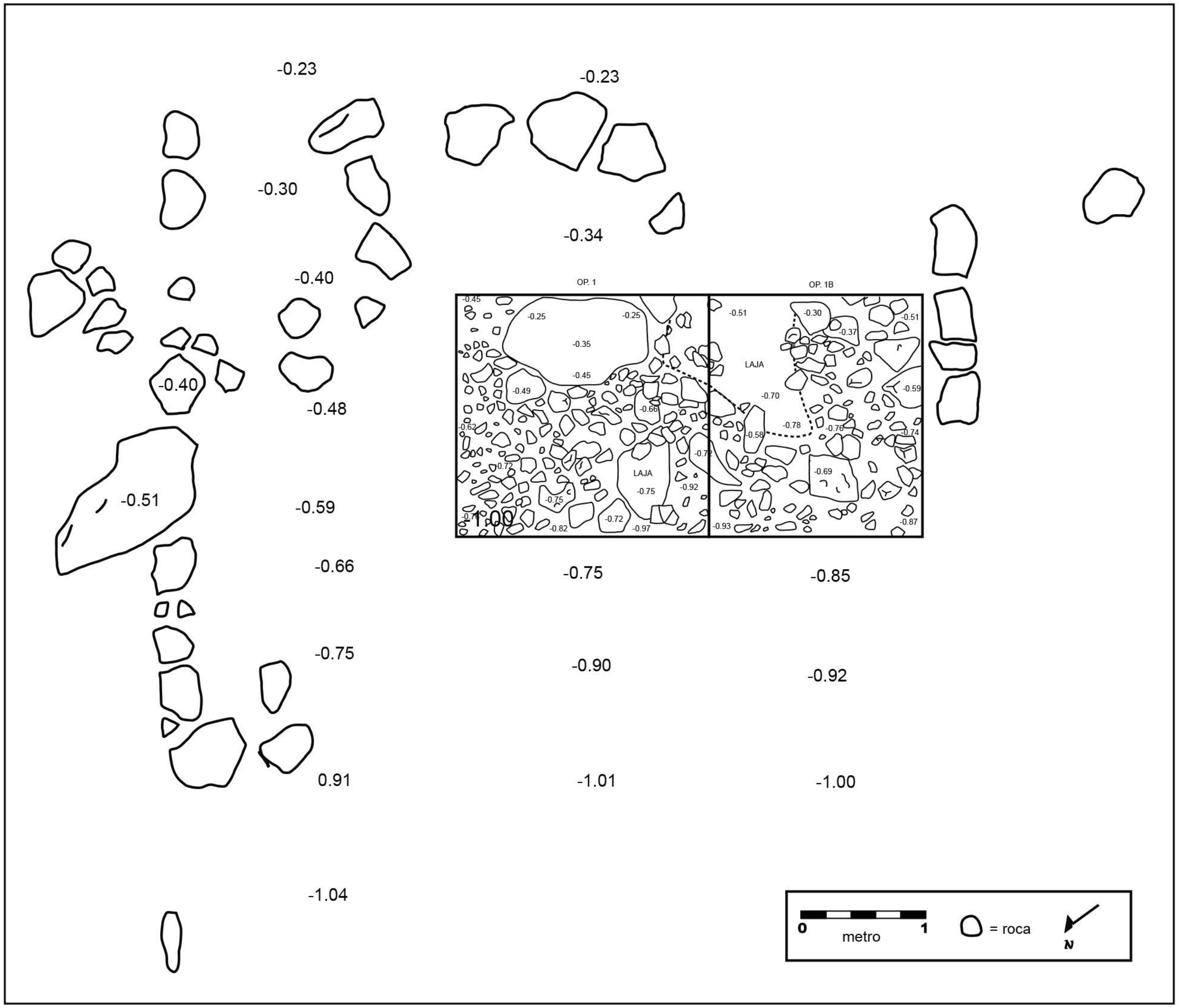


Figure 14. K'anNi', Operation 1 and 1b, area of the ramp

Part 2: Ejido of Sacalaca

Chapter 4: K’an Ni’, Operation 2

Marina Noh Figueroa

Operation 2 was a test pit measuring 2 x 2 meters and was located on the northeast wall of Structure S1W1-8. The area where the unit was placed was cleaned and prepared for excavation. Level 1, Lot 1, corresponds to a wall and the section of the wall collapse, located in the southwest part of the unit. The main objective of this operation was to expose the wall to see the foundation of the structure and thereby understand its chronology and construction episodes (Figure 15).

The dimensions of the discovered boulders ranged from 20 to 30 cm in thickness and are remnants of the wall's collapse; hence they are no longer in their original place. The soil had a hue of 7.5YR 2.5/1 Very Dark Brown and has a clayey texture. This lot of ceramics comprises fragments from the Late Classic to Terminal period (AD 600-1050), mostly identified with the Muna, Chum, and Saxche groups, as well as the Muna slate, Yokat striated, and Saxche orange polychrome types. The predominant types identified are bowls and pots.

Level 1, Lot 2 corresponded to the area characterized by falling stones accompanied by an increased quantity of soil, exhibiting identical texture and color to Level 1, Lot 1. In Level 1, Lot 2, ceramic fragments from the Late-Terminal Classic period were discovered, including Muna slate, Yokat striated, and Saxche orange polychrome types. Among the discovered artifacts, there are fragments of bowls, plates, and pots.

Subsequently, Level 1, Lot 3 started, which corresponded to the southeastern section of the unit and connected with the fallen stones. The extraction of these stones concluded upon the discovery of what seemed to be a further wall, potentially forming a step. In Lot 3, Late-Terminal Classic (Muna, Chum, and Saxche) sherds were discovered, with older examples of the Triunfo striated type-variety. This lot includes a stucco fragment of approximately 5 cm in length and 3 cm in thickness, exhibiting grayish features on its interior, as well as a lithic fragment of flint.

In Level 1, Lot 4, the work consisted of cleaning the step, which exhibited a black sediment (7.5YR 2.5/1 black). The lot was finalized following the cleaning and preparation of this part for its subsequent consolidation. The recovered ceramics were limited in number (61 sherds), spanning from the Late Preclassic period (300 B.C.–250 A.D.) to the Late-Terminal Classic period (600–1050 A.D.), with the Yokat type being the most prevalent.

Subsequent to its excavation, the identified wall was reinforced with a blend of sascab and lime, and subsequently delineated using a mixture of red soil and water. Upon completion of these tasks, the recording and backfiling of the unit proceeded.

Interpretation

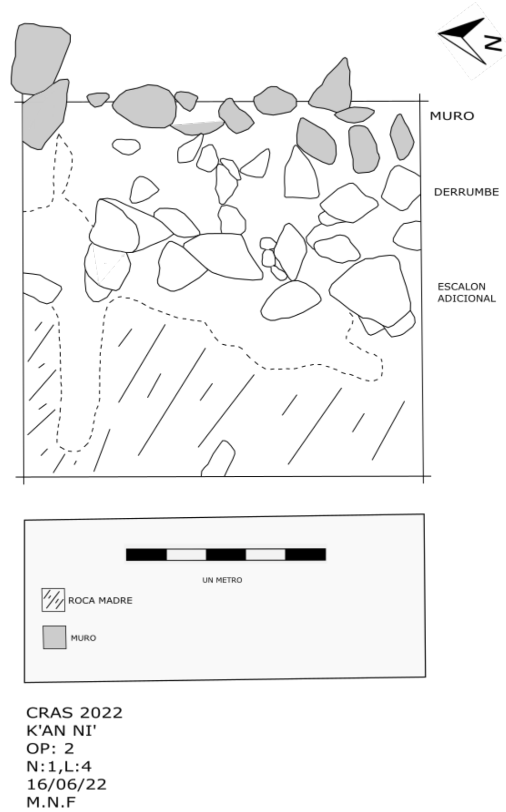
This unit helped to understand the chronology of the site, as well as its ceramic affiliation. According to this, it was observed that K’an Ni’ had a long occupation that spans from the Late Preclassic (300 B.C.-250 A.D.) to the Late-Terminal Classic (600-1050 A.D.), although the period with the greatest abundance of pottery is the latest. Similarly, this excavation revealed the presence of a step that provided access to the upper part of this construction. There was no evidence of a plaza or any artificial leveling in this part of the site.

Figure 15. K'anNi', Operation 2, Surface

Figure 16. K'anNi', Operation 2, Level 1, Lot 1

Figure 17. K’anNi’, Operation 2, Level 1, Lot 2

Figure 18. K’anNi’, Operation 2, Level 1, Lot 3



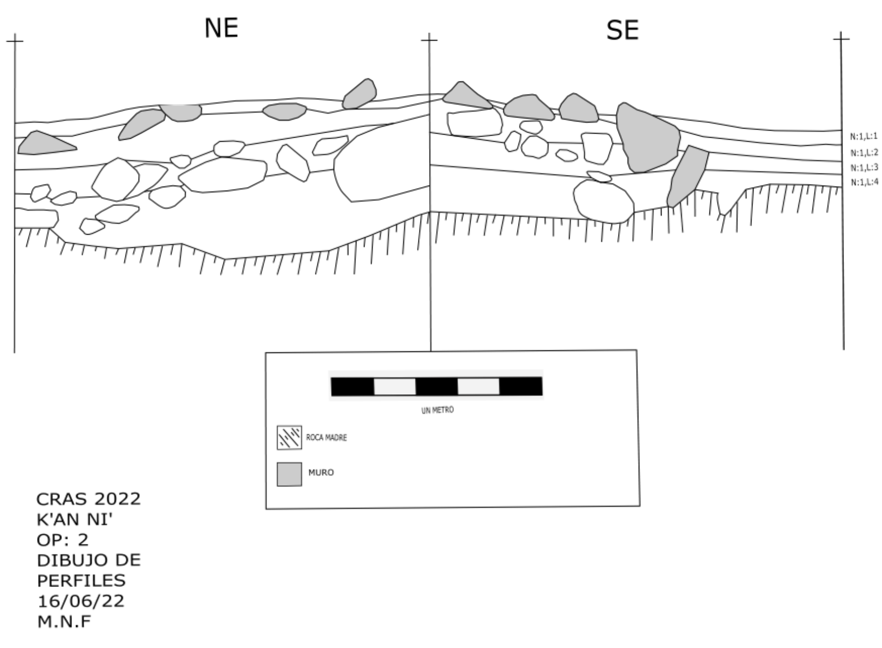


Figure 19. K’anNi’, Operation 2, profiles and plan map

Figure 20. K’anNi’, Operation 2, consolidated

Figure 21. K’anNi’, Operation 2, backfilled

Chapter 5: K’an Ni’, Operation 3

Marina Noh Figueroa

Operation 3 was a test pit located next to the starting wall of Structure N1W1-1, also near a sascabera that runs beneath that construction (Figure 4). Level 1, Lot 1, consisted of what appeared to be a dark-colored sediment (7.5YR 2.5/1) and the collapse of a possible wall, which were actually stones lying without any arrangement (Figure 22). Although the ceramics found in this lot were minimal, they included a variety ranging from the Early Classic to the Late-Terminal Classic.

The lot was changed arbitrarily (Lot 2) since no change in soil color was detected. However, in this lot, part of the bedrock began to be discovered (Figure 23). Although the quantity of sherds was smaller, there is a variety of types ranging from the Late Preclassic (300 B.C.-250 A.D.) to the Late-Terminal Classic (600-1050 A.D.).

Level 1, Lot 3 also has an arbitrary nature, as no soil change was observed, although there was a slight increase in sascab on the northwest side (Figure 24). Very few sherds were recovered from the unit, but they exhibited a great variety, ranging from the Early Classic to the Late-Terminal Classic and even to the Late Preclassic. Once the excavation was completed, the unit was recorded and backfilled until the original surface was reached (Figures 25-27).

Interpretation

Operation 3 showed that the site has a long occupation over time, due to the presence of types ranging from the Late Preclassic (300 B.C. to 250 A.D.) to the Late-Terminal Classic (600-1050 A.D.), with the Late Preclassic period being the time of occupation with the least evidence of material remains, while the period with the greatest peak was the Late-Terminal Classic.

Figure 22. K’anNi’, Operation 3, Level 1, Lot 1

Figure 23. K’anNi’, Operation 3, Level 1, Lot 2

Figure 24. K’anNi’, Operation 3, bedrock

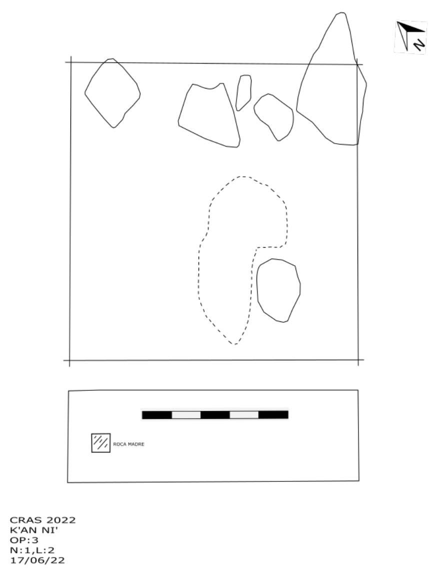


Figure 25. K’anNi’, Operation 3, plan map

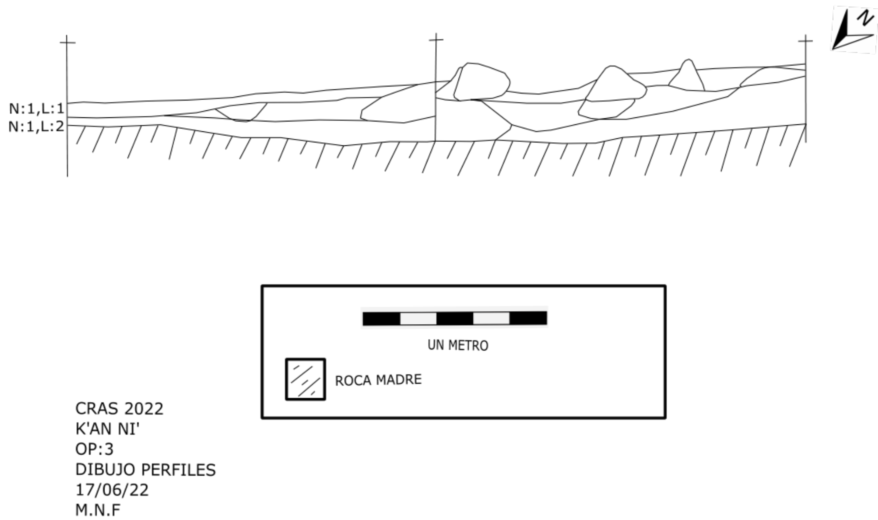


Figure 26. K’anNi’, Operation 3, profiles

Figure 27. K’anNi’, Operation 3, backfilled

Part 2: Ejido of Sacalaca

Chapter 6: San Andres Norte Milpa, Operation 1, Structure N1W1-3

Justine M. Shaw

In 2019, the zone designated as San Andres Norte Milpa (Figure 28) was mapped with the aim of returning in the next season to excavate two round foundation braces atop a natural rise that had been partially leveled as a platform (Structure N1W1-7) and potentially conduct some test pits in the deeper soil to the south of the rise (Figure 29).

That season (2019), features were very visible, as the zone was indeed a *milpa* with corn sprouts withering in the ongoing drought. When the pandemic began to wane and research was resumed in 2022, CRAS project members returned to find the area covered in relatively dense scrubby vegetation interspersed with *caoba* trees that had been planted as part of a government reforestation project. With locals reporting crop failures due to drought throughout the pandemic, the trees were no taller than the scrub vegetation, struggling to survive. When the zone around the structures was cleared, all trees were left undisturbed.

A 6x12-m area was thoroughly cleaned to expose features visible on the surface and a 50x50-cm string grid was laid out (Figures 30 and 31); as will be discussed later, this area was later amplified with an additional meter of two rows to the north. These dimensions were chosen to include the small, fairly flat area to the north of Structure N1W1-3 through the structure itself to a flat area to its south, ending just beyond a *metate*. If the *metate* were associated with the round structure, rather than with other structures and features upon the hillock, the zone between the two might have been the locus of household-related activities that could have left artifactual and chemical traces.

The zone between the *metate* and structure was flat, although the structure itself sloped gradually downward (~40cm) to the north, potentially assisting in the structure's drainage. Following the recording of the planned excavation area using drone and ground-based photography, ~100g soil samples were collected from the center of each unit or, if rocky features were present, from wherever sediment might be obtained. Approximately 3cm of soil was moved aside within each unit before the samples were collected. These constituted samples from Level 1, Lot 1. These constituted samples from Level 1, Lot 1. These samples were analyzed in the soil laboratory of the Autonomous University of Campeche.

Operation 1, Level 1, Lot 1 (Figure 32) began with the suboperations that served to define the interior and exterior in order to define the circular wall comprising the foundation brace. It soon became apparent that the wall was not a single course of stones; instead, it was 2-3 courses high, likely around half a meter in height originally. The collapsed rocks were initially left in place to be recorded once the entirety of Level 1, Lot 1 was excavated; they were then removed, with the material under them constituting Level 1, Lot 2.

Some of the units in Level 1, Lot 1 located within the structure produced plaster fragments with flat surfaces, potentially indicating that the structure had once had a finished interior floor. However, as the pieces were relatively small ($\leq$5cm), they could also have come from a plaster finish upon the stone portion of the wall. Units to the immediate west of Structure N1W1-3 had elevated ceramic counts (Figure 33).

Most of the sediment within Level 1, Lot 1 was black (7.5 YR 2.5/1), although the region to the west of the structure with more ceramic sherds was slightly redder in color (7.5 YR 3/2 dark brown). Suboperation 1j12 of Level 1, Lot 1 had some rocks that appeared to be burned and its sediment was blacker (10YR 2/1) than that typical for Level 1, Lot 1. This could certainly be the product of the location's use as a modern *milpa*, as well as the probable use of it in this manner for some hundreds of years; other units produced occasional pieces of burned plant material.

Its recent use as an agricultural field meant that, although fine and small (2-3cm) roots were present, no larger roots were currently in place near the surface. As the excavation progressed, however, more stumps and roots were revealed, likely cut down prior to the *milpa* present in 2019. The fill comprising Level 1 was silty and well mixed with gravel and small cobbles present. Approximately 18cm below the modern surface, both within and outside the structure wall, sediment changed to a redder (7.5YR 5/3 dark brown) fill with angular cobbles and gravel; this was approximately 10cm in thickness above the uneven bedrock.

Once identified in Suboperations 1j17 and 1j18 (Figure 34), it was not excavated, as the aim of the operation was to study the activities directly associated with the use of the round foundation brace itself, stopping at what had been the occupation surface. It appeared to be a leveling of the vicinity that took place prior to the construction of Structure N1W1-3. This may have taken place during earlier Classic occupations that are evidenced in the vicinity or at a later time, potentially even at the time of the building of the round structure. As suboperations progressed to the south, the deposit that constituted Level 1, Lot 1 became thinner.

In order to ensure that it was followed, to ascertain that it was indeed the living surface upon which Structure N1W1-3 was built, and to see if the *metate* to the south in column "F" of the suboperation grid was likely associated with the round foundation brace, Suboperation 1f3 was excavated independently before the other rows had progressed this far south. This revealed that the *metate* did rest atop the unexcavated deposit below Level 1, Lot 1, sharing the same living surface as Structure N1W1-3. The suboperations in column "F" were then excavated to connect the ongoing row excavations to the *metate* (Figure 35).

Unlike other round foundation braces excavated to date, Structure N1W1-3 appears to have had stucco applied to its floor and some other surfaces. Sisal's Operation 11 (see Chapter 14 this volume), excavated later this same season, also produced some stucco though not in the quantities that were present here. Anecdotally, interior units evidenced numerous very thin (~3mm) flat stucco fragments mixed within the fill of nearly every suboperation, both near the foundation brace wall and in units distant from the wall, implying a plaster floor surface. Within the interior, it was common for units to have stucco fragments as equally represented as sherds.

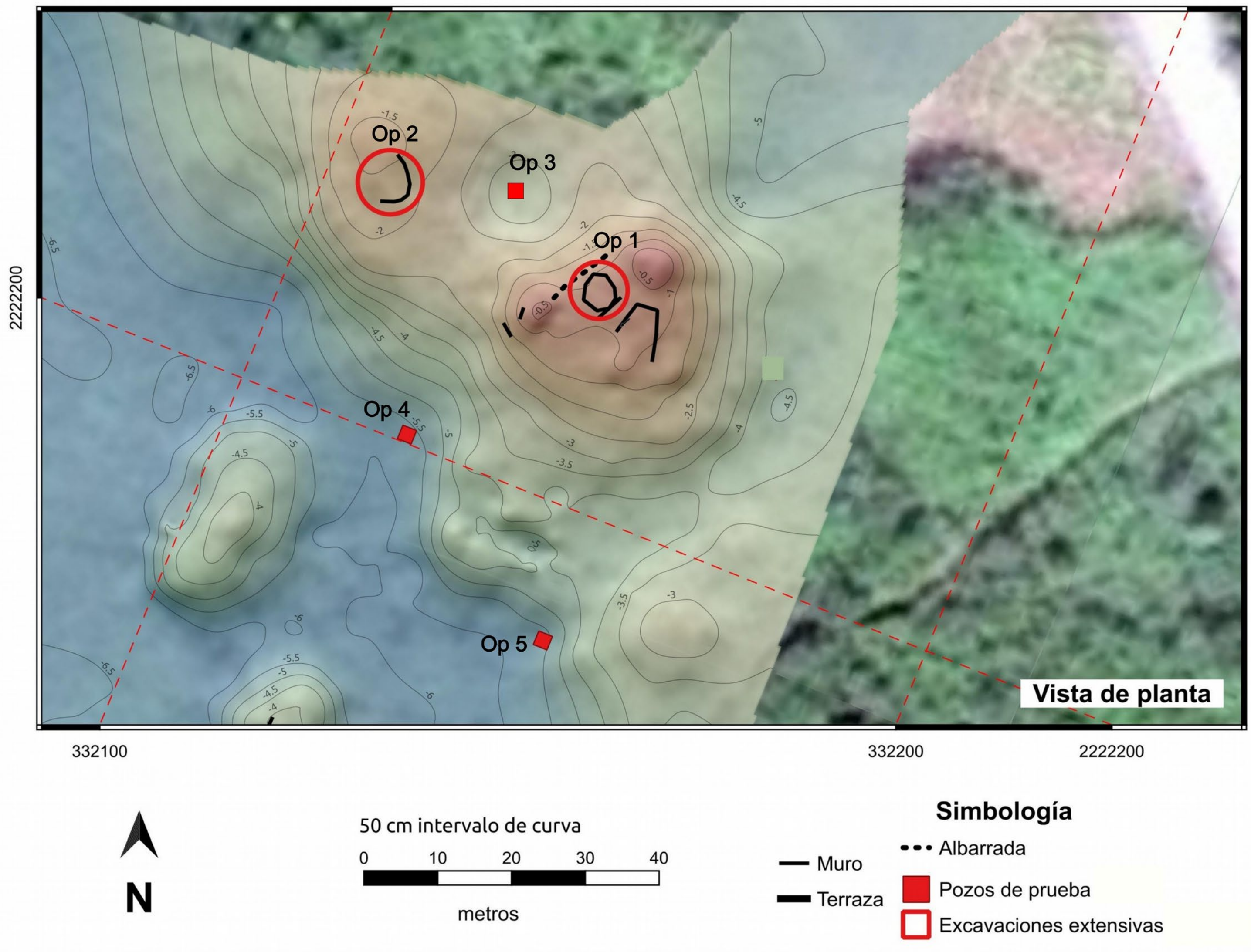


Figure 28. San Andres Norte Milpa, Test Pits and Structural Excavations

Figure 29. San Andres Norte Milpa, Structures N1W1-3 and N1W1-4 and Test Pits (drone view)

Figure 30. San Andres Norte Milpa, Operation 1, Structure N1W1-3, Prior to Excavation

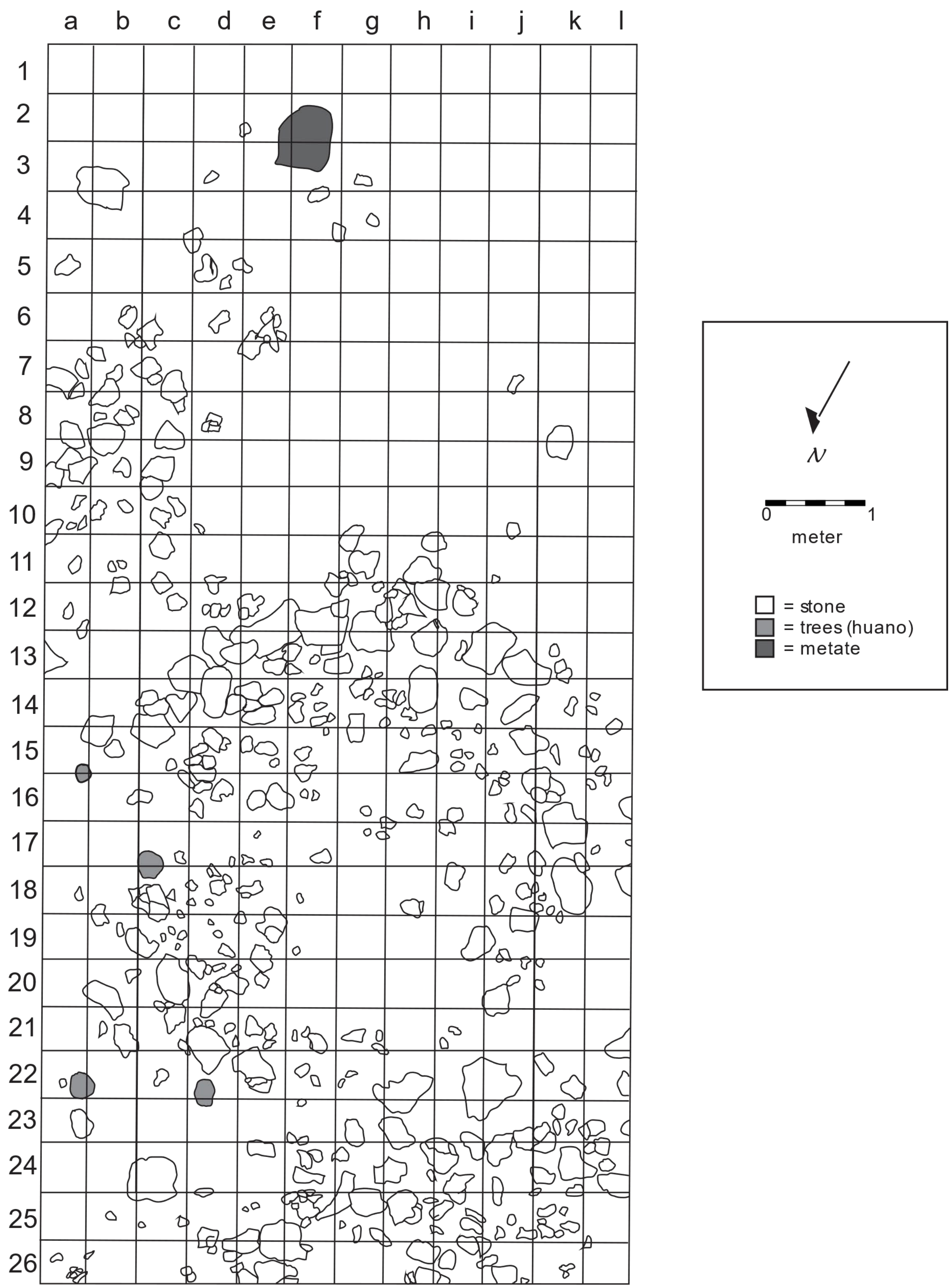


Figure 31. San Andres Norte Milpa, Operation 1, Plan Prior to Excavation

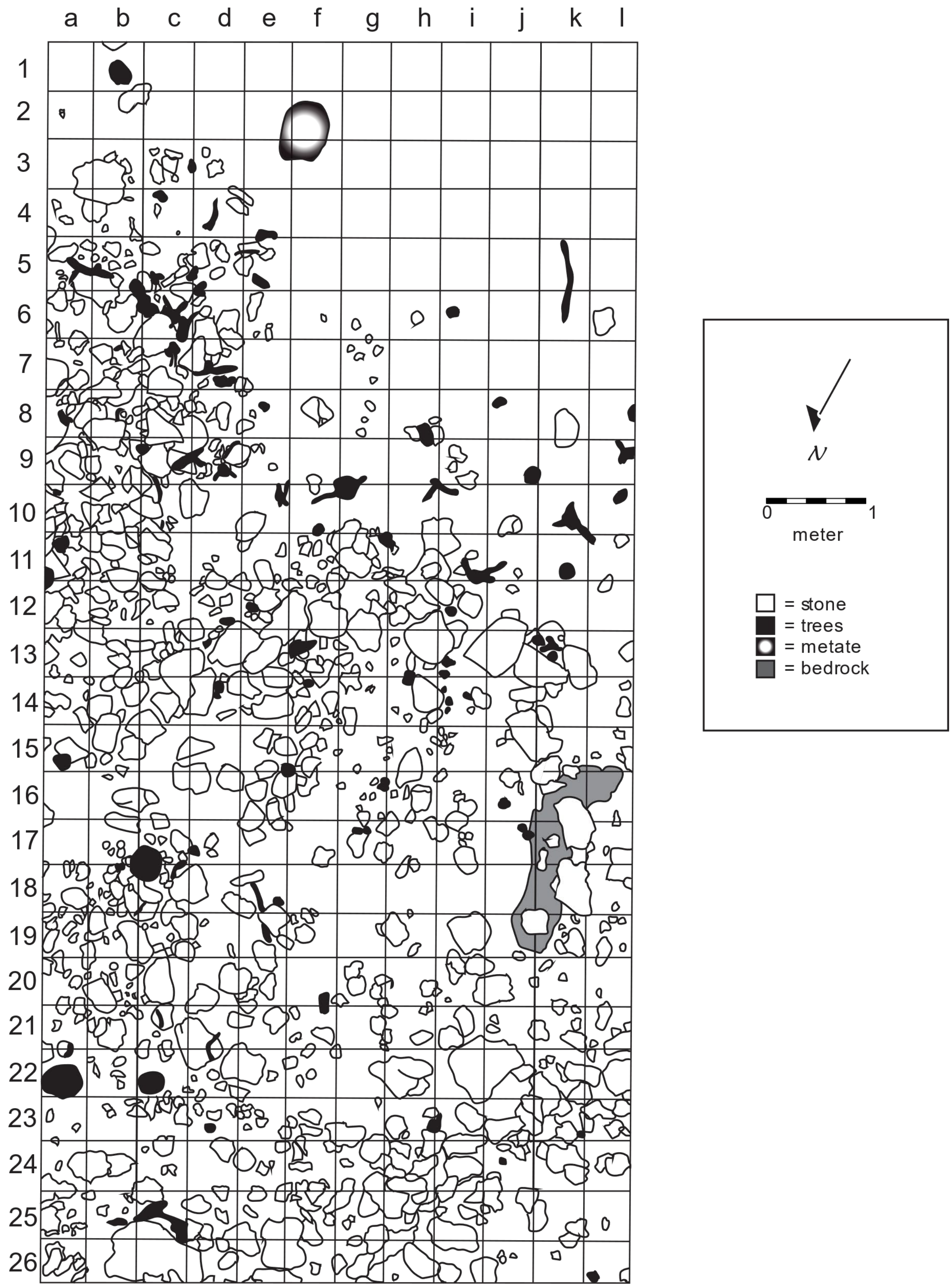


Figure 32. San Andres Norte Milpa, Operation 1, Structure N1W1-3, Level 1, Lot 1

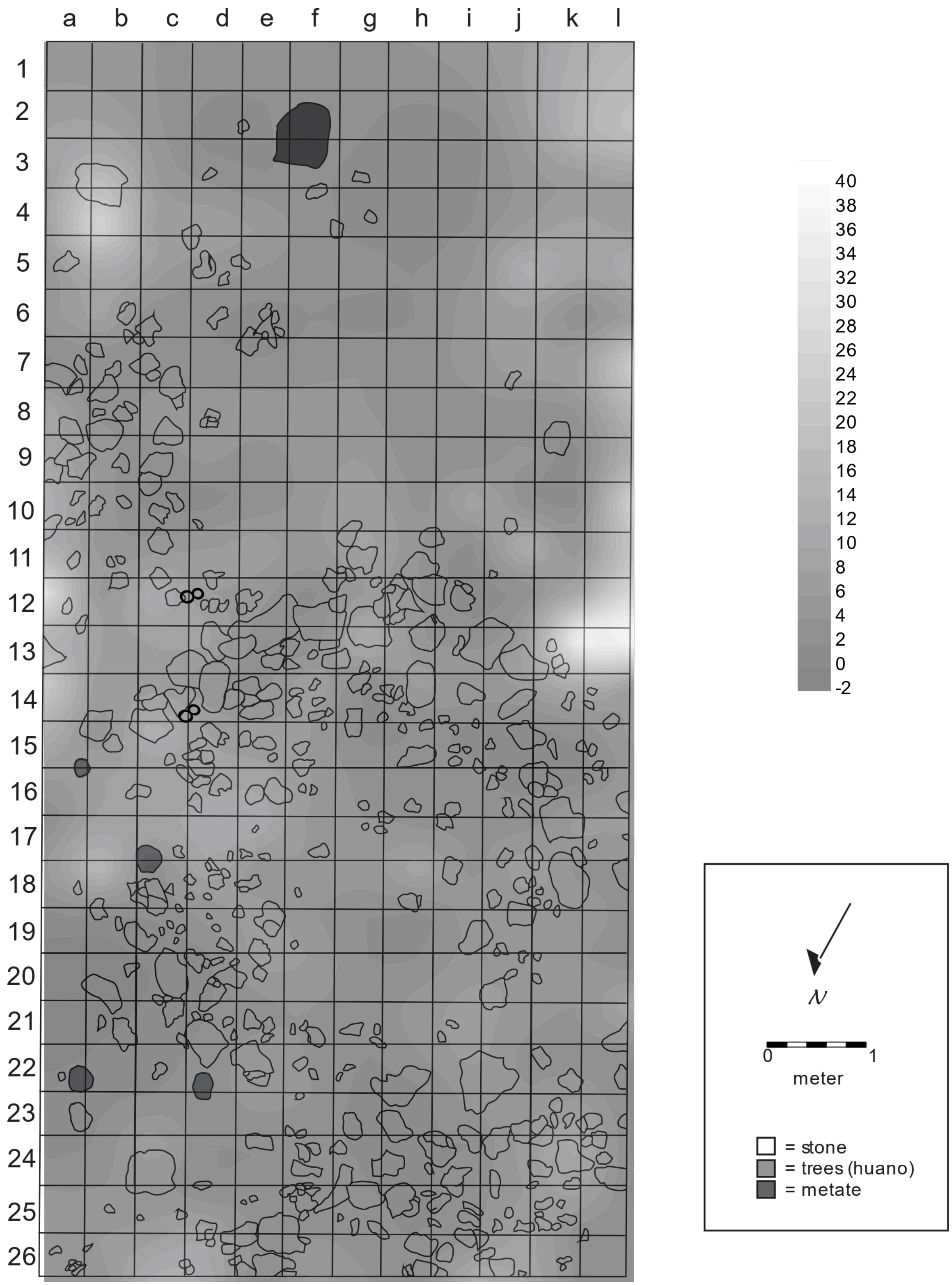


Figure 33. San Andres Norte Milpa, Operation 1, Ceramic Distribution

Figure 34. San Andres Norte Milpa, Operation 1, Structure N1W1-3, Profile at Suboperation 1j17 and 1j18

Fragments found outside the structure wall were less numerous and generally thicker (~1.5cm) and presented some curved surfaces, although some thinner pieces were also present (Figure 36). When all of the stucco pieces were analyzed, there did not appear to be any distinct groups by thickness, however (Figure 37). The quantity of stucco present implies some sort of stucco coating on at least portions of the wall, whether on its vertical face or capping the stone portion of the wall itself.

As suboperations progressed to the south, away from the foundation brace, little to no stucco was found, strengthening the association between the stucco and Structure N1W1-3. The effort and expense to produce this stucco is unexpected for a relatively simple structure thought to pertain to a time when much of the region was abandoned. It is also at odds with the relatively sparse material cultural remains found associated with the structure, although its relatively cleanliness may relate to the structure's function or the personal habits of those who occupied it. The paucity of artifacts may also be related to the fact that, unlike examples from other sites, such as Sisal or San Andres, there is also no monumental or even moderately large architecture nearby from which the material remains of relatively high-status individuals might have been conveniently culled.

Although the surface remains implied that Structure N1W1-3's entrance faced the small mound immediately to its northeast, as Level 1, Lot 1 was removed, it became evident that wall collapse was also present here and the entrance seemed to face its possibly contemporaneous neighbor, Structure N1W1-4, to the northwest, across a natural depression between the two outcrops. Additionally, the *albarrada* visible to the east of Structure N1W1-3 on the surface was observed to north, east, and west of the foundation brace, yet not encircling it in its entirely with the flat zone including the *metate* left unenclosed. This may be because the *albarrada* was unfinished, a southern component was deemed unnecessary because of other perishable features in this vicinity, or it only was required to provide privacy along the round structure's frontal approach.

Figure 35. San Andres Norte Milpa, Operation 1, Structure N1W1-3,
Excavation of Row "F" to *Metate*

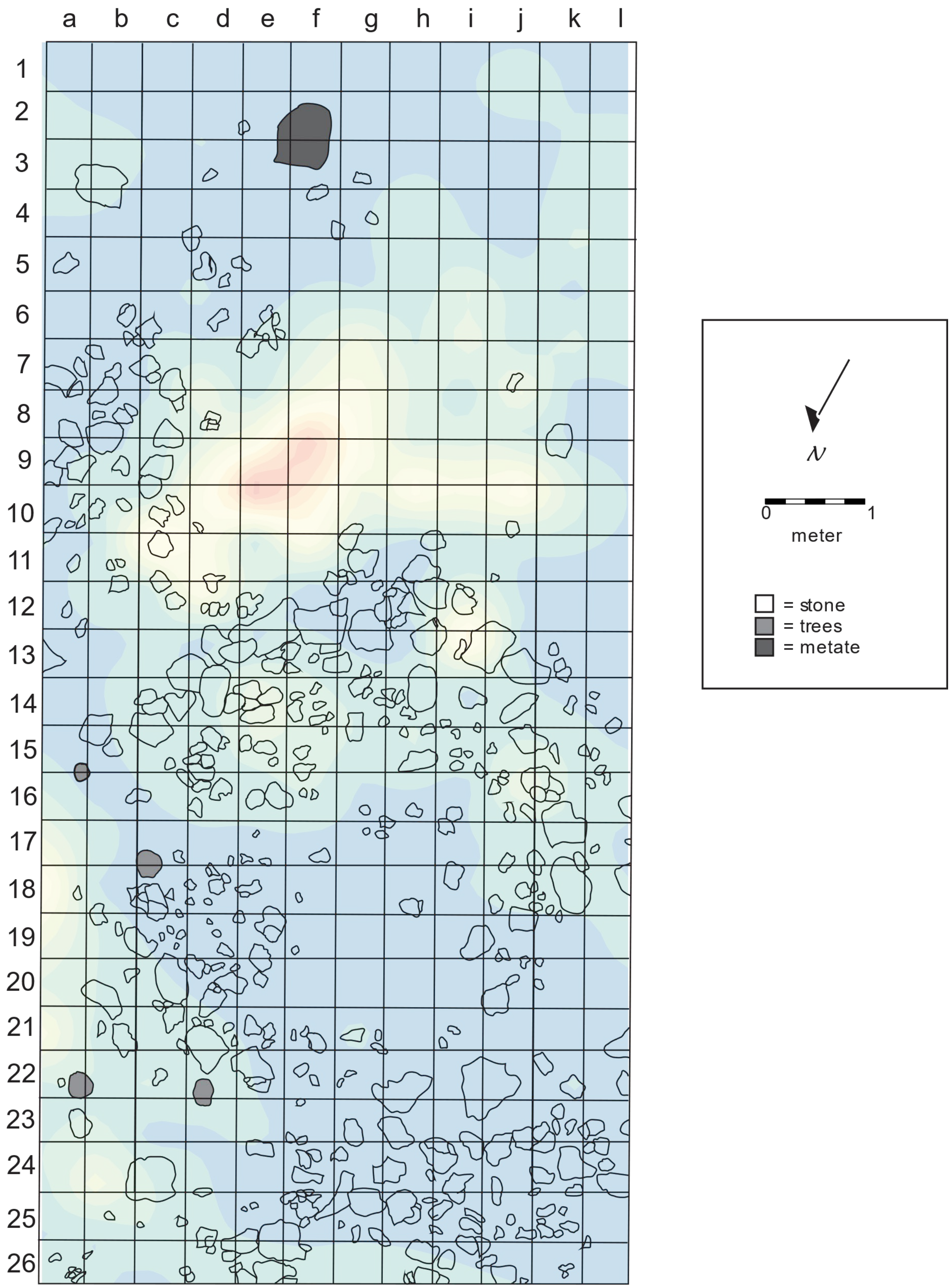


Figure 36. San Andres Norte Milpa, Operation 1, Structure N1W1-3, Distribution of Stucco by Weight in Grams

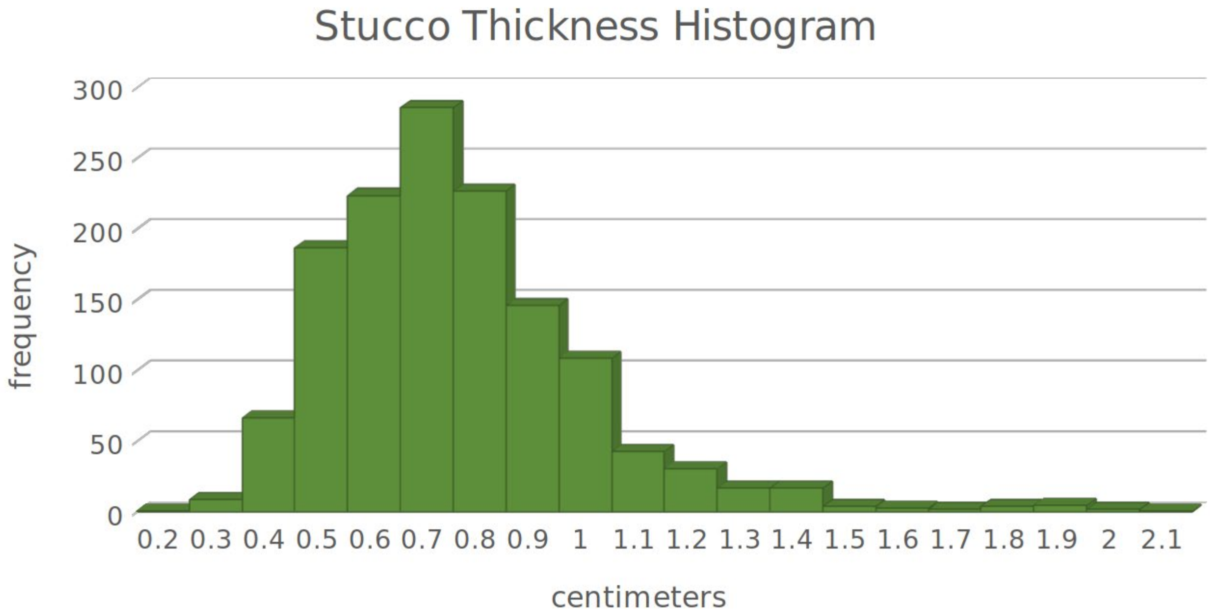


Figure 37. Histogram of Stucco Thickness from San Andres Norte Milpa Operation 1

The pattern of stucco concentration (Figure 38) correlated with a zone of greater collapse debris immediately to the south of the structure; another elevated stucco concentration in the northeastern portion of the operation likely related to material that came from the adjacent small mound. However, the elevated stucco and stone that appear to have come from the southern end of the structure indicate that this rear wall may have been higher than the front wall that includes a northern entrance.

It was hypothesized that the paucity of collapse debris in this frontal portion of the structure could relate to stone reuse for an adjacent later *albarrada*. If this were the case though, the stucco itself should have still been in place in a relatively equal amount, which it clearly was not.

Although the initial excavation only extended to row 24, as the row excavations proceeded northward, two more rows were added (1a25-1l25 and 1a26-1l26) in order to more fully capture the collapse of the structure's northern edge. This made it more possible to compare the amount of collapse from the structure walls to better ascertain its original form.

Level 1, Lot 2 constituted the material present below the collapse debris, stones that were no longer *in situ*, and contained the same fill as Level 1, Lot 1. Once removed, the round nature of Structure N1W1-3 was more evident (Figure 38). However, its original entrance was still not clear because several of its primary large foundation stones had been moved to nearby locations. These rocks had been rolled to form part of an *albarrada* that ran immediately north of the structure, continuing over the small mound to its immediate northwest.

Another *albarrada* had been built on the foundation brace's eastern edge, continuing beyond the structure to the south. It was first thought that these were associated with Structure N1W1-3, in a manner like that seen in some historic and modern traditional Maya houses (Figure 39). The destruction of part of the structure's wall to build the northern *albarrada*, with some of the second course of stones perhaps incorporated into the eastern *albarrada*, makes this explanation seem to be less likely. Instead, in a region and localized zone, with focused Caste War activity, the *albarradas* that post-date the most recent habitation in this part of San Andres Norte Milpa could be fortifications. A network of *albarrada* enclosures associated with this conflict has been observed elsewhere in San Andres (Flores, personal communication).

Additional soil samples were taken from the base of Level 1, Lot 2, as these were the most protected from modern contamination; where present these were analyzed *in lieu* of Level 1, Lot 1 for this reason. Thicker stucco fragments in this layer may be submitted for radiocarbon dating; however, their thick yet flat nature differed from other interior fragments, indicating that they could relate to the surface of the platform that pre-dates the round structure. This would date the earlier Classic remains including the adjacent small mounds, rather than the round structure itself.

Other fragments more clearly associated with Structure N1W1-3 could potentially date the round structure itself if the prolonged exposure to leaching rain has not contaminated the radiocarbon dates with significantly earlier limestone inclusions. Level 1, Lot 2 was concluded upon the same occupation surface as Level 1, Lot 1, at depths ranging from 7-39cm below the modern ground surface (Figures 40).

Ceramics from San Andres Norte Milpa Operation 1 were predominantly Terminal Classic, with Muna Slate and Yokat Striated dominating the types present. Interestingly, although the entire site consists of low-density, small foundation braces dispersed atop hillocks, its interspersed relatively deep soil between the rocky outcrops seems to have remained attractive to settlement for quite a long time, with sherds representing every period from the Middle Formative to a sparse Postclassic were present.

As with most small sites, however, its Early and Late Classic use was much less common than prior and later periods; population seems to have largely contracted to the larger sites in the region during these middle periods. The presence of any ceramics from the Early and Late Classic may represent vessels brought to agricultural fields for daytime work or short stays during particularly labor-intensive portions of preparing fields, planting, or harvesting.

Once the *in situ* remains and *albarradas* were documented with traditional mapping, digital ground-based photography, and sequences of aerial drone photographs for photogrammetric purposes (Figures 41), the foundation brace was consolidated. This involved cleaning any remaining material from between the *in situ* stones and the insertion of mortar to stabilize the structure (Figure 42). The entire excavation was then backfilled with all of the rocks and soil that had been removed, so that the consolidated structure was protected and the original modern surface level was restored (Figure 43).

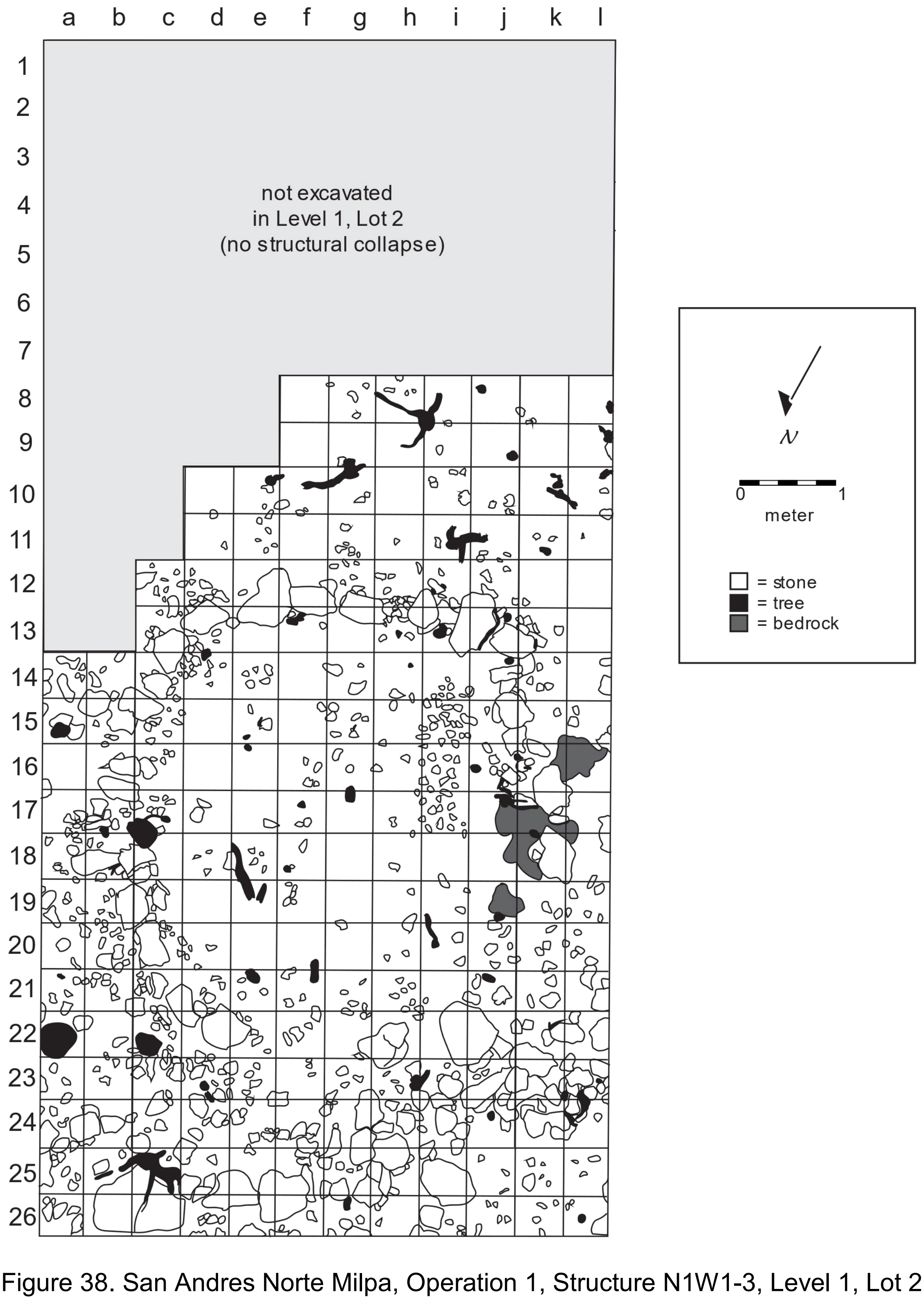


Figure 38. San Andres Norte Milpa, Operation 1, Structure N1W1-3, Level 1, Lot 2

Figure 39. Modern House in Sacalaca with Angled *Albarradas*
(photo by Alberto G. Flores Colin)

Consolidation

This process began with the cleaning of the sediment found between the joints of the stones that made up the foundations of the perishable structure. Once the stones that made up the foundation were completely cleaned, a mixture of lime and sascab in a 3 to 1 ratio, which is the recommended proportion in the conservation literature we follow in the project (Cedillo 1993:100-103; Cedillo et al. 1997), was started to be applied. Once the mixture was applied and after it had dried, a combination of lime and local sediment in equal proportions diluted in water was used to paint, creating a liquid mixture with which the joints of the consolidated stones were touched up to give them a more natural appearance. The objective of this consolidation was to stabilize the structure for better preservation and thereby ensure that the stones forming the foundation remained in their original position (Figures 44-45).

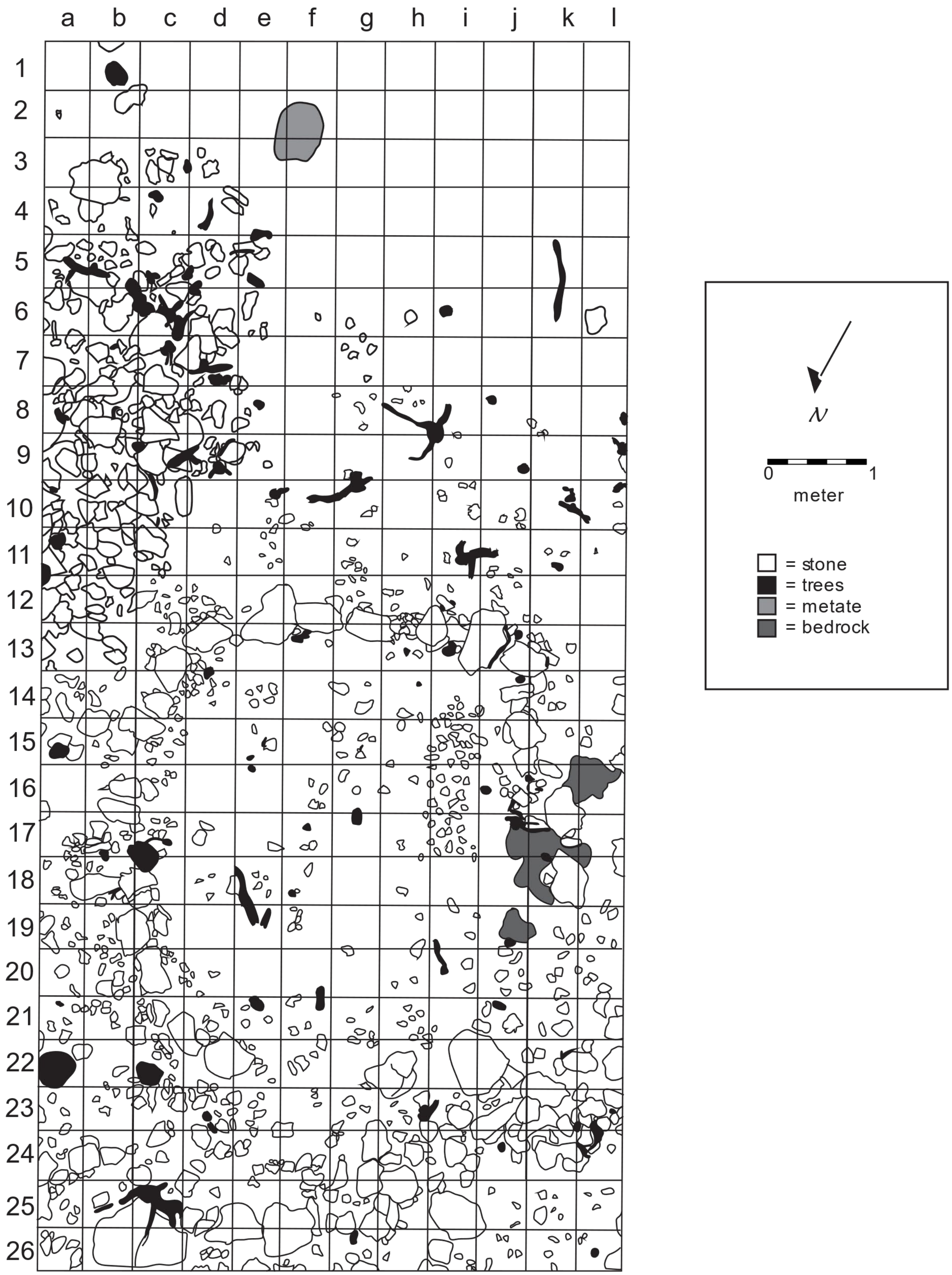


Figure 40. San Andres Norte Milpa, Operation 1, Structure N1W1-3, Completed Excavation Plan

Figure 41. Sacalaca, San Andres Norte Milpa, Operation 1, Photogrammetric View (with strings removed)

Figures 42. San Andres Norte Milpa, Operation 1, Structure N1W1-3,
Views from Drone (End of Excavation and Consolidated)

Figure 43. San Andres Norte Milpa, Operation 1, Structure N1W1-3,
Ground-level Photographs

Figure 44. San Andres Norte Milpa, Operation 1, Structure N1W1-3, Excavated and under Consolidation

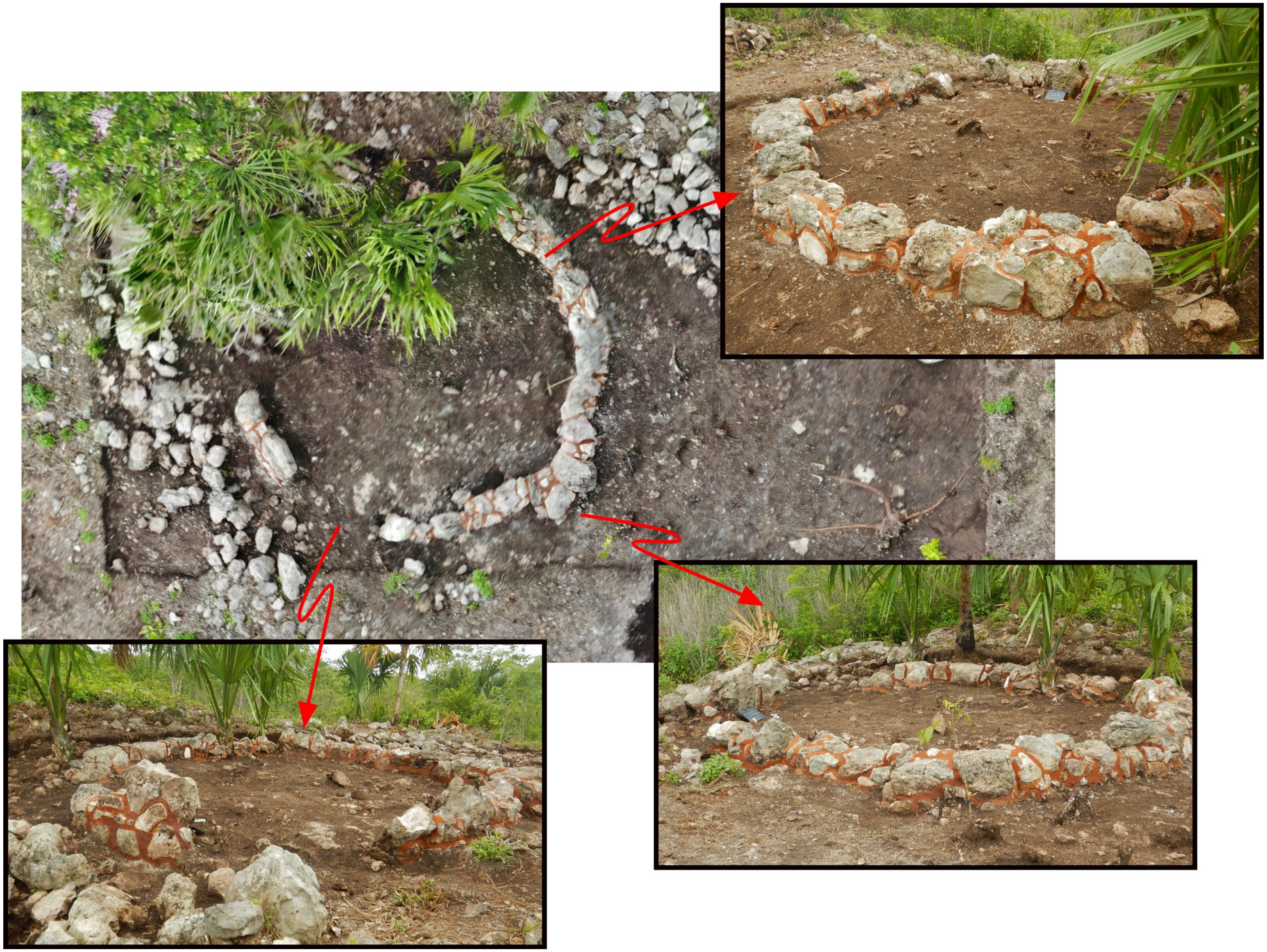


Figure 45. San Andres Norte Milpa, Operation 1, Structure N1W1-3, Consolidated

Part 2: Ejido of Sacalaca

Chapter 7. San Andres Norte Milpa, Operation 2, Structure N1W1-4

Justine M. Shaw

As with San Andres Norte Milpa's Operation 1 (Structure N1W1-3), Structure N1W1-4 (Operation 2) was mapped in 2019 but not able to be excavated until 2022 because of the pandemic. Located on an adjacent natural rise to the northwest of the platform Structure N1W1-7 (Figure 29), the structure is less perfectly round than that targeted in Operation 1; however, it is also not apsidal. Its imprecise form may be due to the movement of rocks following its abandonment. Atop this rise, it would be a pleasant location for those working in the deeper soils below to sit and enjoy a breeze, shifting the larger rocks composing the foundation brace into more comfortable positions.

Structure N1W1-4 also differs from the archetypical round foundation brace in that it contains several bedrock protrusions within its interior and bedrock protrusions were utilized as part of its wall (Figure 46). These extend to roughly the height of the rocks composing the foundation brace, which would have meant that even a roughly finished floor of *chich* or *sascab* would not have been possible throughout its interior.

However, the outcrops are concentrated in the northern portion of the interior, so they may have supported a specialized feature, elevated above the ground surface. Such a feature might have been a granary, bench composed of wood atop the relatively flat and similarly elevated bedrock, or another storage area that would have benefitted from being above the floor but still readily accessible. This interior bedrock differs from that of Parcela Escolar's Structure N10W1-2 that was excavated in 2014 (Johnstone et al. 2019), in which the bedrock protruded to a height well above that of the stones forming the foundation brace and the bedrock dominated the center of the structure, making it more likely to have been a dedicated granary or apiary.

As with other operations in this program of round structure excavation, the zone in and around Structure N1W1-4 was gridded off into 50x50-cm suboperations (Figure 47). Here, the excavation area was 7 m wide E-W and 10 m long N-S. Although there are clearly other features nearby, these dimensions were chosen to include both the smaller round feature and the flat intermediate zone that could have served as an activity area. Soil samples were collected from the center of each unit prior to excavation, with approximately 3cm of sediment moved aside before the collection of ~100 g samples.

The excavation of Level 1, Lot 1 began with some of the northern suboperations taken down to the base of the structure's stones that were not bedrock, with several rows progressing southward in order to try to maintain the same approximate depth; due to the amount of bedrock present and other large stones, the level ranged from 16 to 23 cm in depth.

Other suboperations were simultaneously excavated to the base of a retaining wall near the eastern edge of the operation; these were likewise excavated to base of the wall stones. The southern suboperations (south of row 16) contained a black (7.5YR 2.5/1) sediment, while units to the north had soil that was slightly lighter in color (7.5YR 2.5/2, very dark brown). Gravel and many cobbles, as well as varied unshaped rocks generally less than 25cm in size were present. It appeared that the natural bedrock outcrop had been intentionally filled with rock and some available sediment in order to level the area, with the retaining wall to the east containing the material. Bedrock was revealed in more units as Level 1, Lot 1 was removed.

As the excavation progressed, the round structure that seemed evidenced in ground and aerial photographs prior to excavation did not become any more apparent. However, there were more somewhat more ceramics and lithics in and around this portion of the operation. A bedrock outcrop on what might have been the southern end of the structure seemed to be the most obvious, if not only, potential portion of the foundation brace in that zone (Figures 48 and 49).

Rather than the clear, circular, formal shape detected in Operation 1 at this site, Structure N1W1-4 was more likely an informal construction, such as a field house, granary, or readily erected storage facility for something not requiring extensive protection. Additional soil samples were taken from the base of Level 1, Lot 1 in Suboperations 2f3 and 2f5, with hopes that additional analyses might be conducted to shed more light on the feature's function of the project's standard soil chemistry analyses were not revealing.

In the eastern and southern portions of the operation, what had appeared to be a retaining wall took on the form of part of an apsidal foundation brace, with its eastern wall more well preserved than its western side and only its southern curve remained. It seems to have predated the circular construction, potentially being partially dismantled for the latter's construction.

As with Operation 1, ceramics from San Andres Norte Milpa Operation 1 were predominantly Terminal Classic, with Muna Slate and Yokat Striated dominating the types present. Interestingly, although the entire site consists of low-density, small foundation braces dispersed atop hillocks, its interspersed relatively deep soil between the rocky outcrops seems to have remained attractive to settlement for quite a long time, with sherds representing every period from the Middle Formative to a sparse Postclassic were present.

As with most small sites, however, its Early and Late Classic use was much less common than prior and later periods; population seems to have largely contracted to the larger sites in the region during these middle periods. The presence of any ceramics from the Early and Late Classic may represent vessels brought to agricultural fields for daytime work or short stays during particularly labor-intensive portions of preparing fields, planting, or harvesting.

Consolidation

The process commenced with the removal of sediment located between the joints of the stones constituting the foundations of the apse wall and the structural stones. Upon completion of this process, a mixture of lime and sascab was applied in a 3:1 ratio, as advised in the conservation literature referenced in the project (Cedillo 1993:100-103; Cedillo et al. 1997). After the mixture was applied and dried, a solution of lime and adjacent sediment in equal quantities, diluted in water, was utilized for painting, thereby enhancing the joints of the consolidated stones to get a more natural appearance. The aim of this consolidation was to stabilize the building for improved preservation, so ensuring that the stones comprising the foundation remained in its original position

(Figure 50). Upon completion, the entire operation was backfilled to its original elevation (Figure 51).

Figure 46. San Andres Norte Milpa, Operation 2, Structure N1W1-4, Photo Prior to Excavation

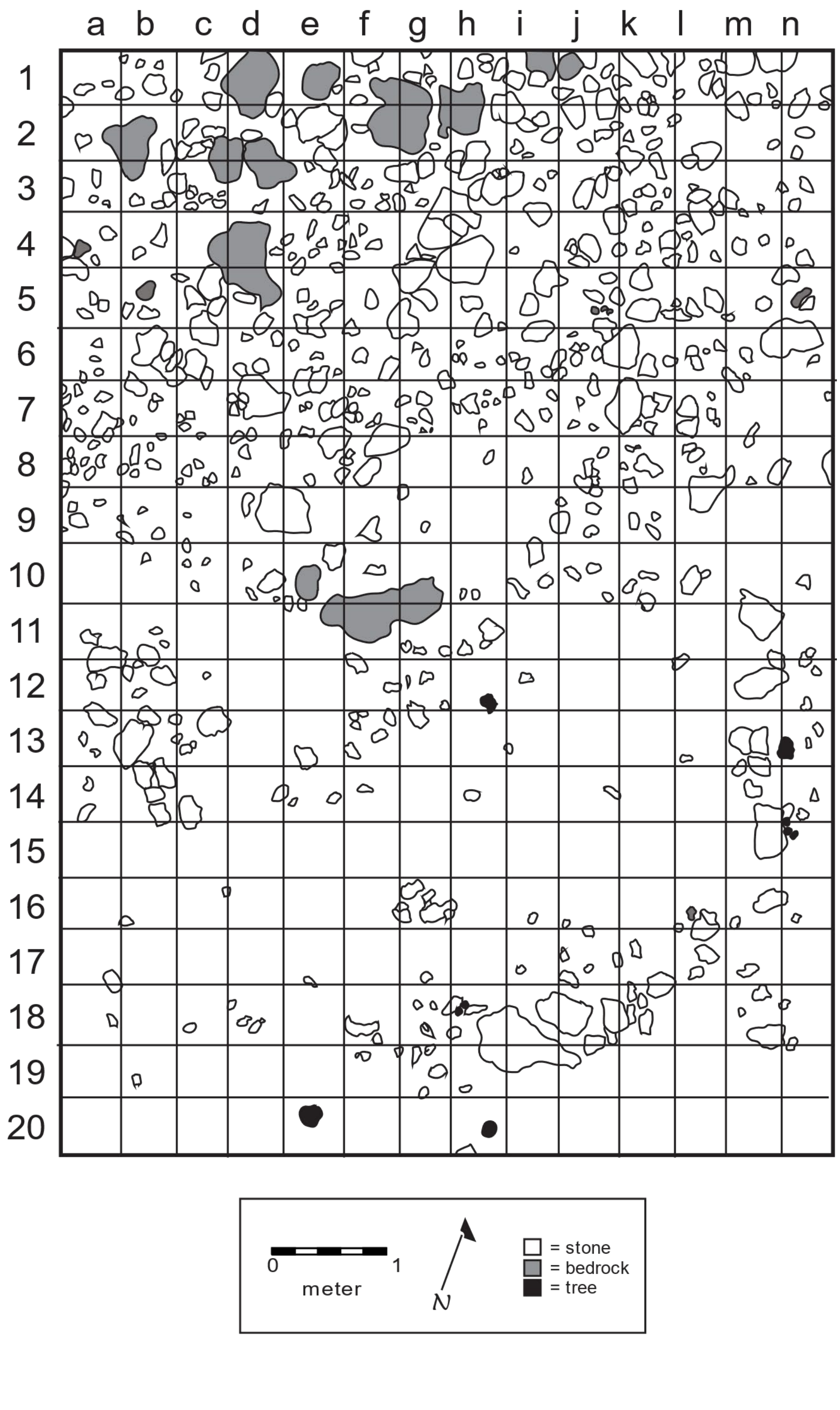


Figure 47. San Andres Norte Milpa, Operation 2, Structure N1W1-4, Plan Prior to Excavation

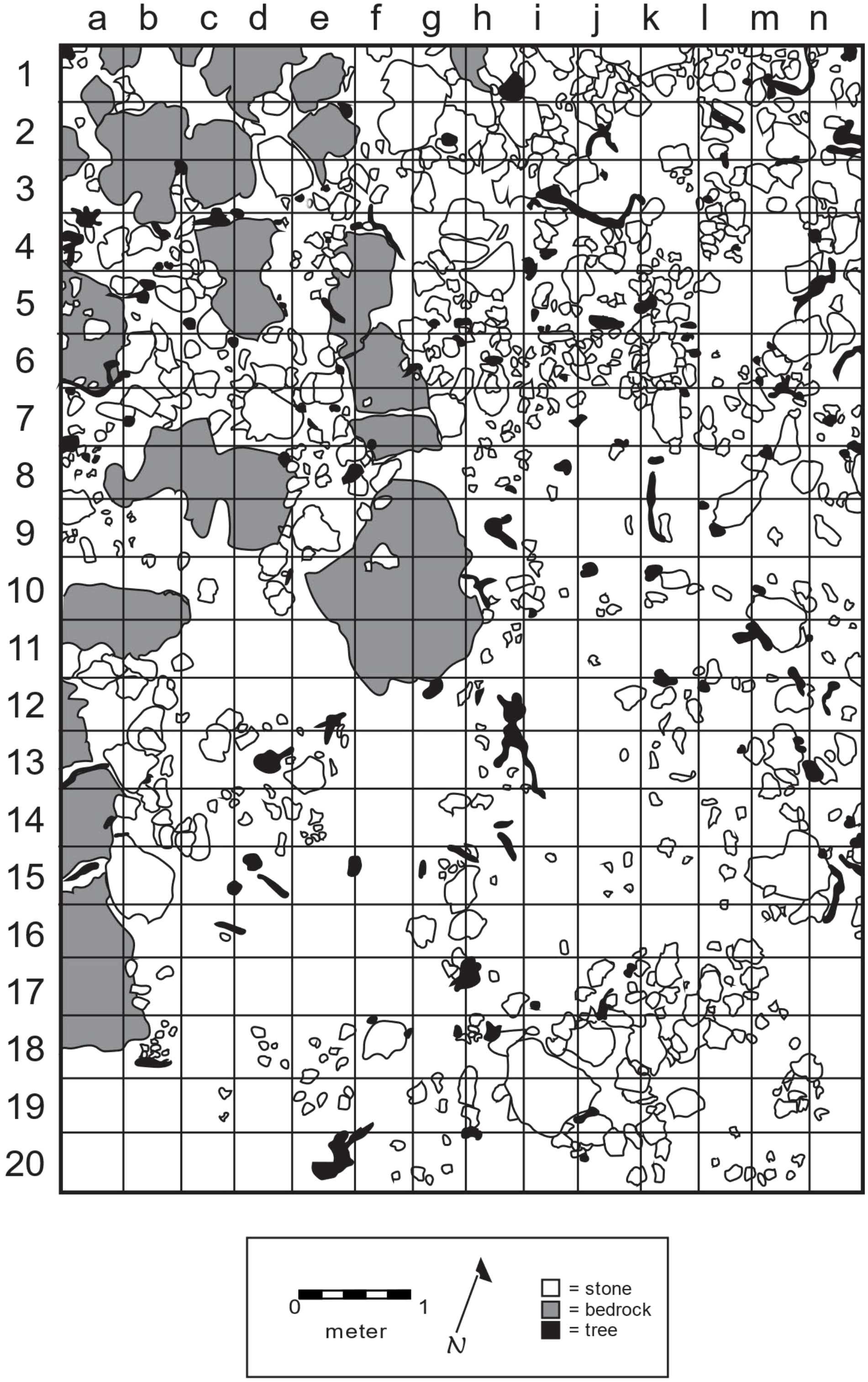


Figure 48. San Andres Norte Milpa, Operation 2, Plan of Level 1, Lot 1

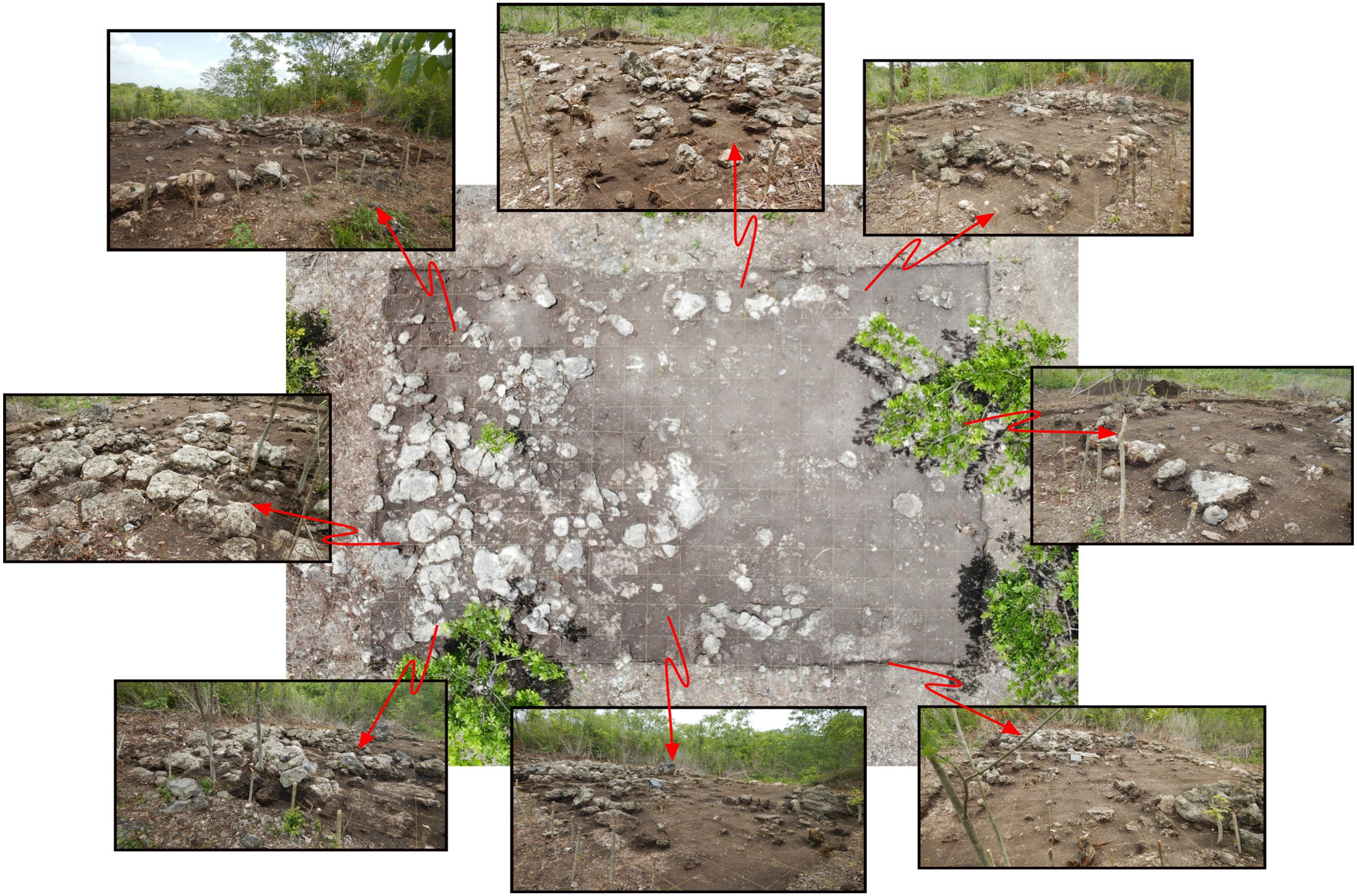


Figure 49. San Andres Norte Milpa, Operation 2, Structure N1W1-4, excavated

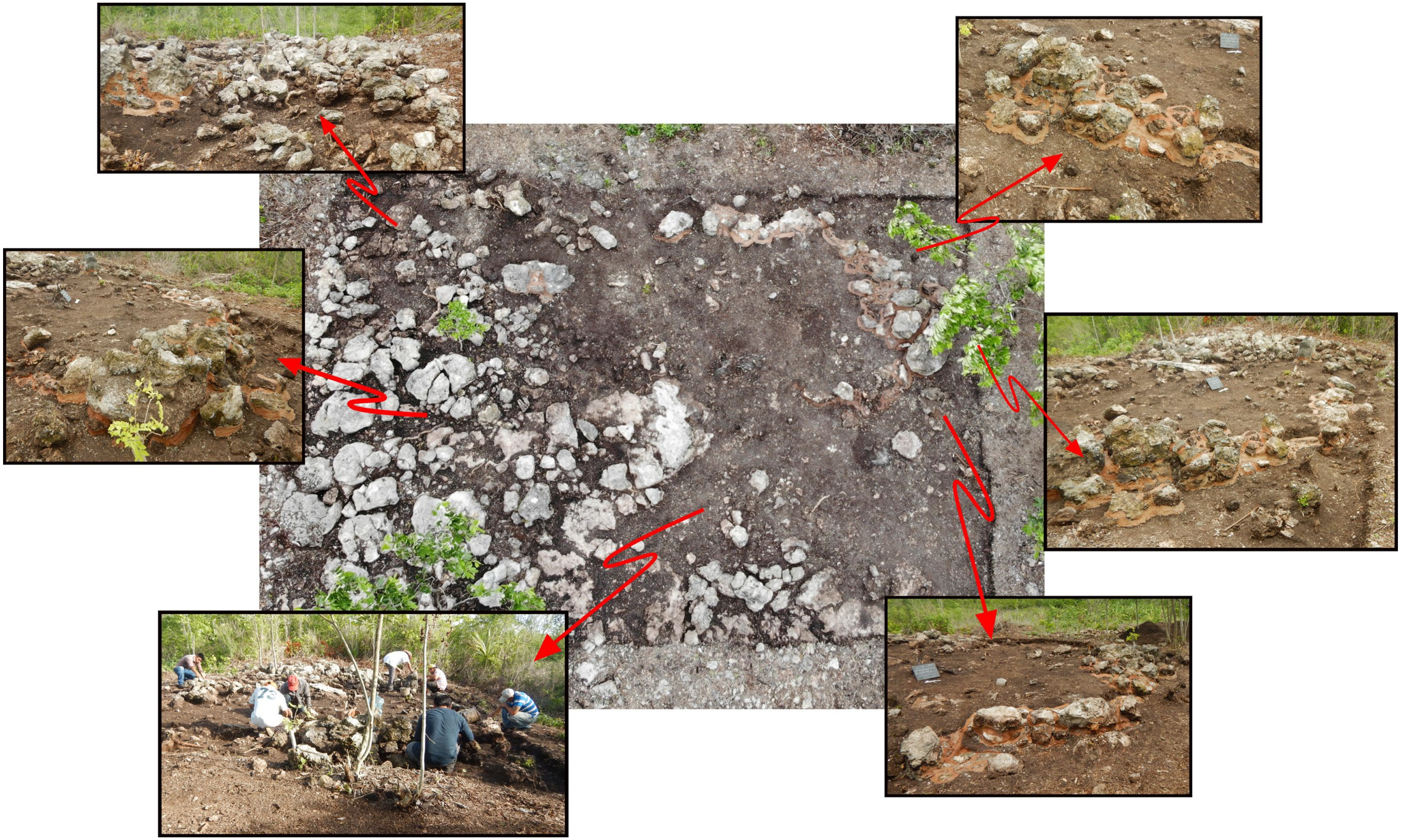


Figure 50. San Andres Norte Milpa, Operation 2, Structure N1W1-4, consolidated

Figure 51. San Andres Norte Milpa, Operation 2, backfilled

Part 2: Ejido of Sacalaca

Chapter 8: San Andres Norte Milpa, Operation 3

Thania E. Ibarra

Operation 3 comprised a 2 × 2 m pit situated between Structures N1W1-3 and N1W1-4, where were Operations 1 and 2. The aim of this operation was to gather and record materials from the collapse of Structure N1W1-3, as part of Operation 1 (see to Figure 28). The excavation was carried out using an arbitrary system of 10 and 20 cm, as needed. To begin the excavation, the secondary vegetation that predominated in the area was first cleared (Figures 52 and 53).

No archaeological material or stone potentially associated with any construction was identified on the surface. The decision was made to proceed with Level 1, Lot 1, characterized by humus soil that is slightly clayey and loose, with a Munsell color of 2.5YR 3/1 (dark reddish gray) and containing a substantial amount of organic material. Additionally, unarranged tiny boulders measuring less than 10 cm were detected (Figure 54). This layer contains ceramic materials from the Joventud group (Joventud red type), Muna group (Muna slate type), and Chum group (Yokat striated type), which dated to the Middle Preclassic (600-300 B.C.) and Late Terminal Classic (600-1050 A.D.), thereby establishing its chronology as Late Terminal Classic.

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The designation was changed to Level 2, Lot 1 due to a noted shift in soil color, transitioning to a more reddish hue (5YR 3/3 dark reddish brown) and exhibiting a clayey texture, alongside the emergence of tiny limestone boulders typically located above the bedrock. The thickness of this layer was 20 cm, and it was determined to change the lot arbitrarily, as the soil exhibited uniform color and texture (Figure 56). Minimal ceramic material has been found, primarily from the Middle Preclassic and Late Preclassic periods.

Level 2, Lot 2 consisted of uniform soil, identical in both hue and texture. This stratum measured 20 cm in depth and, in the absence of ceramic artifacts, was determined culturally sterile, marking the conclusion of the excavation and the final layer examined. The bedrock was discovered in the eastern half of the unit, along with several small stones (Figures 57-59). The minor ceramic sample discovered at the beginning of this level has been dated to the Middle Preclassic and Late Preclassic periods.

The excavation unit was subsequently filled with the excavated and filtered material, thereby concluding the activities of this operation (Figure 60).

Interpretation

The objective of the test pit, intended to ascertain the collapse or possible debris from Structure N1W1-3, was dismissed during the excavation. No construction materials were identified, indicating their nonexistence in this area. The pottery evidence indicates two separate occupations: one from the Middle Preclassic and Late Preclassic (Level 2), and another from the Late-Terminal Classic, corresponding to Level 1. No cultural elements were discerned in the unit, resulting in the determination that this portion of the site was natural terrain.

Figure 52. San Andres Norte Milpa, Operation 3, Surface, beginning of the excavation

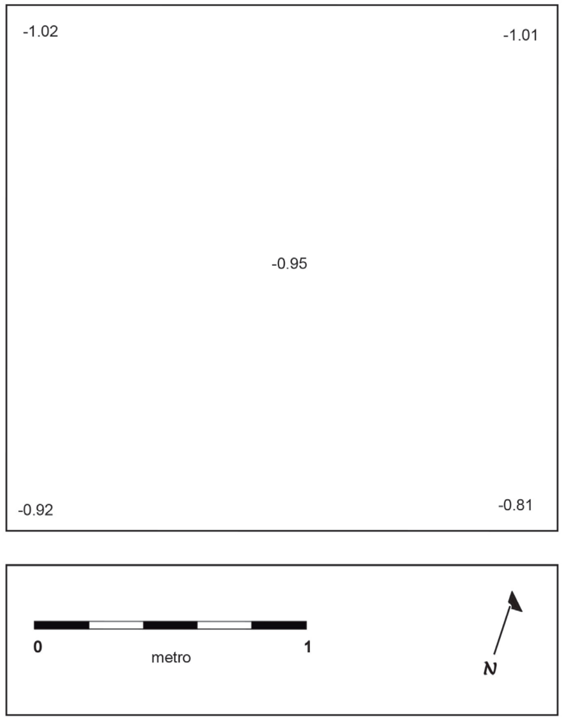


Figure 53. San Andres Norte Milpa, Operation 3, Surface, plan map.

Figure 54. San Andres Norte Milpa, Operation 3, End of Level 1 Lot 1.

Figure 55. San Andres Norte Milpa, Operation 3, End of Level 1 Lot 2.

Figure 56. San Andres Norte Milpa, Operation 3, End of Level 2 Lot 1.

Figure 57. San Andres Norte Milpa, Operation 3, End of Level 2, Lot 2 and the excavation.

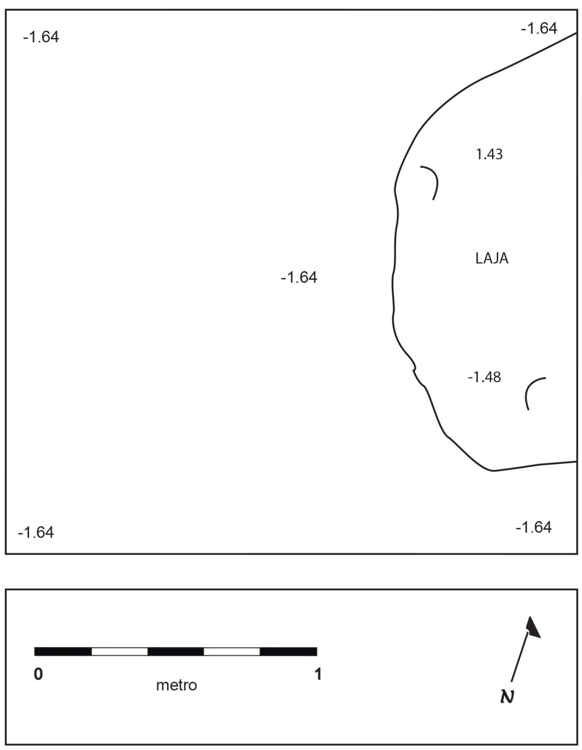


Figure 58. San Andres Norte Milpa, Operation 3, Level 2, Lot 2, plan map.

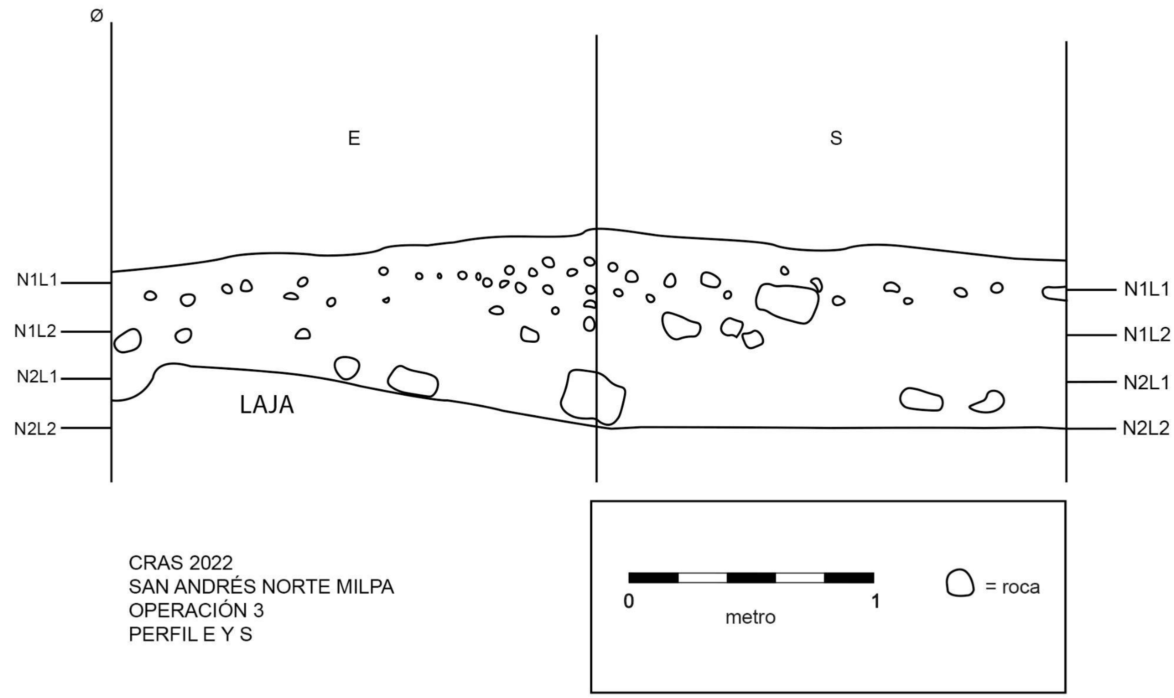


Figure 59. San Andres Norte Milpa, Operation 3, East and South profiles.

Figure 60. San Andres Norte Milpa, Operation 3, Backfilled.

Part 2: Ejido of Sacalaca

Chapter 9: San Andres Norte Milpa, Operation 4

Marina Noh Figueroa

Operation 4 at the San Andres Norte Milpa site consisted of a 2×2-m stratigraphic pit, located on the lower southwest slope of Operation 1, linked to Structure N1W1-3 (Figure 28). The fundamental objective of this excavation is to recover ceramic artifacts potentially originating from the upper portion, where Structure N1W1-3 is situated, and to determine the existence of any cultural surface in this area (Figure 28).

The northern side of the pit was designated as Lot 1, as it exhibited a slope due to its position at the terminus of the natural hillside, hence designating the southern side as Lot 2, which corresponds to the lower elevation.

In Level 1, Lot 1 had a depth of around 20 cm, concluding when encountering the bedrock. This lot comprised organic soil characterized by a soft texture, occasional gravel, and a dark brown coloration (7.5YR 2.5/2 very dark brown). The retrieved ceramic artifacts encompass sherds from the Middle Preclassic (600-300 B.C.) to the Late Terminal Classic (A.D. 600-1050), with the Muna group (Muna slate variety Muna) and the Chum group (Yokat striated variety Yokat) serving as the most illustrative examples. The predominant forms recognized from these ceramic sherds are pots and bowls.

Level 1, Lot 2, concluded approximately 30 cm beneath the surface, revealing a more substantial accumulation of stones, roughly 10-5 cm thick, however intermingled with the same sediment type as the preceding lot. The quantity of pottery recovered was limited (28 pieces), spanning from the Middle Preclassic (600-300 B.C.) to the Late-Terminal Classic (A.D. 600-1050), with the later era being the most predominant.

Interpretation

The excavation of Operation 4 uncovered the identical two periods of habitation recognized in the preceding stratigraphic strata. Owing to its location at the base of a slope, it was presumed to be a refuse site; however, the remnants were inadequate to substantiate this presumption. All material remnants originate from the overflow of the upper section of the hill where Structure N1W1-3 is situated.

The pottery groups with the most significant presence were Joventud (Preclassic), Muna, and Chum (Late-Terminal Classic, A.D. 600-1050). This information suggests prolonged occupation at the site; yet, the absence of artifacts from the Early Classic period heightens the likelihood of intermittent occupation.

Figure 61. San Andres Norte Milpa, Operation 4, Surface.

Figure 62. San Andres Norte Milpa, Operation 4, Level 1, Lot 1.

Figure 63. San Andres Norte Milpa, Operation 4, Level 1, Lot 2.

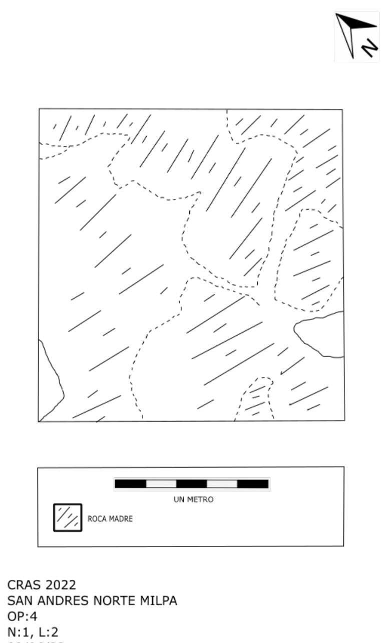


Figure 64. San Andres Norte Milpa, Operation 4, plan map.

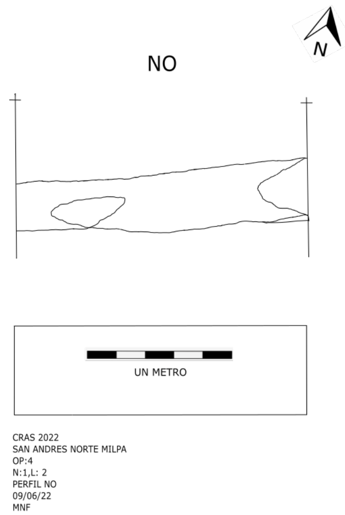


Figure 65. San Andres Norte Milpa, Operation 4, profile.

Figure 66. San Andres Norte Milpa, Operation 4, Backfilled.

Part 2: Ejido of Sacalaca

Chapter 10. San Andres Norte Milpa, Operation 5

Marina Noh Figueroa

Operation 5 comprised a test pit of 2 × 2 meters, situated to the southeast of Operation 1 (Structure N1W1-3), aimed at locating ceramic artifacts to assist in identifying the site's occupations (see Figure 28). Operation 5 comprised a test pit of 2 × 2 meters, situated to the southeast of Operation 1 (Structure N1W1-3), aimed at locating ceramic artifacts to assist in identifying the site's occupations (see Figure 28).

Following the surface cleaning and removal of leaf litter, Level 1, Lot 1 was dug, revealing a dark brown sediment (7.5 YR 2.5/2 very dark brown) with a soft texture, containing pebbles and few stones approximately 3-5 cm deep (Figures 67 and 68). This level yielded a scant quantity of ceramic artifacts (about 12 sherds), dating to the Late-Terminal Classic period (AD 600-1050), predominantly from the Chum group, specifically of the Yokat striated type, variety Yokat.

At a depth of around 20-30 cm, it was necessary to change the lot due to minor variations in the soil and an increased prevalence of gravel and stones. In Level 1, Lot 2 (Figure 69), a limited quantity of ceramic artifacts was recovered, corresponding to the Late-Terminal Classic period (AD 600-1050). This lot had a dark reddish-brown hue (5YR 2.5/2 dark reddish brown). The bedrock was situated approximately 40 cm deep on the northeast side, however on the southwest side, the slab is considerably deeper owing to the natural incline of the soil.

The test pit was finalized with the discovery of bedrock across the unit (Figures 70-71). Upon logging the unit, the test pit was backfilled with the same material that had been withdrawn (Figure 72).

Interpretation

In Operation 5, it indicated a natural deposition, as no cultural stratum was observed. Minimal ceramic artifacts were recovered, suggesting limited cultural activity in the region. Nevertheless, the limited ceramic artifacts recovered date to the Late-Terminal Classic period (AD 600-1050), with the Chum group, of the Yokat Striated type of the Yokat variety, being the most prevalent. The pots are the predominant form identified.

Figure 67. San Andres Norte Milpa, Operation 5, Surface.

Figure 68. San Andres Norte Milpa, Operation 5, Level 1, Lot 1

Figure 69. San Andres Norte Milpa, Operation 5, Level 1, Lot 2

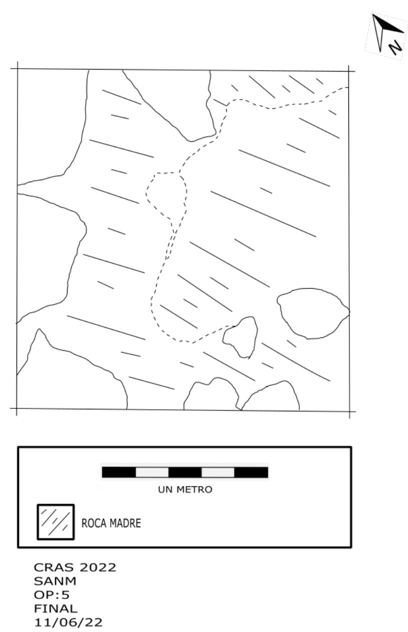


Figure 70. San Andres Norte Milpa, Operation 5, plan map

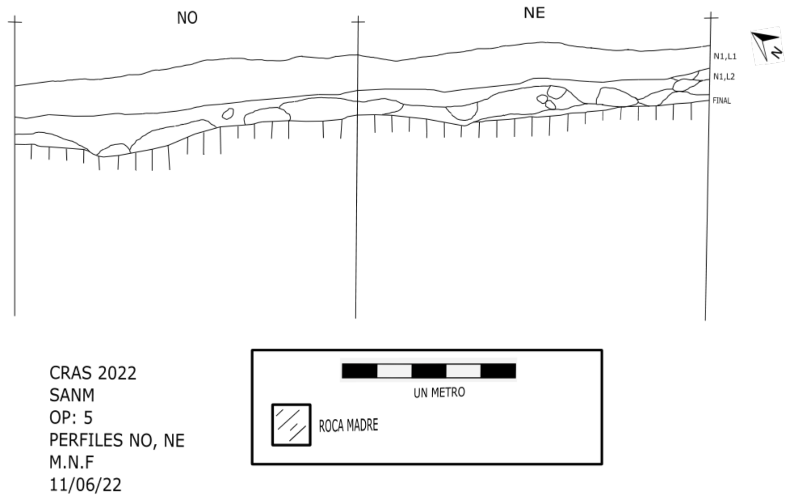


Figure 71. San Andres Norte Milpa, Operation 5, profiles

Figure 72. San Andres Norte Milpa, Operation 5, Backfilled

Part 2: Ejido of Sacalaca

Chapter 11: San Isidro Yodzonot, Operation 3

Thania Ibarra

Operation 3 was a 2x2-m test pit intended to determine the chronological sequence of the site, particularly regarding Structure N1W2-1 (Figure 73). The excavation unit was situated outside a stone alignment at the northern base of the structure, aligned at 108º east, so this axis was employed to orient the test pit. The excavation method employed cultural stratification, using a trowel to remove the soil.

The surface was initially cleaned due to the presence of substantial vegetation and organic matter (Figure 74). Upon clearing the area, the excavation unit was defined (Figure 75). No archaeological artifacts were discovered on the surface; hence, excavation of Level 1 Lot 1 commenced. The soil had a dark brown hue (10YR 2/2 extremely dark brown) and has a clayey texture. A further arrangement of unrefined stones was discovered along the same axis as those previously identified from the surface, in a tiered configuration. Consequently, this area was partitioned and assigned as Level 1, Lot 2. The rocks measured between 30 and 40 cm. The recovered ceramics date to the Middle Preclassic period, featuring specimens from the Joventud and Dzudzuquil groups, including several pot and bowl shapes (Figure 76).

The rest of the well was excavated as Level 1, Lot 2, corresponding to the northern region. No large stones were discovered in this lot, leading to the conclusion that this would be the exterior of Structure N1W2-1. The soil's hue and texture resembled those of Level 1, Lot 1 (10YR 2/2 extremely dark brown) and exhibited a clayey consistency. Ceramic artifacts from the Middle and Late Preclassic periods were recovered and associated with groups such as Joventud and Saban (Figure 77).

Following that, the excavation of Level 2 persisted, revealing parts devoid of rocks within the unit. Consequently, it was partitioned into two lots, Level 2, Lot 1 and Level 2, Lot 2, to enhance the management of potential staircase. At Level 2, Lot 1, 10 cm were excavated until the staircase rocks were exposed, which were part of the same formation as those previously exposed. The soil showed a clayey texture and a dark brown hue (10YR 2/2 extremely dark brown). The recovered ceramic artifacts were from the Middle Preclassic and Late-Terminal Classic periods.

The area identified as Level 2, Lot 2 was excavated until the rocks were exposed. These boulders appear to be associated with a potentially deteriorated step or may constitute the fill of a substructure or the plaza beneath which Structure N1W2-1 is situated. The soil had a clayey texture and a dark brown hue (10YR 2/2 extremely dark brown). The recovered ceramic artifacts were likewise from the Middle and Late Preclassic periods.

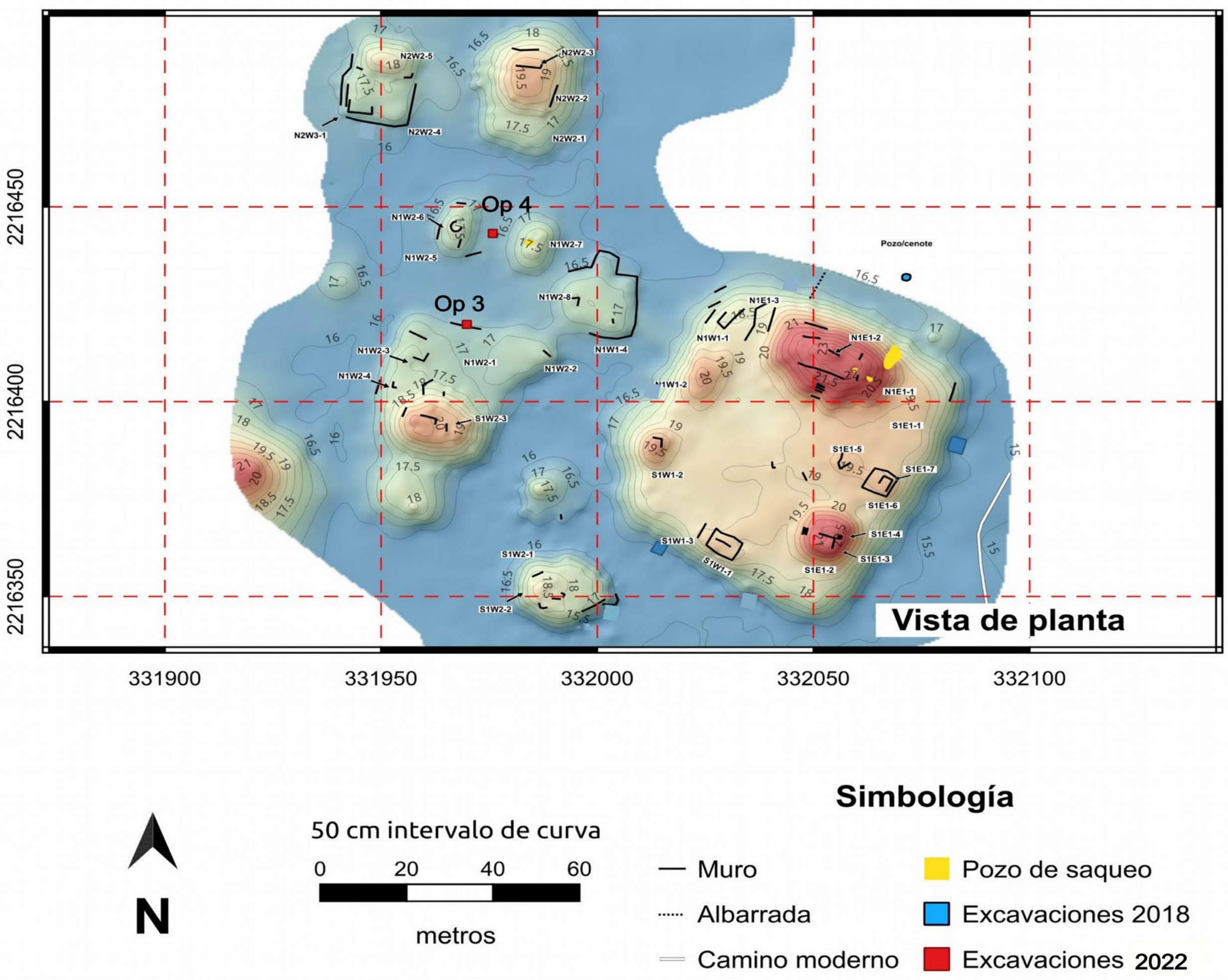


Figure 73. San Isidro Yodzonot, Location of the excavations

Given the assumption that we could be outside of Structure N1W2-1, it had been decided to expand the excavation unit by one meter to the north to achieve improved definition of the element and enhanced control of the unit. This extension was designated Operation 3B (Figure 78).

Level 1, Lot 1 consisted of clay-textured soil exhibiting a dark brown hue (10YR 2/2 extremely dark brown), mixed with organic matter. This lot's ceramic material is attributed to the Middle and Late Preclassic periods, featuring pieces from the Sierra, Saban, Dzudzuquil, and Joventud groups. Because of the noted change in the soil's color and texture, which had become increasingly clayey and somewhat reddish, a decision was made to change the levels. This coincided with the emergence of several medium-sized rocks, approximately 20 to 30 cm.

For the subsequent layer, Level 2, it was determined to partition the area into three sections owing to a potential circular aggregation of rocks. The area within the potential circle element was labeled as Level 2, Lot 3, whereas the two areas outside the potential circular element were labeled as Level 2, Lot 1 and Level 2, Lot 2 (Figure 79). No ceramic materials were retrieved from any of the Level 2 lots, except for a few very deteriorated sherds found in Lot 1, which could not be identified.

Upon completing the final stage of occupation and its subsequent exposition, the excavation was finalized (Figures 80-82), and the structure recognized as a staircase was consolidated with a blend of lime, sascab, and earth (Figure 83). While cleaning the stairs, pottery artifacts from the Middle Preclassic period were discovered, suggesting its construction during that time. Once the excavation was completed, the unit was documented and subsequently backfilled with the original excavated soil (Figure 84).

Interpretation

The goal of excavating this unit was to get a stratigraphic sequence of the plaza adjacent to Structure N1W2-1 to determine the site's chronological sequence. Nonetheless, this was not totally feasible due to the presence of the staircase and maybe a substructure upon which Structure N1W2-1 is constructed. Another option is that it constitutes the plaza's fill; nevertheless, a more extensive excavation would be required to validate these hypotheses.

The majority of the excavated pottery artifacts were dated to the Middle and Late Preclassic periods, suggesting that the construction of Structure N1W2-1 likely occurred during this timeframe. The material recovered from what seems to be a stone accumulation north of the stairs, perhaps the plaza fill, was heavily eroded, making it impossible to assign a relative dating.

Material from the Late-Terminal Classic was detected alone in Level 2, Lot 1, but appears to have originated from an intrusion. Additional excavation of units is required to enhance comprehension of a potential early occupation within the settlement.

Figure 74. San Isidro Yodzonot, Operation 3, Cleaning of the area

Figure 75. San Isidro Yodzonot, Operation 3, Surface

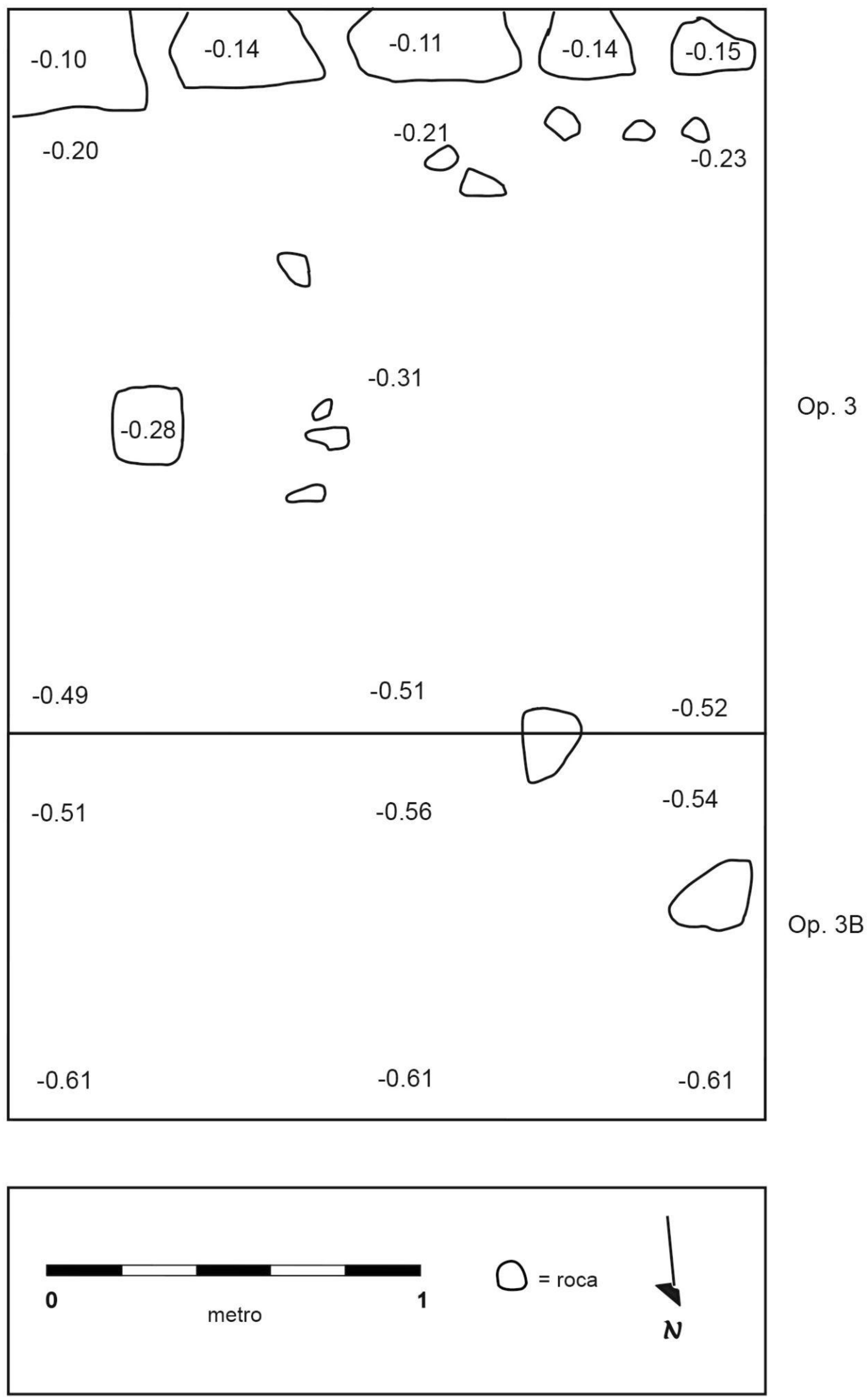


Figure 76. San Isidro Yodzonot, Operation 3 and 3b, Surface, plan map

Figure 77. San Isidro Yodzonot, Operation 3, End of Level 1, Lot 1.

Figure 78. San Isidro Yodzonot, Operation 3, End of Level 1, Lot 2.

Figure 79. San Isidro Yodzonot, Operation 3b, Surface.

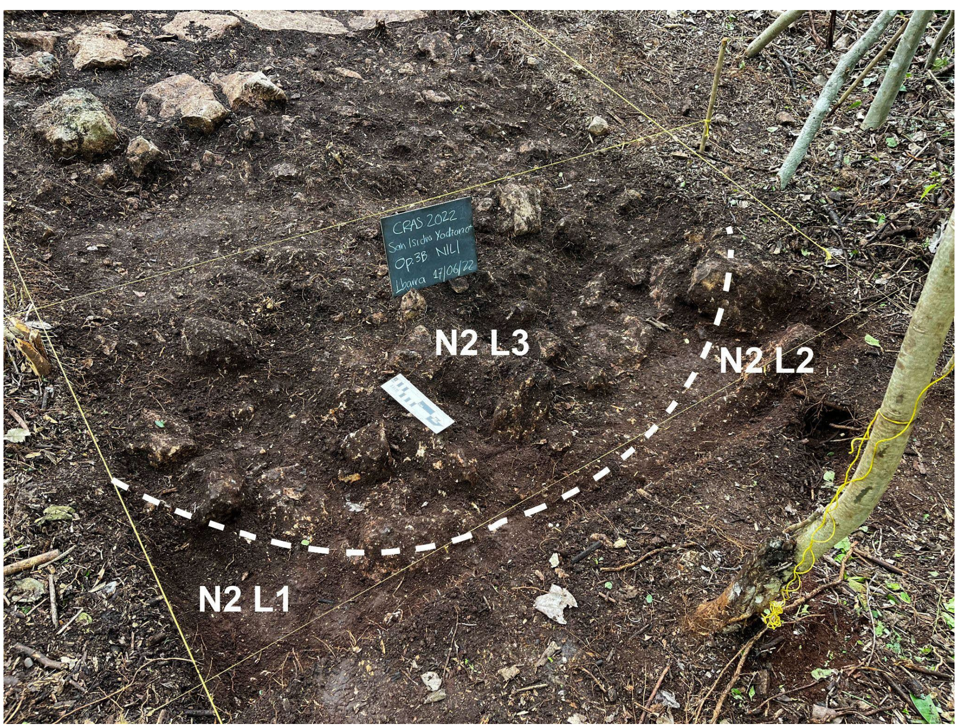


Figure 80. San Isidro Yodzonot, Operation 3, Level 2, Lots 1, 2, and

Figure 81. San Isidro Yodzonot, Operation 3 and 3b, End of excavation

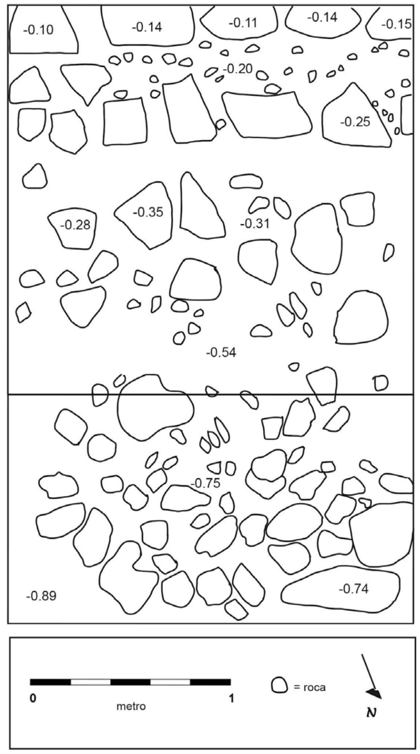


Figure 82. San Isidro Yodzonot, Operation 3, End of excavation, plan map

Figure 83. San Isidro Yodzonot, Operation 3, Stairway consolidated

Figure 84. San Isidro Yodzonot, Operation 3 and 3b, Backfilled

Part 2: Ejido of Sacalaca

Chapter 12. San Isidro Yodzonot, Operation 4

Alberto G. Flores Colin and Marina Noh Figueroa

The San Isidro Yodzonot site was discovered in 2018 and subsequently mapped in 2019 (Flores and Badillo 2018; Flores et al. 2019). During the registration duties, a ballgame configuration was identified, consisting of two parallel structures of identical dimensions (16 m) forming the sides, together with two constructions that constituted the ends of the court (see Figure 74). The configuration of the ballgame court appears to have been modified, potentially changing its function over time, as one end zone served as a platform for another structure that seems to have constructed during the Terminal Classic, along with several alignments crossing the sides in multiple directions (Figure 85). Therefore, it was resolved to excavate a test pit to ascertain the dating and construction sequence of this complex.

Level 1 consisted of the humus layer that covered the entire unit, characterized by a dark brown hue. A series of stones, approximately 20 x 30 cm in size, has emerged in this lot, likely resulting from the collapse of adjacent constructions. Consequently, it was determined to designate the area as Level 1, Lot 2 (Figures 86 and 87). After the removal of all of the stones from the excavated area, the persistent dark brown soil from Lot 1 was identified, which was dug as Lot 3 and extended several additional centimeters until an eroded surface floor was discovered across the unit (Figure 88).

The pottery recovered in Lots 1 and 2 were somewhat few, however numerous specimens from Middle Preclassic groups, including Saban and Joventud, were present, together with several sherds from the Late Preclassic period (Flor). The existence of fragments from the Late Terminal Classic, specifically from the Yokat striated and Muna slate groups, signifies that this Level 1, including the three lots, is related to this period.

The eroded floor was excavated as Level 2, Lot 1, consisting of deteriorated light brown stucco interspersed with gravel stones. The consistency was notably sandy, and after several centimeters excavated several stones of 10 cm in size, which constituted the base of the floor, became exposed (Figure 89). The stones were removed as Lots 2 and 3 of Level 2, consisting of stones and soil characterized by a brown hue and sandy texture (Figure 90). The ceramics discovered at this level comprised somewhat more than 50 fragments, representing a combination of groups from the Middle Preclassic, including Saban and Joventud, predominantly of the Dzudzuquil cream to reddish-brown variety.

At the conclusion of this Level 2, a second floor was identified, featuring well-preserved areas; nonetheless, numerous sections had experienced erosion due to roots and weathering. As a result, this Level 3 was divided into four lots. The initial lot was to the northeastern section of the excavation unit and consisted of a layer of plaster positioned just above Floor 2, possibly signifying a repaving or a floor that had experienced erosion and weathering (Figure 91). The layer measured around 3 to 5 cm in thickness, devoid of ceramic sherds or other cultural objects.

The second lot pertained specifically to Floor 2, which had well-preserved sections that maintained their polished surface (Figures 92 and 93). The floor consists of plaster with a thickness of 5-7 cm and a sandy texture. The pottery discovered in Lot 2 were extremely limited, comprising of two fragments of Saban unsliped type and Chunhinta Black. Lot 3 was a lot measuring approximately 30 x 15 cm, situated in the eastern section of the unit, possibly resulting from a root identified in Level 2, hence excluding the possibility of it being a post hole. Underneath the stucco floor, Level 3, Lot 4 (Figure 94) was uncovered, functioning as the basis of the floor, consisting of a series of stones measuring around 10 x 7 cm, mixed with a sediment of red soil and sand.

After the complete removal of Level 3, a stratum of red soil (Level 4, Lot 1), referred to locally as *chak luum*, was uncovered, representing the initial occupation surface of the area. Level 4 was dug several centimeters, revealing bedrock in the northeastern section sloping toward the west (Figure 95). In this section of the unit, approximately 40 cm were excavated until a well-compacted and culturally sterile sediment was encountered, at which point the excavation was terminated and documentation was conducted through drawings and photographs (Figures 96-98). During this level, a solitary fragment of Joventud red pottery was discovered, dating to the Middle Preclassic period.

Consolidation

No architectural elements were found within the excavation, except for the wall that was discovered at Level 1 and almost directly at the surface. However, in order to ensure the stability and preservation of this element, it was consolidated with a mixture of lime and sascab, which was painted with local sediment diluted in water to give it a more natural appearance (Figure 99-100). Once this process was completed and the entire unit was recorded, the unit was refilled to reach the original level (Figure 101).

Interpretation

This excavation unit, along with the data obtained from Operation 3, revealed many interesting aspects, both of the site and of the ballgame itself. The first of these is related to its temporality, as the ceramic evidence clearly indicates that it was constructed and used during the Middle Preclassic, which raises many questions due to the early nature of this complex.

Regarding the construction sequence revealed in this unit, Level 4, Lot 1 corresponded to the natural surface of the area, when the first occupation was established. As already mentioned, this must have occurred during the Middle Preclassic period. Subsequent to this, but within the same period, a floor (Floor 2) began to be constructed, which had as its base a fill of stones averaging about 10 x 7 cm, partially mixed with *chack luum* (Level 3, Lots 2 and 3).

On this base, the stucco floor was laid, which had a polished and high-quality surface, although it was found to be partially eroded in the northeastern section. Subsequently, there seems to have been a small layer of repaving that covered the floor, which was excavated as Level 3, Lot 1. As in the previous level, the ceramics found were very scarce but belonged to ceramic groups from the Middle Preclassic. This floor level must be the court's first surface, as it matches the ball game's lateral structures.

Subsequent to the aforementioned period, during the Middle Preclassic, a further leveling with a distinct stucco floor (Floor 1) was constructed, which was observed to be severely degraded and mixed with the humus layer's soil. Consequently, it is proposed that this level aligns with the period of site abandonment or when the structures ceased to be utilized. The elevation of the ball court suggests a redesign of the complex and potentially a change in function, as it would have restricted or partitioned the court area; nonetheless, the available data does not allow for definitive conclusions.

The elevation of the plaza is mirrored in the wall situated in Level 1, Lot 1, which appears to be part of a sequence of steps constructed in that section of the court, resulting in a trapezoidal appearance when viewed in cross-section. Consequently, both Floor 2 and the wall of Level 1 would have elevated the court within the lateral area above the elevation observed in the rest of the plaza, suggesting that the function of this ball court may have changed during these two construction phases (Figures 102 and 103).

The excavation solely encompassed the area beyond the wall delineating this unevenness. Since it was an unsealed context, we do not know the exact period of its construction. However, the sherds that were located during the excavation are from the Middle Preclassic, Late Preclassic, Early Classic, and Terminal Late Classic periods, representing the entire occupational sequence of the settlement. No Postclassic ceramics have been discovered in the excavations conducted thus far at the site, suggesting that the final phase of habitation occurred during the Terminal Classic period.

In summary, Operation 4, along with the preceding units of this site, confirms that the settlement was constructed during the Middle Preclassic period, perhaps representing its peak of occupation. Its proximity to the El Cedralito site, located around 12 km to the west, is noteworthy, as it also contains a ball court from the Preclassic period. Continued research is essential to comprehend the significance of these early Prehispanic settlements in the region as well as the role of the ball games in these early stages.

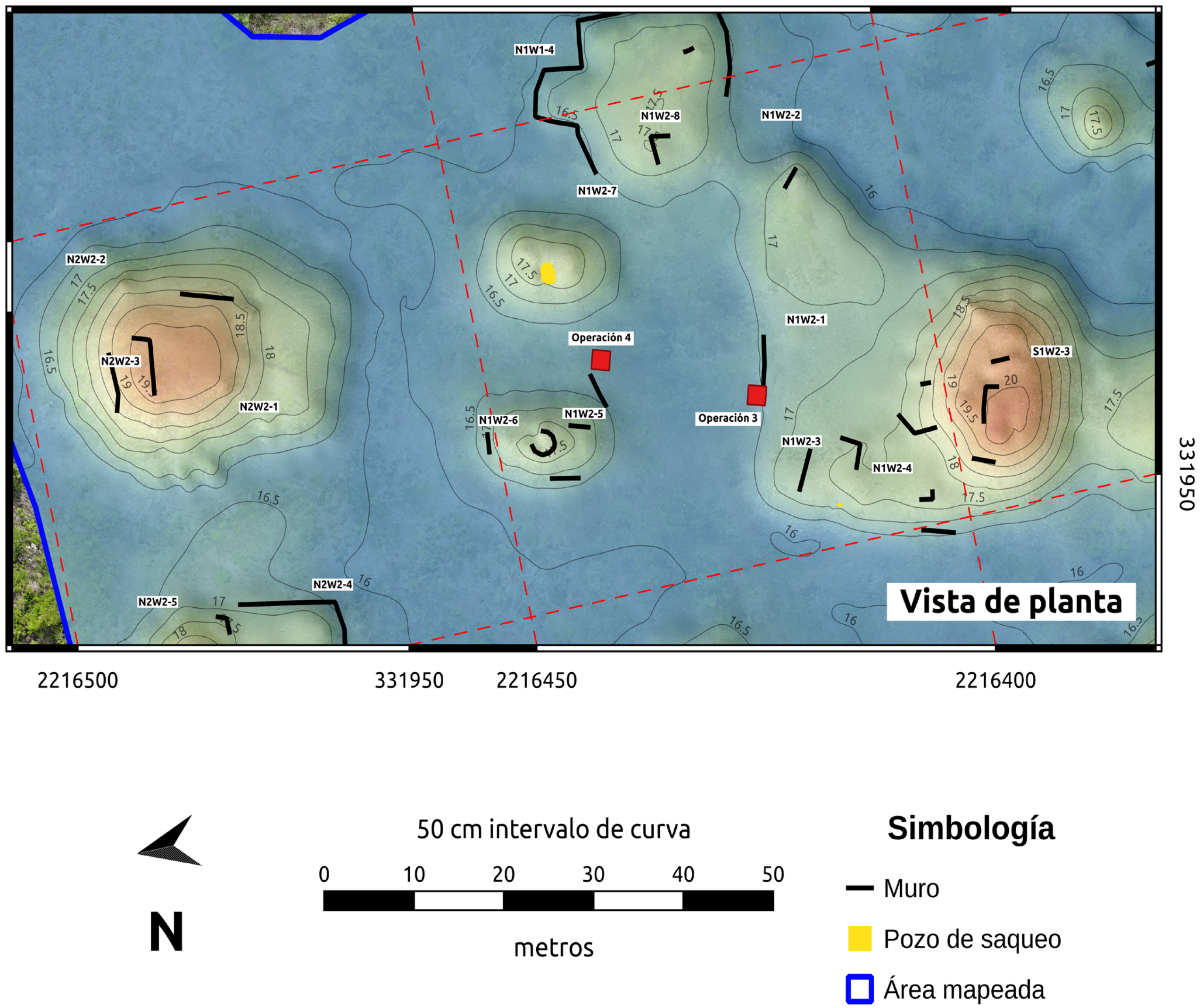


Figure 85. Ballcourt complex, San Isidro Yodzonot

Figure 86. Operation 4, San Isidro Yodzonot, surface

Figure 87. Operation 4, San Isidro Yodzonot, Level 1, Lot 2

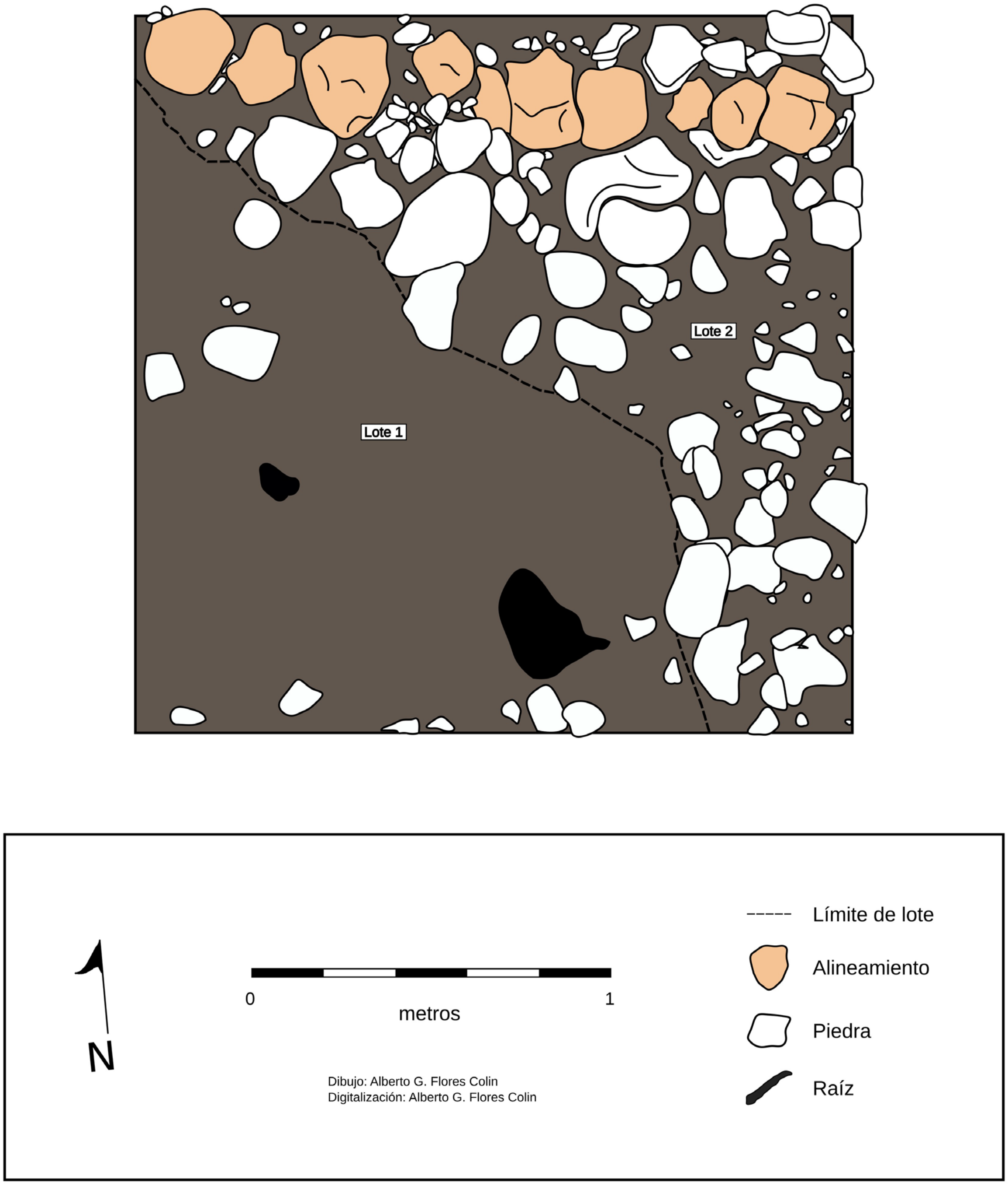


Figure 88. Operation 4, San Isidro Yodzonot, Level 1, Lots 1 and 2

Figure 89. Operation 4, San Isidro Yodzonot, Level 1, Lot 3

Figure 90. Operation 4, San Isidro Yodzonot, Level 2, Lot 1

Figure 91. Operation 4, San Isidro Yodzonot, Level 2, Lot 3

Figure 92. Operation 4, San Isidro Yodzonot, Level 3, Lot 1

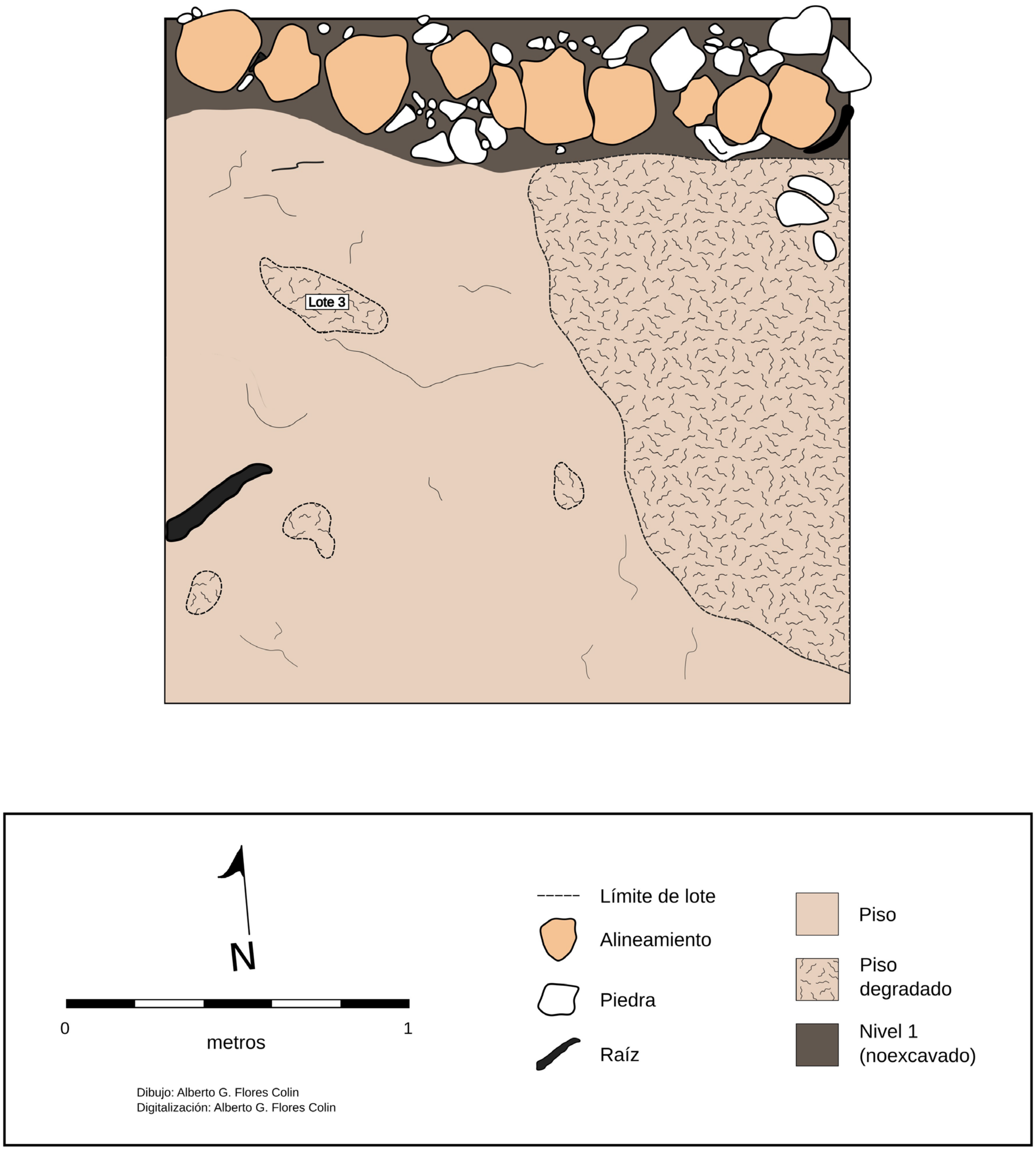


Figure 93. Operation 4, San Isidro Yodzonot, Level 3, Lots 1-3, plan map

Figure 94. Operation 4, San Isidro Yodzonot, Level 3, Lots 1, 2, and 3

Figure 95. Operation 4, San Isidro Yodzonot, Level 3, Lot 4

Figure 96. Operation 4, San Isidro Yodzonot, Level 4, Lot 1

Figure 97. Operation 4, San Isidro Yodzonot, end of excavation

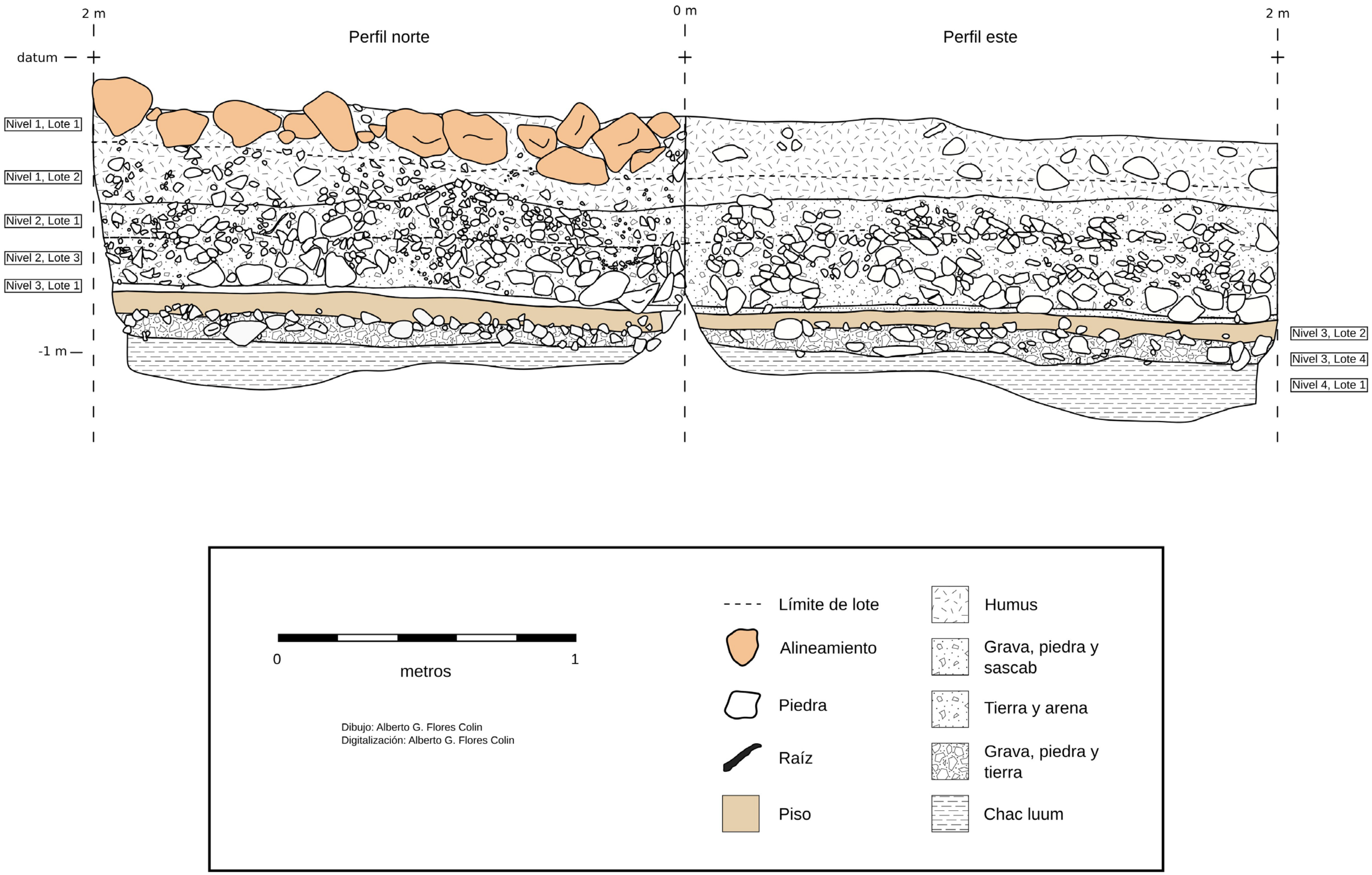


Figure 98. Operation 4, San Isidro Yodzonot, profiles

Figure 99. Operation 4, San Isidro Yodzonot, consolidation

Figure 100. Operation 4, San Isidro Yodzonot, Photogrammetry Model

Figure 101. Operation 4, San Isidro Yodzonot, Backfilled.

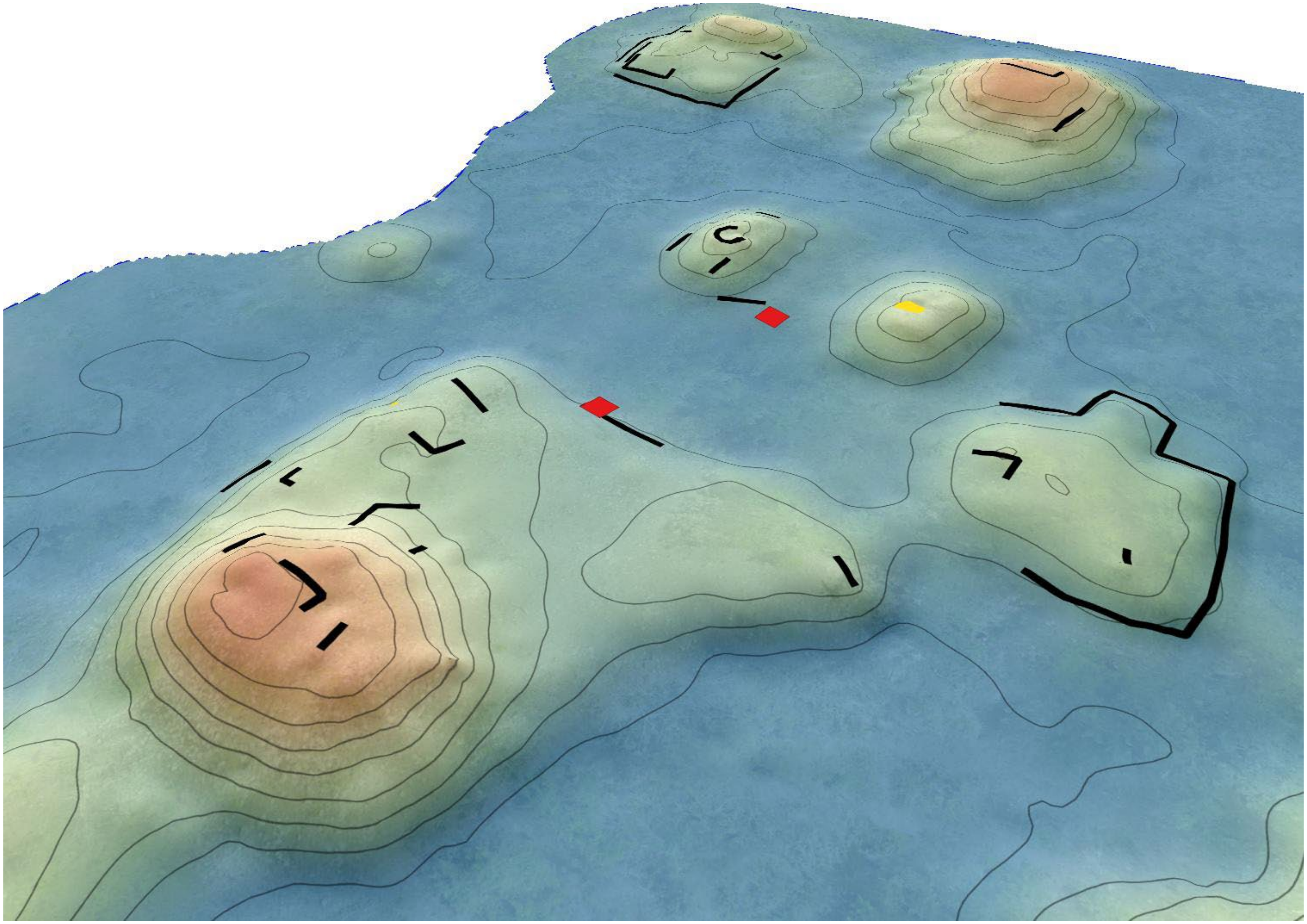


Figure 102. Operation 4, San Isidro Yodzonot, Ballcourt, 3D view

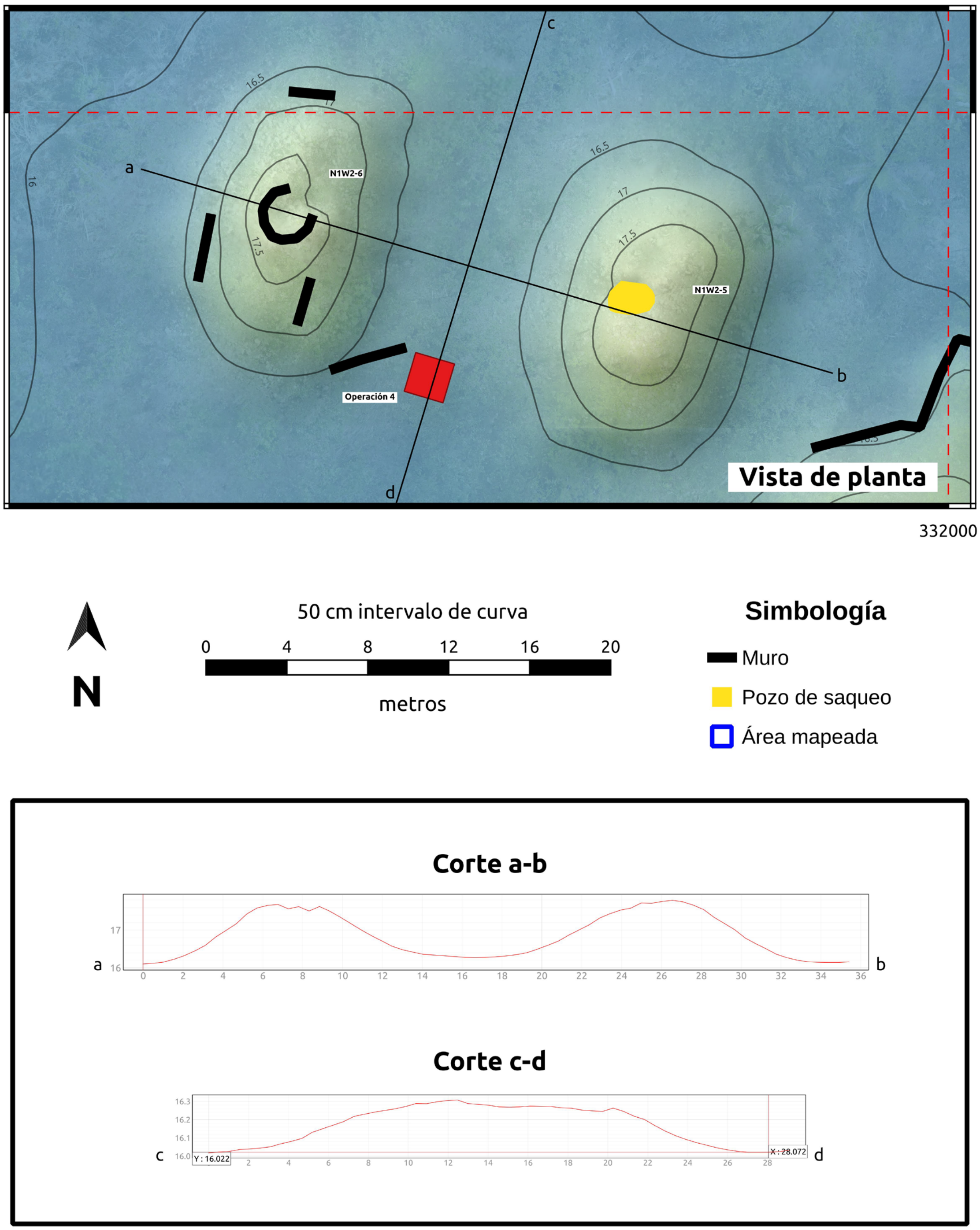


Figure 103. Operation 4, San Isidro Yodzonot, Ballcourt, plan map and profiles

Part 3: Ejido of San Felipe

Chapter 13. Sisal, Operation 10, Structure N2W2-3

Justine M. Shaw, Alberto G. Flores Colin, Marina Noh, and Thania Ibarra

In 2018 and 2019, two contiguous zones were excavated in a residential portion of Sisal, to the northwest of the acropolis and other architectural forming the site core (Figure 104). The first to be excavated as Operation 8 (Shaw 2019), Structure N2W2-1, was a round foundation brace dating to the Late Terminal Classic based upon stratigraphy and artifact content (Figure 105); a radiocarbon date(s) from burials confirm the hypothesis (see Chapter 21). The following season, in 2019, what was believed to be another round structure was excavated in the extensive Operation 9 (Figure 106; Shaw 2020). However, when surface sediment was removed the feature took upon an entirely different appearance, that of an L-shaped terrace segment that appeared to date to the Late Formative period, although the zone saw continued use through at least the Terminal Classic.

As part of a larger program to investigate round structures that appear late in the history of a number of sites within the Cochuah region, two additional round structures at Sisal were selected for excavation the next season (with investigations delayed until 2022). Structure N2W2-3, Operation 10, was positioned to provide contiguous soil and artifact patterning with the prior extensive excavations, whereas Operation 11 (following chapter) lay approximately 100m to the south atop an earlier platform. Aerial drone photography exploring the unmapped larger context around this portion of Sisal revealed further settlement that included additional round structures and a round foundation brace was located immediately to the west of Operation 11 (Figure 107).

Consistent with the other buildings excavated in the program of round structure excavation initiated in 2018, Operation 10 was divided into 50x50-cm suboperations, tracked by a system of numbers and letters. Surface remains were documented prior to excavation (Figures 108 and 109). Measuring 7m north-south and 9m east-west, the operation was designed to begin where Operation 9 had left off and encompass the zone immediately around the round structure.

The ground surface was highest in the southwest corner, approaching a natural rise with a small foundation brace upon it (outside the excavated area), sloping gradually down to the east and north 12-31cm. Having not been used as a *milpa* or cattle pasture for several years, it had been covered by scrub vegetation and some taller trees. All trees were left in place, meaning that most of the images for photogrammetry were recorded by low-hovering drone or a camera on an extension stick, rather than from the higher aerial perspective that had been used in 2019 or in the reconnaissance of the unmapped adjacent zones.

Operation 10, Level 1, Lot 1's surface was a black (7.5YR 2.5/1) loose sediment with relatively few pebble inclusions and numerous rootlets from small ground-covering vegetation. The sand-sized particles interspersed throughout meant that it readily crumbled when excavated with hand tools. As the layer was removed, it became evident that redder sediment underlay the immediate surface in part of the operation; to the north of Column C and west of Row 8, overlapping with the foundation brace's location (both interior and exterior), the sediment was slightly redder (2.5YR 3/3 dark reddish brown) with occasional patches of red mineral inclusions (10R 4/6). As each 50-cm unit was already independently tracked, these zones were not further subdivided by coloration.

Excavation was begun in units containing the rocks forming the foundation brace, so that it could be halted at the estimated occupation surface, near the base of the rocks visible on the surface. This same depth was continued in other adjacent units across the entire operation (Figure 110). Sediment samples were collected from each suboperation for the level when each was concluded, with the goal of soil chemistry being reflective of past occupation, rather than modern activities.

Level 1, Lot 1 attained a depth of 8-25cm (Figure 111). Although relatively little sediment was removed, artifacts were relatively dense within the thin layer, with nearly every unit producing ceramics and many containing lithics; unlike Sisal's Operation 11 and San Andres Norte Milpa's Operation 1, no plaster was evidenced.

Upon completion of Level 1, Lot 1, additional deeper rocks that appeared to be in alignment with the round structure were visible. These were particularly evident in the western portion of the round wall. As Operation 8 had revealed that its round structure had been seated with relatively little sediment between its basal course and bedrock, it was determined that an additional level (Level 2, Lot 1) should be excavated in order to ensure that the actual occupation surface was reached. This was concluded at either bedrock or approximately 1.25cm below the operation's datum (on average 43 cm below the original surface), with additional soil samples being collected a few centimeters before the level was concluded in each suboperation.

In addition to revealing additional stones that had collapsed from a multi-course foundation brace, Level 2, Lot 1 (Figure 112) also contained additional deposits of what had initially appeared to be red mineral inclusions in the first level; these were concentrated immediately outside the western portion of the exterior wall, in Suboperations e10, e 12, f12, d13, e11, f11, and g11. Where it was possible to isolate the red (10R 4/6; Figure 113) sediment, which seemed to have been burned into larger friable chunks (2-3mm) than the surrounding sediment, it was removed as Level 2, Lot 2 and the blacker sediment around and under it was Level 2, Lot 3.

The zone to the west of the foundation brace as also characterized by an increased concentration of collapse debris and lithics. Lithics included not only chipped chert and occasional obsidian blade fragments, but also round reddish limestone balls. These varied in size from less than 1 cm to 3-4 cm. The smaller examples were considerably more round, with larger examples being rounded but less regular in shape. On their own, many examples might have been discarded as natural occurrences formed by weathering. However, their frequency and spatial concentration suggests an intentionality in collection and use, if not actually production. Some functions might have been as gaming pieces or, particularly for larger examples, for smoothing ceramic surfaces during the leather-hard stage of production.

Near the close of the excavation, in the center of the structure, what appeared to be a violated cache was discovered, with a redder fill that distinguished it from the surrounding matrix (Figures 114 and 115). The feature first appeared as larger ceramic sherds dispersed between dispersed uncut stones. With one on the eastern edge being a rim sherds, it was thought that the find might represent a dedicatory cache or urn burial. However, no intact ceramics or other artifacts were found following careful excavation.

The burned material found immediately outside the structure walls, which in the absence of stucco remains might have once been daub; violated nature of the potential cache; and adjacent metate that had been broken prior to its period of more intense weathering from exposure (Figure 116) may indicate that the end of the occupation in this locus was not peaceful. Thought to have been occupied well after the abandonment of the site core, it could be that this continued to be a period of turmoil. There could also be less violent explanations for the remains, as perishable structures will readily burn, metates may naturally break with natural faults and weathering or even be intentionally broken in reverentially terminating a dwelling, and the cache may have been disinterred in order to bring its remains to a new location.

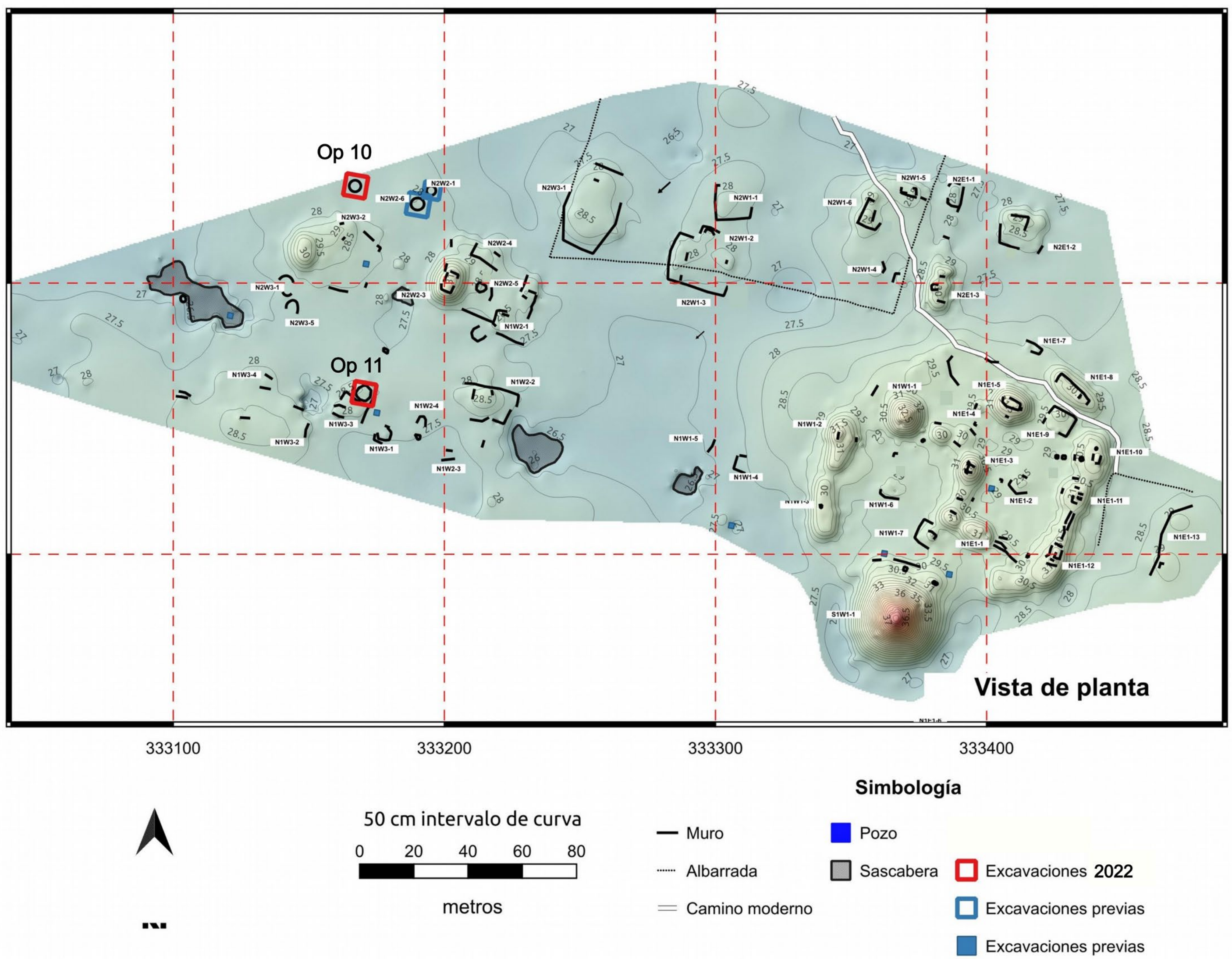


Figure 105. Sisal, location of operations

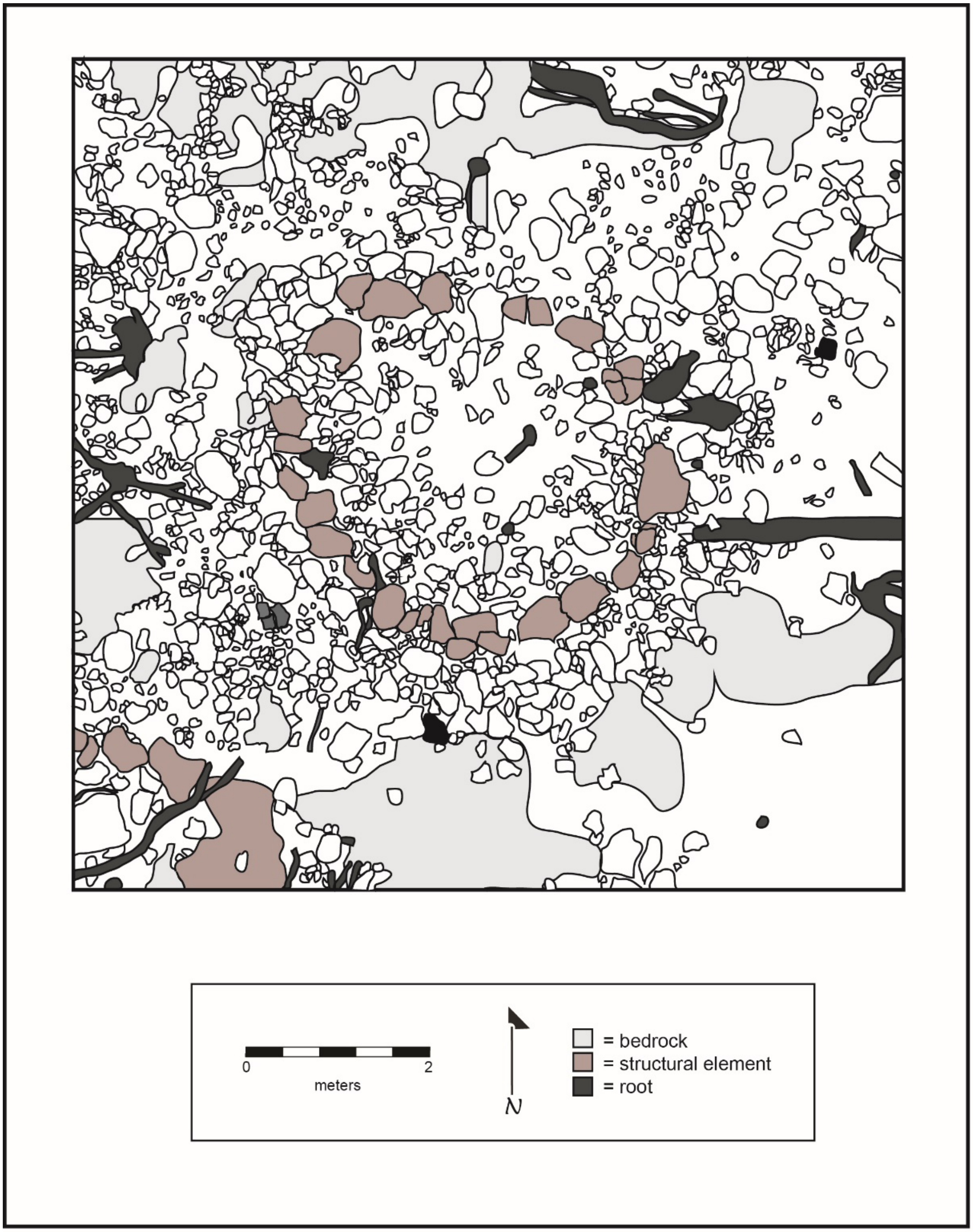


Figure 106. Sisal, Operation 8, excavated

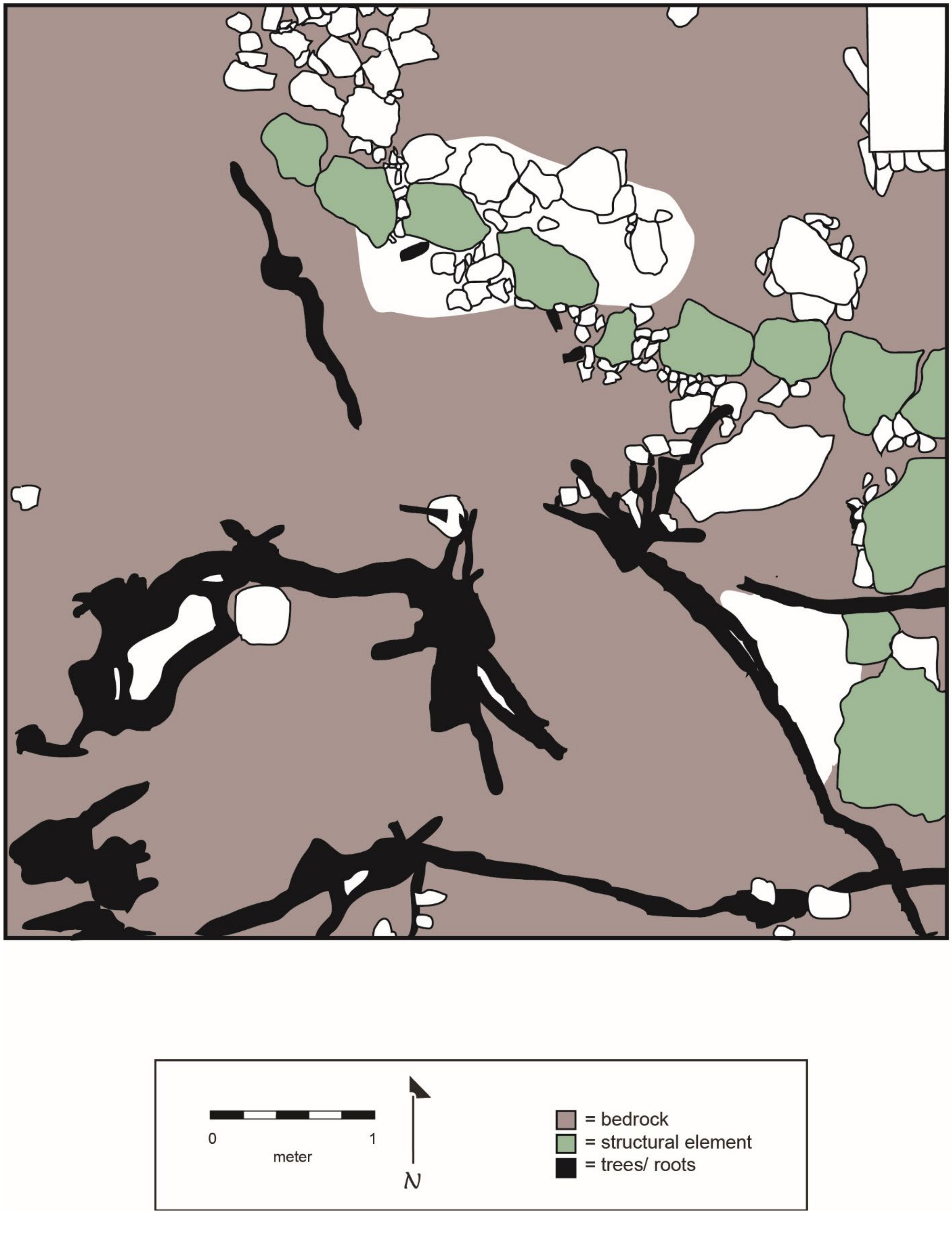


Figure 107. Sisal, Operation 9, excavated

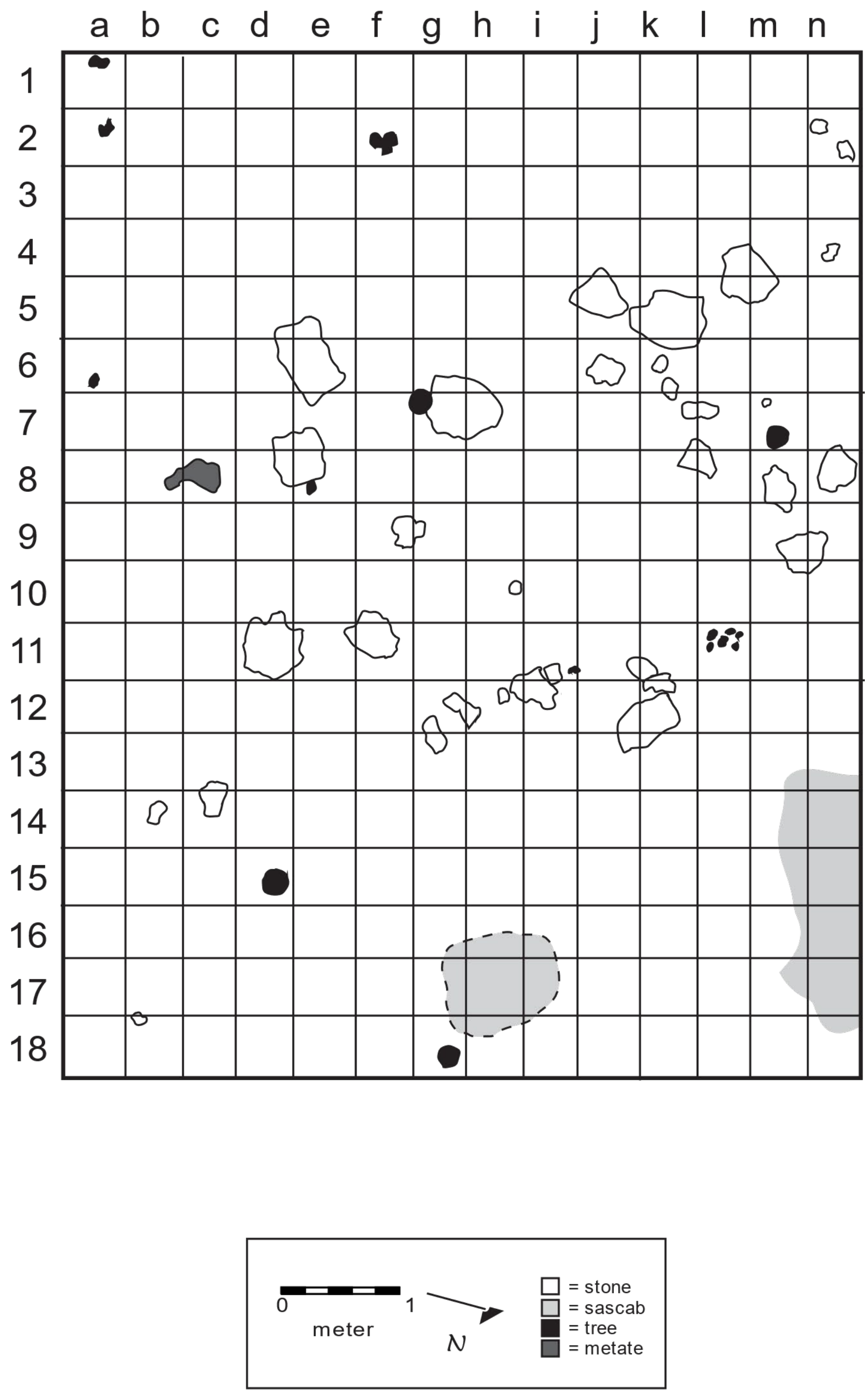


Figure 108. Sisal, Operation 10, prior to excavation, plan map

Figure 109. Sisal, Operation 10, prior to excavation

Figure 110. Sisal, Operation 10, Level 1, Lot 1, excavation process

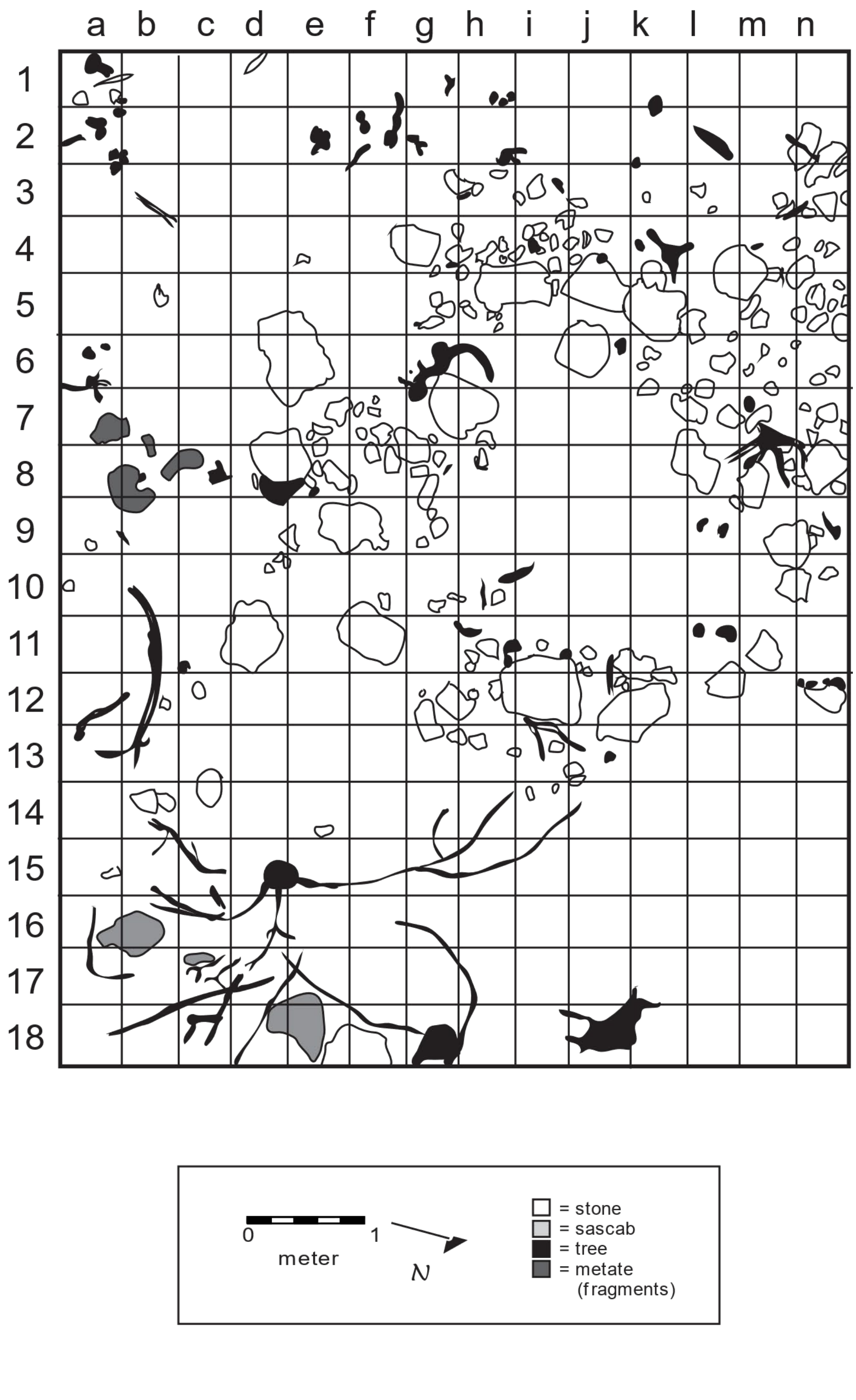


Figure 111. Sisal, Operation 10, Level 1, Lot 1, plan map

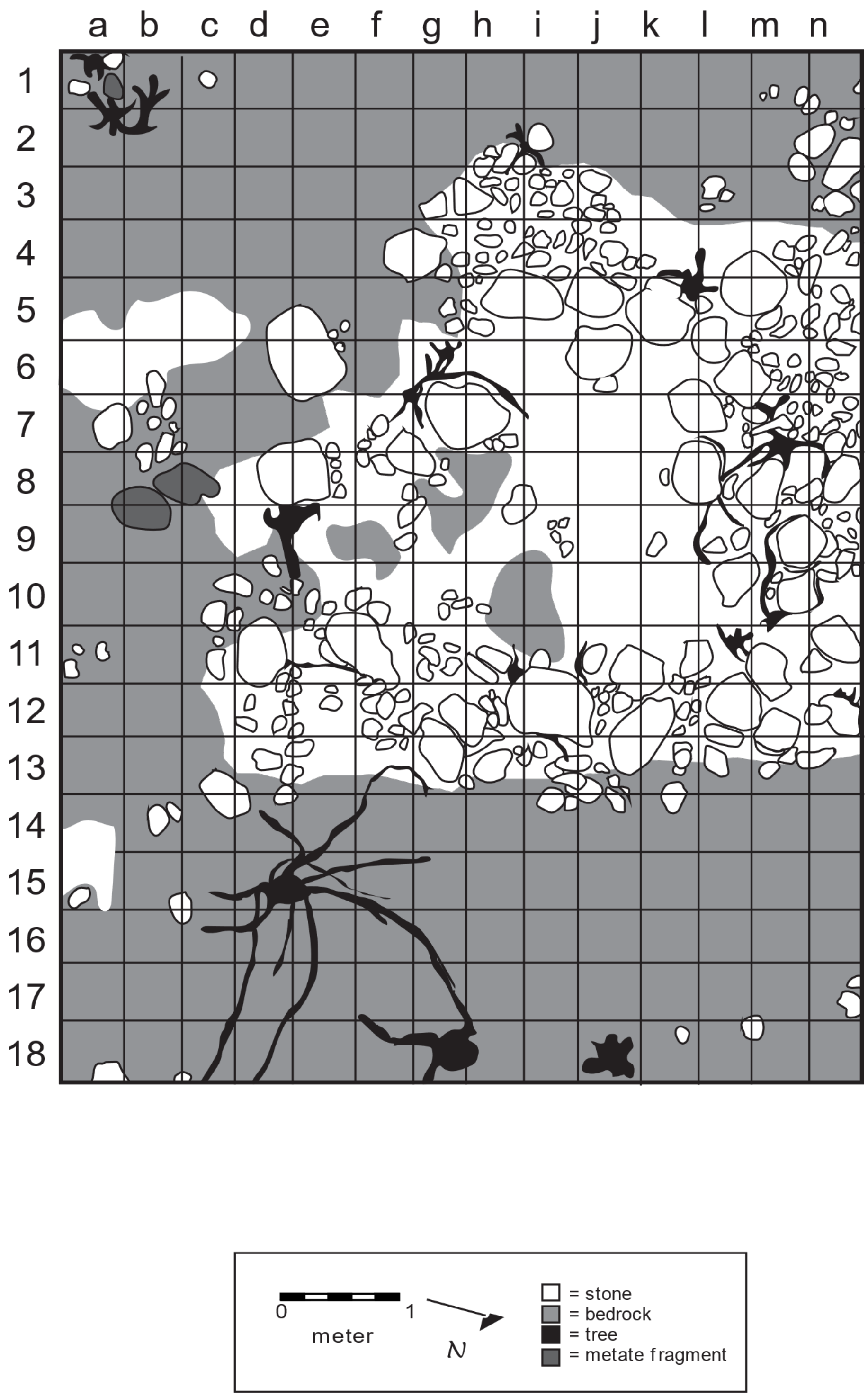


Figure 112. Sisal, Operation 10, Level 2, Lot 1, plan map

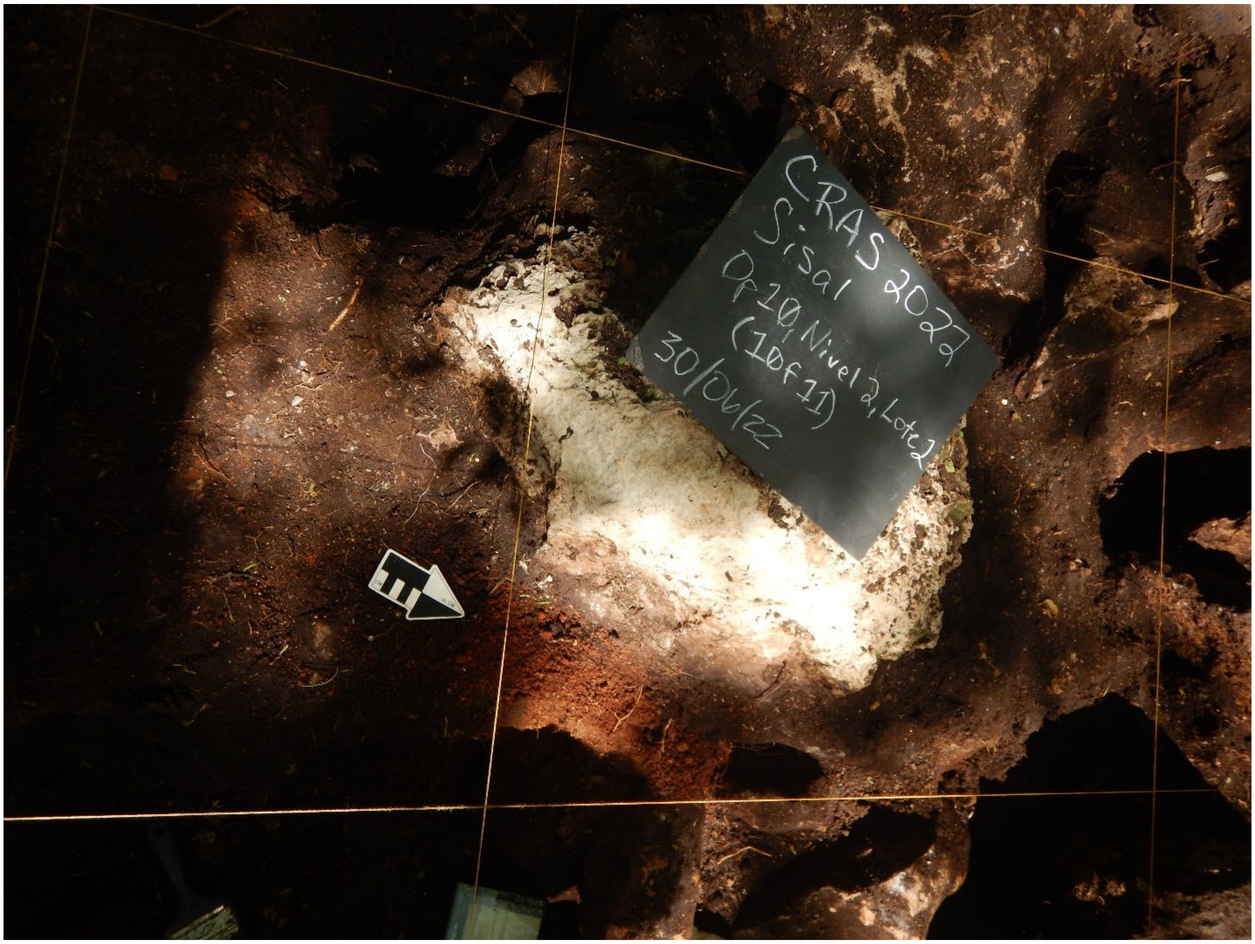
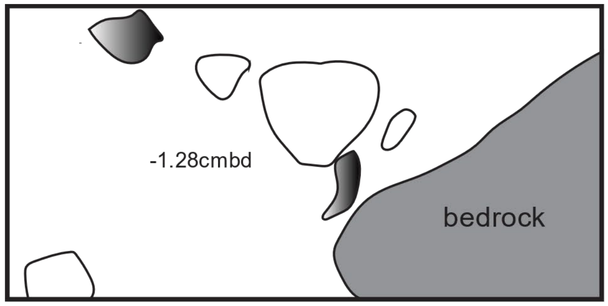
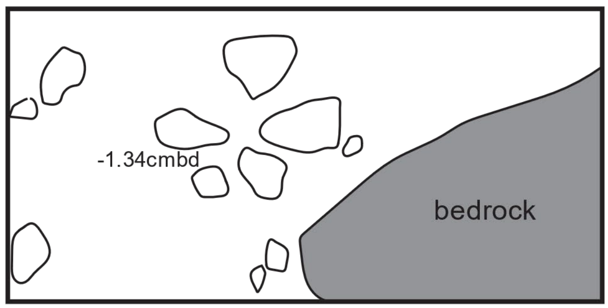


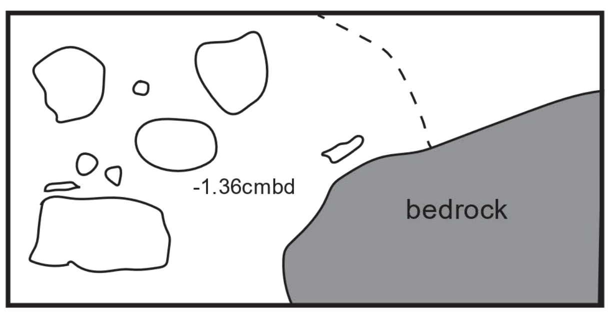
Figure 113. Sisal, Operation 10f11, Level 2, Lot 2, red soil deposit



Operation 10, Level 2, Lot 2, Cache Plan



Operation 10, Level 2, Lot 3, Cache Plan



Operation 10, Level 2, Lot 3, Final Cache Plan

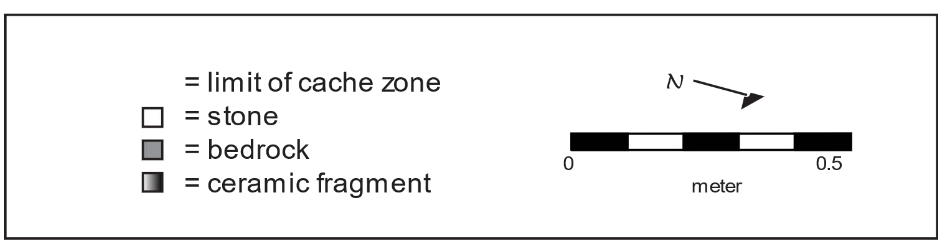


Figure 114. Sisal, Operation 10, plan map sequence of the excavation of the cache

Figure 115. Sisal, Operation 10, Cache, beginning (top) and end (bottom)

Ceramics from the operation (Figure 117) ranged in age from small quantities of the Middle Formative Saban, Chunhinta, Dzudzuquil, Pital, and Joventud groups through the Terminal Classic Cehpech horizon. Of the latest time period, by far the most well represented of all time periods, the ceramics were typical of other Late Terminal Classic round structures. Muna Slate and Yokat Striated were by far the most numerous types, with Ticul Thin Slate and Sacalum Black on Slate being found in lesser quantities. As with other round structures, these are believed to have been taken from earlier Terminal Classic structures that were abandoned by the time of the occupation phase associated with the round structures.

Consolidation

Upon completion of the excavation and documentation of all in situ stones (Figure 118), the consolidation of the foundation of perishable structures was executed. The operation commenced with the removal of silt from the joints of the stones constituting the circular foundation, which was subsequently substituted with a mixture of lime and sascab in a 3 to 1 ratio, in accordance with the project's standards (Cedillo 1993:100-103; Cedillo et al. 1997). After the mixture dried, it was painted with an equal blend of lime and local sediment to get a more natural appearance. The consolidation technique sought to stabilize the construction for enhanced preservation, so ensuring that the stones comprising the foundation remained in their original positions (Figure 119). Upon completion of this process, the excavation unit was backfilled with the previously extracted dirt (Figure 120).

Figure 116. Sisal, Operation 10, Broken Metate Fragments

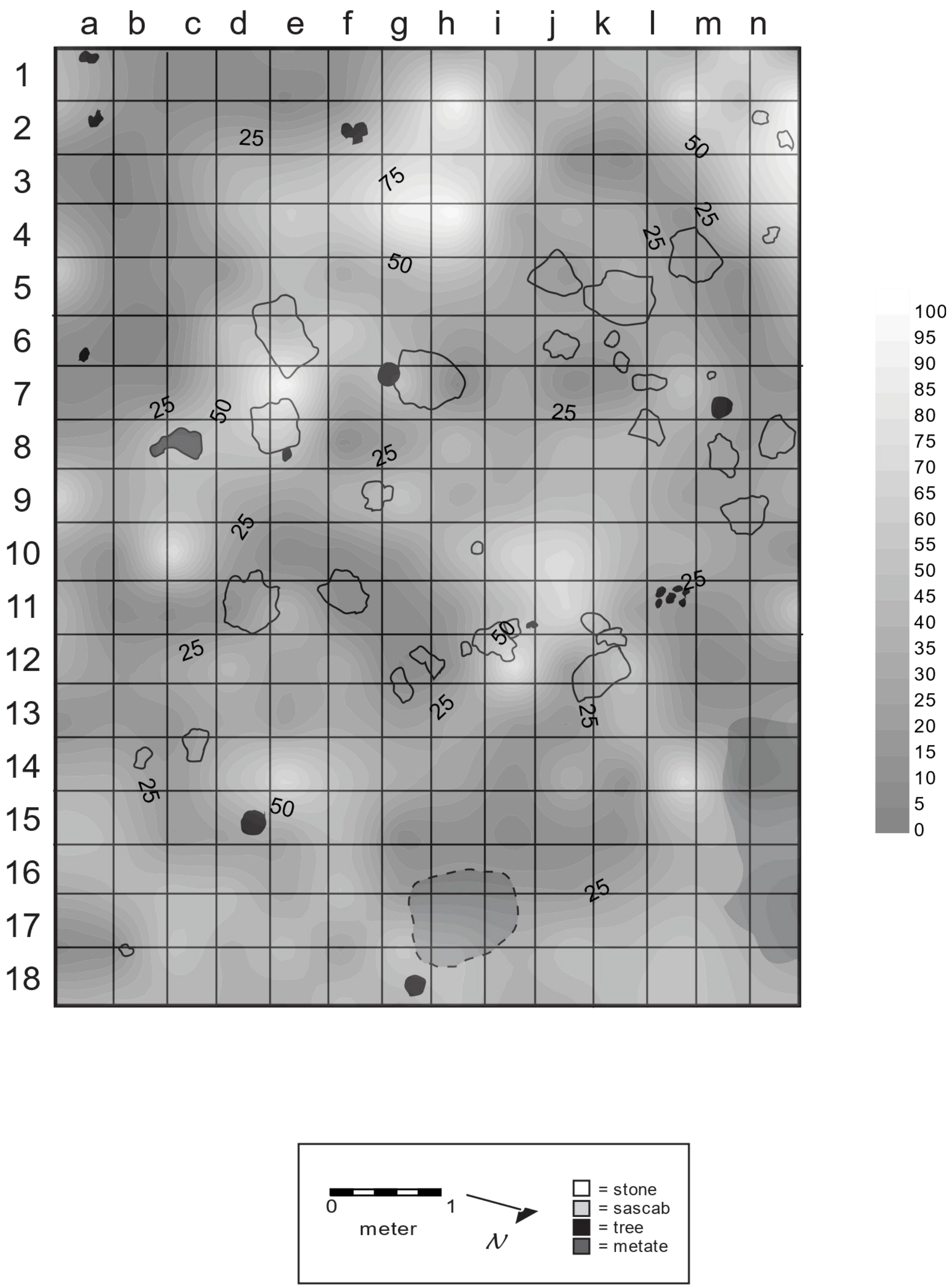


Figure 117. Sisal, Operation 10, Ceramic Distribution

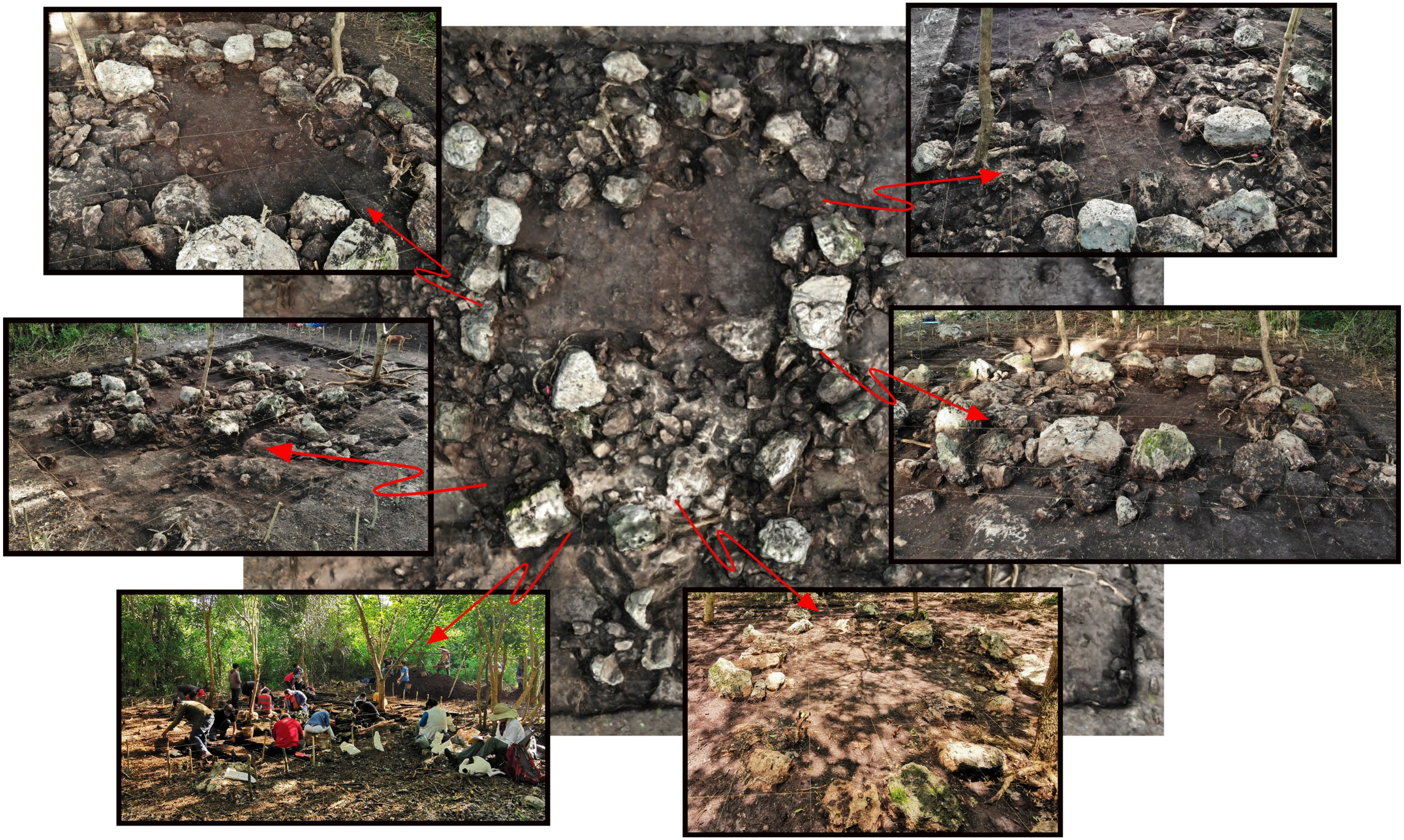


Figure 118. Sisal, Operation 10, Level 2, Lot 1, excavated

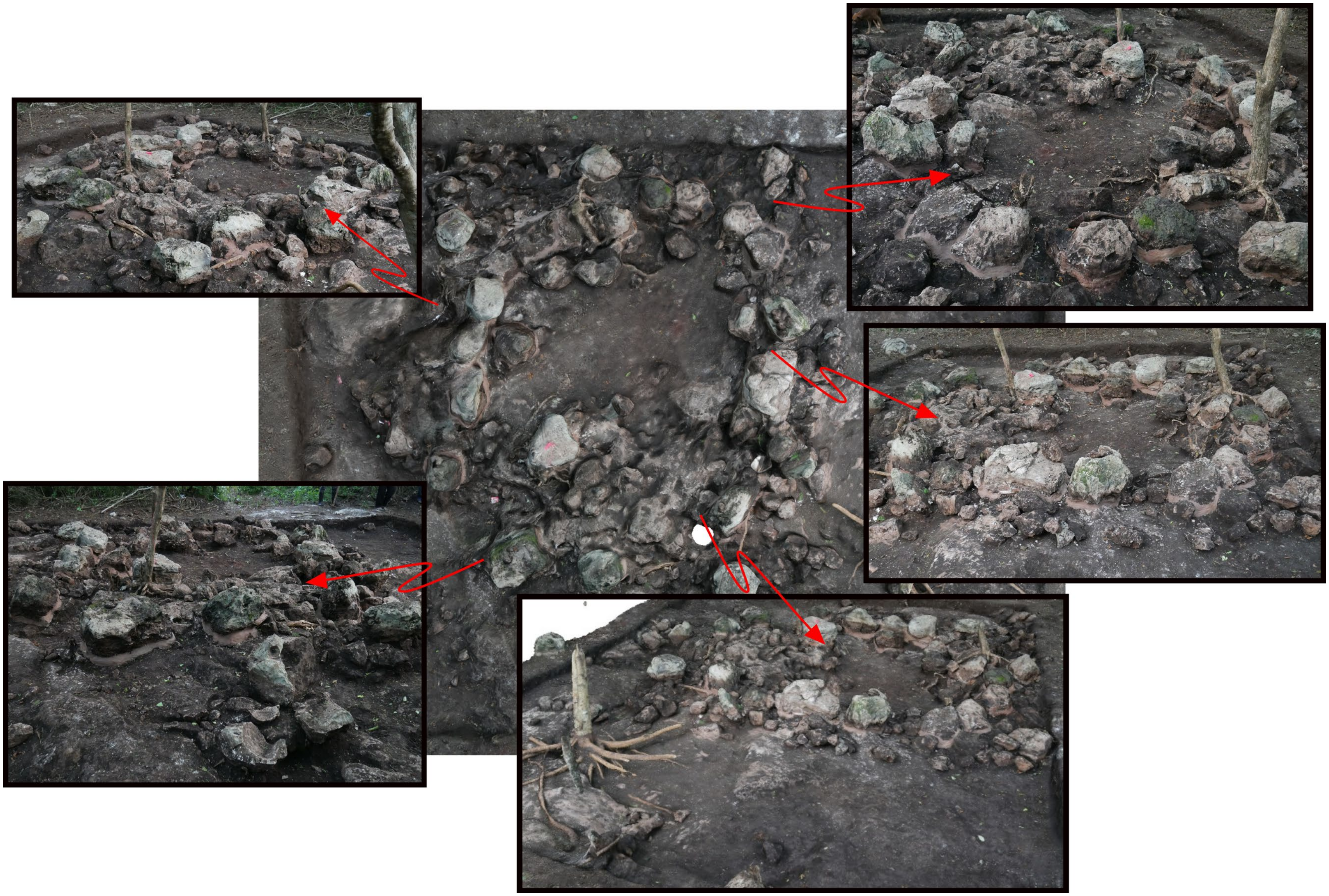


Figure 119. Sisal, Operation 10, consolidated

Figure 120. Sisal, Operation 10, Backfilled

Chapter 14: Sisal, Operation 11, Structure N1W3-1, the *Metate* Platform

Alberto G. Flores Colin, Thania E. Ibarra and Marina Noh Figueroa

Structure N1W3-1 was recorded in 2008 when the Sisal site was mapped (see Figure 105). Back then, the area was dedicated to cattle grazing and was covered by abundant grasslands. Although the area had been affected by this activity, no looting or material extraction areas were found that affected buildings in the area.

Structure N1W3-1 was the foundation for a circular perishable structure, measuring 6 x 6 m, which is located on the northern part of a preexisting platform. In the latter (Structure N1W3-3), in 2010, a test pit was excavated, which resulted in an occupation sequence that goes from the Late Formative to the Terminal Classic, although its construction dates to this last period (Shaw et al. 2011). Similarly, the circular foundation brace was thought to belong to that period, albeit to a later phase.

In addition, also partially on Structure N1W3-3, other circular foundations were located (Structure N1W3-2), very similar to Structure N1W3-1, but this lie in the southeastern part of the platform. As with the rest of the circular structures investigated this year, the objective of this excavation was precisely to better understand the relationship between the two construction phases of occupation and re-occupation, in order to understand and define both ceramics and architecturally, the post occupational phase of the Terminal Classic.

The excavation covered all of Structure N1W3-1 and its surrounding area (Figure 121), with the additional objective of knowing the function of these circular foundations and their different areas of activity (through soil analysis), in order to compare these results with the circular structures excavated in this season, as well as in previous ones. The excavation unit of this structure first covered 8.5 x 9.5 m. However, it was later expanded to 12.5 x 12.5 m, aiming to better document the open areas adjacent to Structure N1W3-1, which had considerable potential for being the areas of activity of the individuals who used this foundation.

The first step of the excavation was to establish a grid, that was later subdivided into subunits of 50 x 50 cm, giving a total of 625. The reason for using this closed grid was to be able to document with greater precision each one of the findings, as well as obtain more detailed soil samples to be analyzed using the spot test technique, all with the aim of better understanding the activities carried out inside and outside this foundation.

Regarding the nomenclature, all the subunits were designated with letters and numbers (Figure 122), where the columns correspond to the letters that were distributed from east to west (from A to U, including four additional columns named with a double letter (aa to dd), while the rows were numbered from north to south (from 1 to 25). The excavation followed the cultural stratigraphy and ended when the occupation level was located, which corresponds to the surface of the platform that gives it base, therefore, the platform was not affected. The process of excavation of the structure began from the central area of the circular foundation and continued out of it in all directions, starting first with the northern section and later continuing with the southern part.

As already mentioned, Structure N1W3-1 was a foundation brace for a circular structure, measuring 6 x 6 m, which is made up of stones of about 50 x 40 cm on average that seems to have been reused from other buildings or from the platform that bellows it (Structure N1W3-3). These foundations appear to have had only one course, although, in some parts, where some smaller stones were used, two courses may have been used to reach the higher sections.

These foundations are formed by a continuous wall, although there is a missing section in the southeastern part of the construction that could have been the entrance since it faces the high and level part of the platform (Structure N1W3-3), which must have been having been used as a patio by the users of this building.

The sediment was quite homogeneous throughout the entire excavation (grayish brown 7.5YR 3/2), with a clayey silt consistency, with the exception of the southwestern part, between columns aa and dd and between rows 12 and 17, where the coloration was slightly lighter (7.5 YR 3/3), although it preserved the same composition.

Once the sediment of all the excavation subunits was removed, it was possible to clearly observe the walls at the northeast and north part of the platform, Structure N1W3-3 (Figure 123), as well as the wall that makes up the circular foundation (Structure N1W3-1). There is a difference in height between the upper part of Structure N1W3-3 (the platform) and the area of the northern wall, in addition, the core of this building appears to be partially exposed.

This suggests that the circular foundation, Structure N1W3-1, was built with stones taken from this part of the platform, which indicates that the latter was in disuse and was partially dismantled to build the foundation brace, which confirms the pattern that we have observed in other parts of the study region and that we have called a Terminal Classic post-occupational phase.

In addition, in columns aa-dd, between rows 17-19, an alignment was observed that followed a northwest-southeast direction and ended just below the circular foundation (Structure N1W3-1). This alignment, formed partially by carved stones (Figure 124), possibly is the foundation of a platform superstructure (Structure N1W3-3), part of its retaining wall, or an attached platform that extends to the west. . However, these assumptions were not verified since no excavation was carried out beyond a few centimeters until the occupational level of the foundation was reached. However, judging by its shape, it is likely that this alignment is part of an attached smaller platform.

The ceramics located were highly variable, but we are still awaiting the results of the analysis. Several lithic fragments were found in the southern part of the excavation, mostly outside the circular foundation and on top of the upper part of the platform. The stucco material located in this building was very little and it seems that it does not have a particular distribution, although it was a little more abundant in the area of the circular foundation (Structure N1W3-1).

Another element to highlight is that several *metate* fragments were found scattered in various parts of the unit (Figure 125), which did not have a particular arrangement and were placed as fill stones. In addition to the above, in columns from O-Q, between rows 21-25, a *metate* of about 60 x 45 cm was located that lay directly on the occupational surface, which was quite eroded and even had a hole in the deepest part of the grinding area (Figure 126).

In addition, in the part of its edge, it presented three and possibly a fourth circular hole, also a product of wear and that gives the impression of having been used to place some substance or product separately from the rest of the grinding, although they could also be the remnants of a previous carving if the stone with which this *metate* was made was reused (possibly from a jamb). In future seasons it is expected to be able to analyze the residues in the center of the *metate* and the circular holes in order to determine what their possible use was.

Furthermore, about 80 cm to the south of this *metate*, two *metate* hands were located, placed one next to the other, just a few centimeters below the occupational surface. One of the hands measures 20 x 8 cm, while the other 13 x 7 cm (Figures 127 and 128). The first seems to be a type of calcite with a very light color (7.5 YR 8/6), while the other is a more porous stone with a brown color (5YR 6/8). These pieces are currently undergoing more specialized studies in the UNAM laboratories, in order to determine their composition and possible origin.

In all of the units, a soil sample was collected once the occupational level was reached, which is being analyzed in the Soil Laboratory of the Center for Sustainable Development (CEDESU) of the Autonomous University of Campeche. Once all the subunits were excavated, a detailed record of all the stones that comprise this context was made (Figures 129-131).

Consolidation

In order to ensure the stability and preservation of Structures N1W3-1, all the architectural elements that were exposed were consolidated. Basically, the entire base of the stones that made up the foundation wall was consolidated with a mixture of lime and *sascab* powder (Figure 132), which, once dry, was painted with earth to achieve a more natural appearance. Once this was done, the excavation was fully documented and the unit was backfilled with all the sediment that was extracted during the excavation (Figure 133).

Interpretation

The excavation of Structure N1W3-1 confirmed the pattern of reuse of spaces that we have been observing in the region and that motivated the investigation into this type of circular foundation braces. This pattern has been designated as the Terminal Classic Postoccupational phase when much of the architecture of previous periods was partially dismantled and reused to build perishable structures of which only their foundations remain. We cannot say if they are the same settlers who still continue to inhabit the same spaces or if they are other groups that come from other areas and settle in the centers of the abandoned cities because the ceramic types are the same and there is no presence of any foreign indicator within material culture.

In this sense, the occupational sequence recorded in this operation indicates that the platform (Structure N1W3-3) was first built, which could have had a perishable structure in the western part, of which we only observed one alignment. This building is contemporary to the development of the Sisal site and was later abandoned or fell into disuse at the end of the Terminal Classic, when it was partially dismantled to build the circular foundation with perishable walls and roof, which, together with the Structure N1W3-2, another circular structure, used the level part of the platform to carry out their activities. We are still awaiting the results of the spot test soil analysis, which will give us further indications of what these activities may have been.

Lastly, the discovery of the *metate* along with the two hands may indicate that this area was dedicated to food preparation; however, the holes found on the edge of the *metate* may be suggesting another function. We hope that the physical and chemical analyzes that are being carried out on the hands help us to clarify this question. Due to the advanced degree of wear, it is also likely that this *metate* was originally used by the inhabitants of the platform (Structure N1W3-3) and that it was later reused by the builders of the circular foundations during the post occupational phase.

On the other hand, the position in which the *metate* hands were found (one on top of the other), in addition to the fact that they were a few centimeters below the occupational level marked by the base of the *metate*, suggests that they were deliberately buried, perhaps as part of a termination ritual since the *metate* was broken and was possibly no longer used.

Figure 121. Sisal, Structure N1W3-1, surface, photogrammetry

Figure 122. Sisal, Structure N1W3-1, surface, plan map

Figure 123. Sisal, Structure N1W3-1 (foundation brace) and Structure N1W3-3 (platform front wall)

Figure 124. Sisal, Structure N1W3-3, alignment (possible attached platform)

Figure 125. Sisal, Operation 11, fragments of *metates*

Figure 126. Sisal, Operation 11, metate

Figure 127. Metate mano, Structure N1W3-3, Sisal (Mano 1)

Figure 128. Metate mano, Structure N1W3-3, Sisal (Mano 2)

Figure 129. Sisal, Structure N1W3-3, excavated, plan map

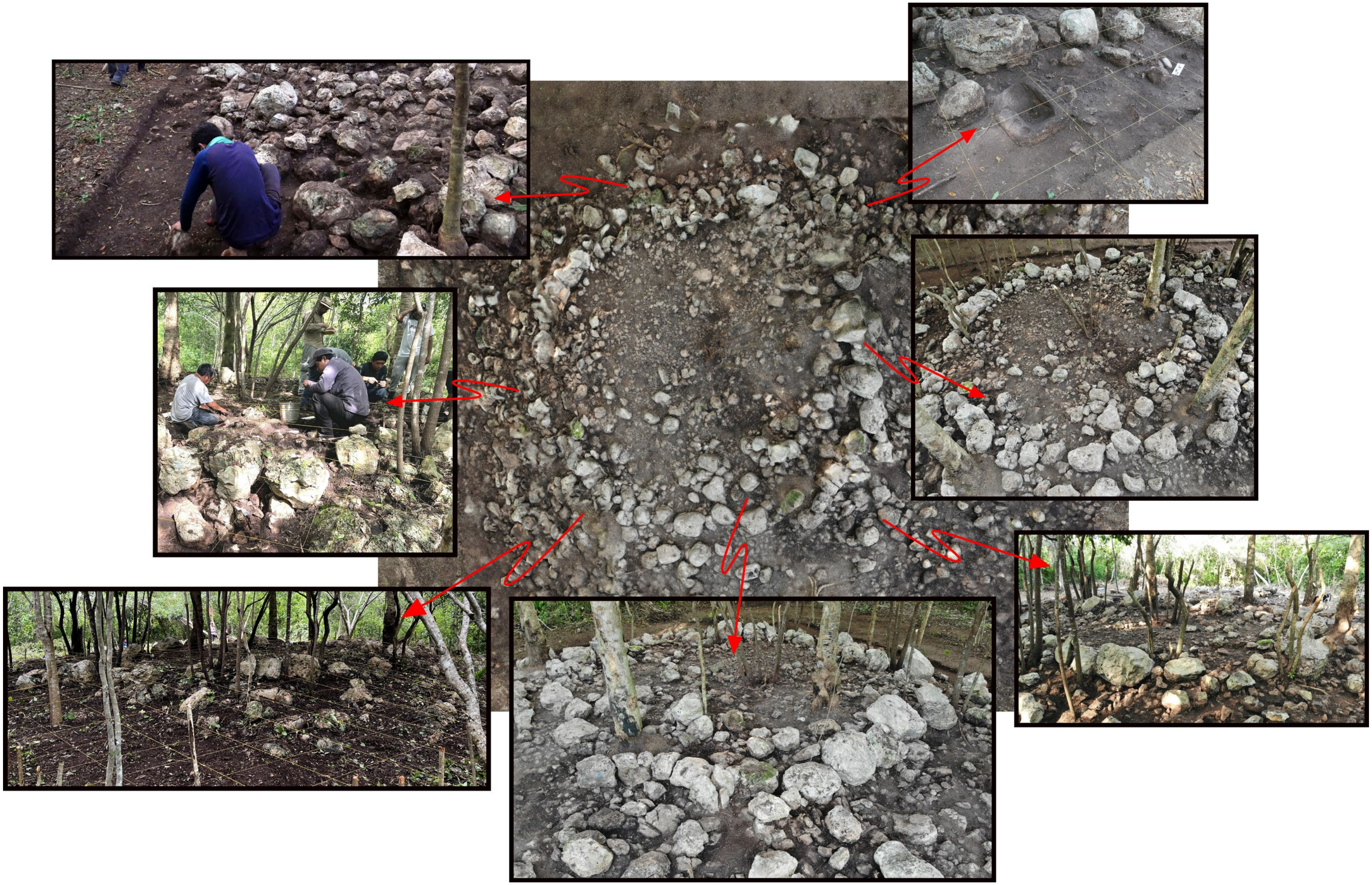


Figure 130. Sisal, Structure N1W3-1, excavated, photogrammetry plan

Figure 131. Sisal, Structure N1W3-1, excavated, photogrammetry, 3d view

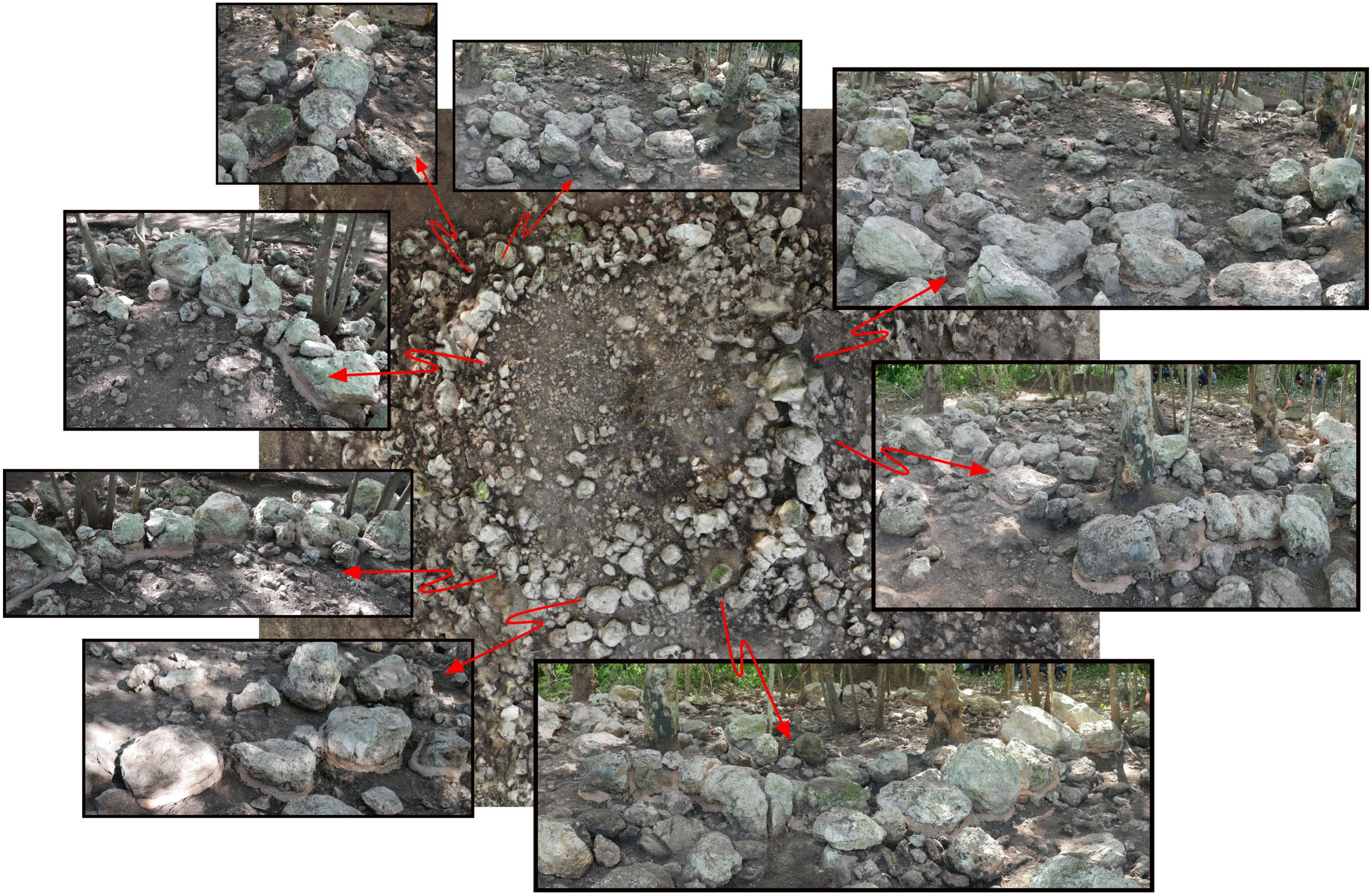


Figure 132. Sisal, Structure N1W3-1, Consolidated

Figure 133. Sisal, Structure N1W3-1, Backfilled

Part 4: Summary and Analysis

Chapter 15. Ceramic Summary of the 2022 Season

Monica Oreb Camargo Tamayo and Ricardo Abraham Mateo Canul
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In the 2022 season of the CRAS project, a total of 15,029 ceramic fragments were recovered from four Prehispanic settlements: Sisal, San Andres Norte Milpa, K'an Ni', and San Isidro Yodzonot. The site with the highest presence of ceramic material is Sisal, recording a total of 12,298 ceramic sherds, while the San Andres Norte Milpa site recorded a total of 2,071 fragments. The two sites with the least amount of recorded material are K'an Ni' and San Isidro Yodzonot, with 350 and 310 sherds respectively (Figure 134).

All the ceramic material from the CRAS-2022 project was classified using the type-variety analysis system parameters, with the aim of understanding the chronology of the settlements and the intercultural relationships of the study region.

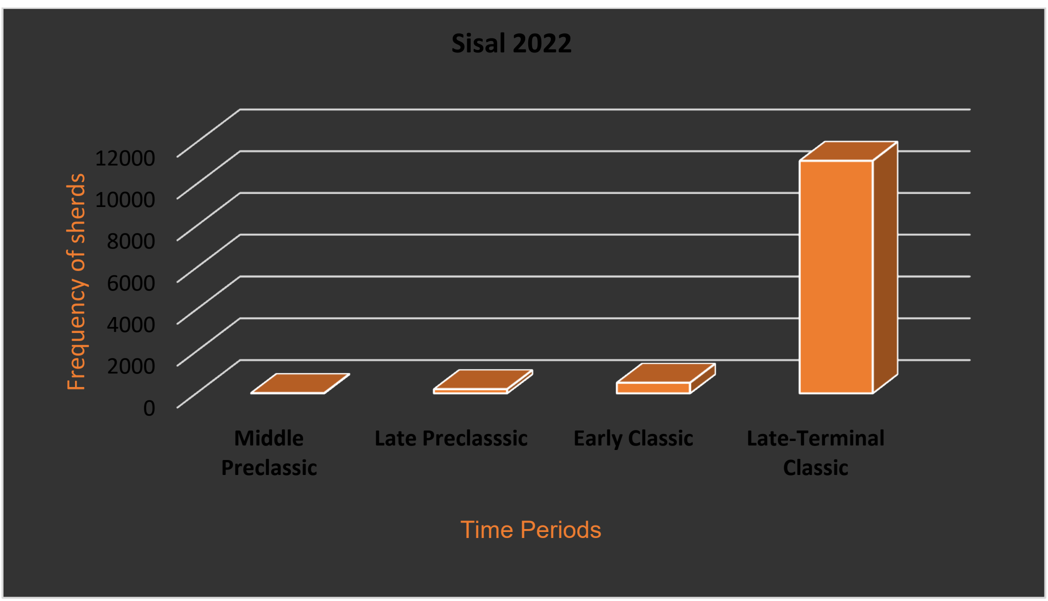


Figure 134. Total number of sherds per Prehispanic settlement for the 2022 season of the CRAS project.

Sisal

Being the site with the largest amount of pottery, a long and continuous occupation could be observed (Figure 135; Table 1), starting from the Middle Preclassic (700-300 B.C.) to the Terminal Classic (900-1050 A.D.). The Middle Preclassic was represented by the Saban, Chunhinta, Dzudzuquil, Pital, and Joventud groups (Figure 136). For the Late Preclassic period (300 B.C.-250 A.D.), an increase in ceramic material was observed compared to the previous period, in which the groups Xanabá, Unto, Tipikal, Sierra, Polvero, Flor, and again the Saban group with the types Tancah burdo and Chancenote striated: variety Chiquilá were recorded (Figure 137).

From the Early Classic period, the ceramic groups specific to northern Yucatán were recognized, such as the Chuburná and Maxcanú ceramic groups. Similarly, the groups specific to the eastern region of the Yucatán Peninsula were recorded, such as the Batres, Cetelac, Tituc, Huachinango, and Saban groups (with the Saban type without slip: Becoob variety). Likewise, the presence of the Shangurro, Triunfo, Aguila, and Balanza groups was observed (Figure 138).

During the Late Classic period, the presence of the Saxche, Petkanche, Sayan, and Infierno groups was noted, which were incorporated into the Tepeu ceramic sphere. Similarly, the groups Dzitya, K'inich, Sat (with the Chemax black on slate type) and Arena of the Motul sphere were recorded (Figure 139). For the final part of the Late Classic and during the Terminal Classic, the groups Muna, Vista Alegre, Zumpulche, Traino, Teabo, Ticul, Dzitas, and Chum were identified.

Regarding the latter, it was the most prominent group, with tall and short-necked pots featuring striated decoration (Yokat striated type, with its Yokat and Non-specific varieties respectively). In 603 fragments of the Chum group, particles of ground shell were observed as part of the composition of their paste, which were noticeable from the surface with striated decoration. Therefore, in the present study, it was decided to establish the Chan Xikin variety of the striated Yokat type, as it is possibly a local production of the region (Figure 140).

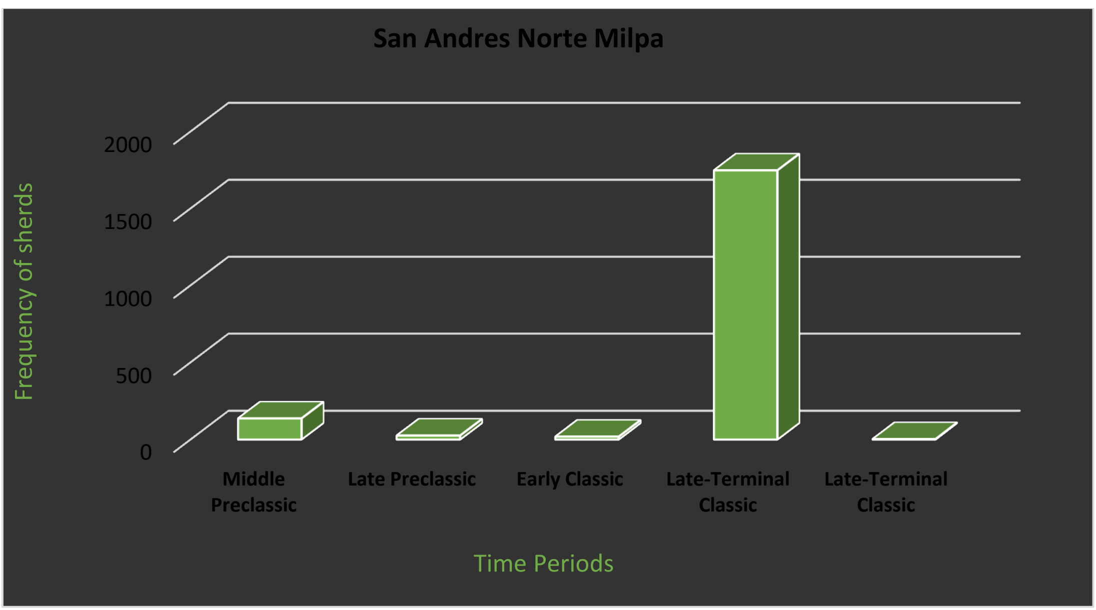


Figure 135. Frequency of sherds over chronological periods at the Sisal site

Table 1: Sisal					
Time Period	Ceramic Horizon	Group	Type	Variety	Frequency
900-1050 d.C.	Sotuta	Dzitas	Dzitas slate	Dzitas	7
			Dzitas slate	Not specified	1
			Balantun black on slate	Balantun	1
		Ticul	Ticul thin slate	Ticul	103
		Teabo	Teabo red	Teabo	29

Table 1: Sisal					
Time Period	Ceramic Horizon	Group	Type	Variety	Frequency
900-1050 d.C.	Sotuta	Dzitas	Dzitas slate	Dzitas	7
			Dzitas slate	Not specified	1
			Balantun black on slate	Balantun	1
		Traino	Traino brown	Traino	1
		Zumpulche	Zumpulche thin slate	Zumpulche	4
		Vista Alegre	Vista Alegre striated	Vista Alegre	40
Late Classic 600-900 d.C.	Cehpech	Muna	Muna slate	Muna	2422
			Muna slate	Concave	1
			Muna slate	Oriental	6
			Sacalum black on slate	Sacalum	287
			Sacalum black on slate	Oriental	5
			Tekit incised	Tekit	3
			Akil impressed	Akil	7
			Special with black paint and impressed		1
		Chum	Yokat striated	Yokat	83
			Yokat striated	Not specified	7218
			Yokat striated	Chan Xikin	603
		K'inich	K'inich orange	K'inich	3
		Dzitya	Dzitya black	Dzitya	4
			Ekpedz incised	Ekpedz	2
			Haabin gubiado incised	Haabin	1
			Chacte composed	Chacte	2
			Special with incised and punched decoration		2
			Special with half-round molding decoration		1
	Tepeu	Saxche	Saxche polychrome orange	Saxche	27
			Saxche polychrome orange	Dzabtun	1
			Desquite red on orange	Desquite	1
		Petkanche	Petkanche polychrome orange	Petkanche	31
		Sayan	Sayan red on cream	Sayan	2
		Encanto	Encanto striated	Encanto	34
		Infierno	Infierno black	Infierno	8
			Infierno black	Punzado	1
		Arena	Arena red	Arena	178
		Sat	Chemax black on preslate	Chemax	1
		Not designated	Bichrome cherry red and orange		1
		Not designated	Unsliped cazuela		1
		Not designated	Tick on bay spliped		1
		Not designated	red tepeu		1
		Not designated	unsliped striated		1
		Not designated	bay paste black core		1
		Not designated	cream, red and orange		1
		Not designated	striated asa		1
		Chuburna	Chuburna brown	Chuburna	5
		Maxcanu	Maxcanu bay	Maxcanu	113
			Tacopate drizzled on	Tacopate	5

Table 1: Sisal					
Time Period	**Ceramic Horizon**	**Group**	**Type**	**Variety**	**Frequency**
900-1050 d.C.	Sotuta	Dzitas	Dzitas slate	Dzitas	7
			Dzitas slate	Not specified	1
			Balantun black on slate bay	Balantun	1
Early Classic 250-300 d.C.	Cochuah	Batres	Batres red	Batres	142
			Coba composed	Coba	1
			Oxkintok composed applicated	Oxkintok	1
		Saban	Saban unsliped	Becoob	51
		Cetelac	Cetelac desgrasante vegetal	Cetelac	4
		Tituc	Tituc polychrome orange	Tituc	45
		Triunfo	Triunfo striated	Triunfo	114
			Triunfo striated	Neck scars	4
		Aguila	Aguila orange	Aguila	12
			Dos Arroyos polychrome orange	Dos Arroyos	2
		Balanza	Balanza black	Balanza	4
		Shangurro	Valladolid bichrome incised	Valladolid	1
		Huachinango	Fango bichrome	Fango	2
Late Preclassic 300 a.C.-250 d.C.	Chicanel and Nabanche Early	Saban	Tancah burdo	Tancah	14
			Chancenote striated	Chiquila	124
		Xanaba	Xanaba red	Xanaba	8
		Unto	Unto black on striated	Unto	3
		Tipikal	Tipikal red on striated	Tipikal	2
		Sierra	Sierra red	Sierra	33
			Laguna Verde incised	Laguna Verde	3
		Polvero	Polvero black	Polvero	1
		Flor	Flor cream	Flor	9
			Flor cream	incised punzado	1
			Mateo red on cream	Mateo	2
Middle Preclassic 700-300 a.C.	Nabanche Early	Saban	Saban unsliped	Saban	3
		Chunhinta	Chunhinta black	Ucu	4
			Nacolal incised	Nacolal	1
		Dzudzuquil	Kuche incised	Kuche	1
	Mamom	Pital	Special with red paint and modeling		1
		Joventud	Joventud red	Joventud	4
Total					11849

Eroded	410
Not identified	15
Tejo	18
Ceramic ball	1
Artifacts	1
Stucco	1
Stone	3

a b

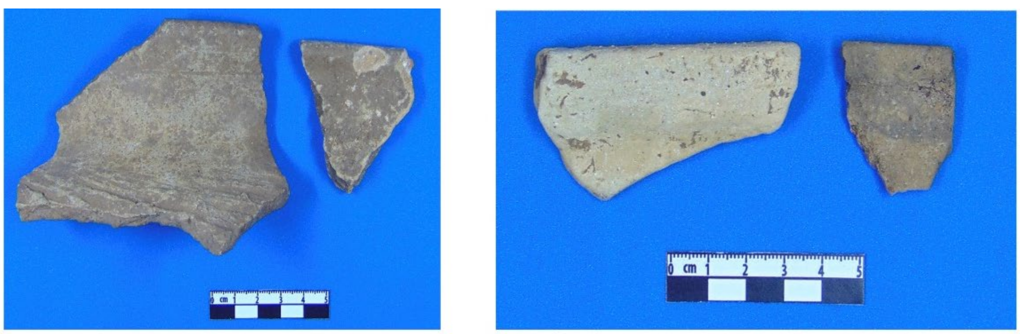
Figure 136. a) Ceramic Group Joventud; b) Ceramic Group Chunhinta.
Middle Preclassic, Sisal.

a b

Figure 137. a) Ceramic Group Sierra; b) Ceramic Group Saban (type Chancenote striated: variety Chiquila). Late Preclassic, Sisal.

a b

Figure 138. a) Ceramic Group Triunfo; b) Ceramic Group Batres. Early Classic, Sisal.



a b

Figure 139. a) Ceramic Group Encanto; b) Ceramic Group Arena. Late Classic, Sisal.

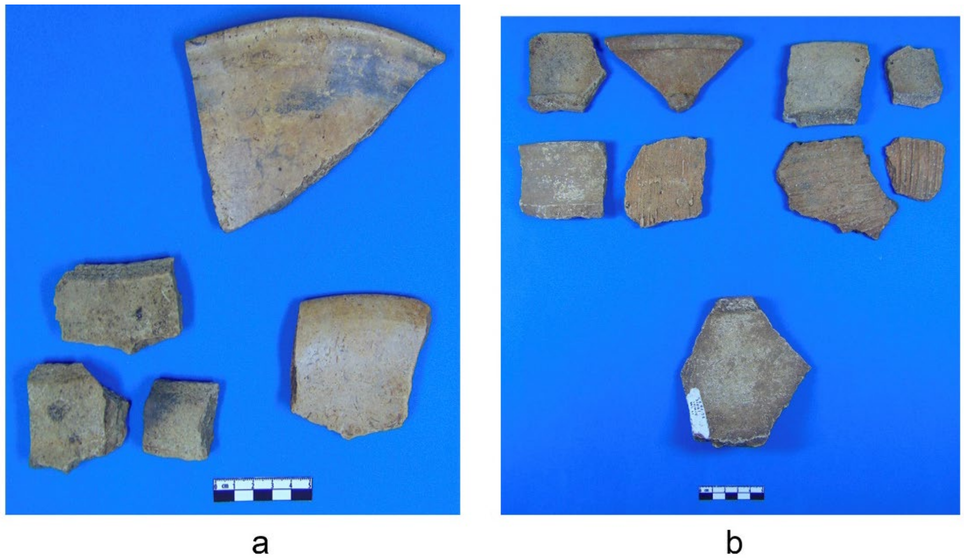


Figure 140. a) Ceramic Group Muna; b) Ceramic Group Chum. Late/Terminal Classic. Sisal.

San Andres Norte Milpa

As a result of the ceramic analysis of the San Andres Norte Milpa settlement, a long occupation was observed that began in the Middle Preclassic period and ended during the Postclassic (Figure 141, Table 2).

During the Middle Preclassic, the Chunhinta, Dzudzuquil, Pital, Joventud, and Saban groups were recognized. It is during the Late Preclassic that the Saban group remains (with the Tancah burdo and Chancenote striated types, with their Chancenote and Chiquilá varieties) along with the Sierra and Tipikal groups (Figures 142 and 143).

The Early Classic period is represented by the Saban groups (with the Becoob variety), Batres, and Aguila (Figure 144). During the Late Classic/Terminal period, the presence of the Chum, Muna, Vista Alegre, Teabo, and Ticul groups was observed (Figure 142). The presence of the Postclassic was very scarce, being represented by three sherds from the Navula group (Figure 146).

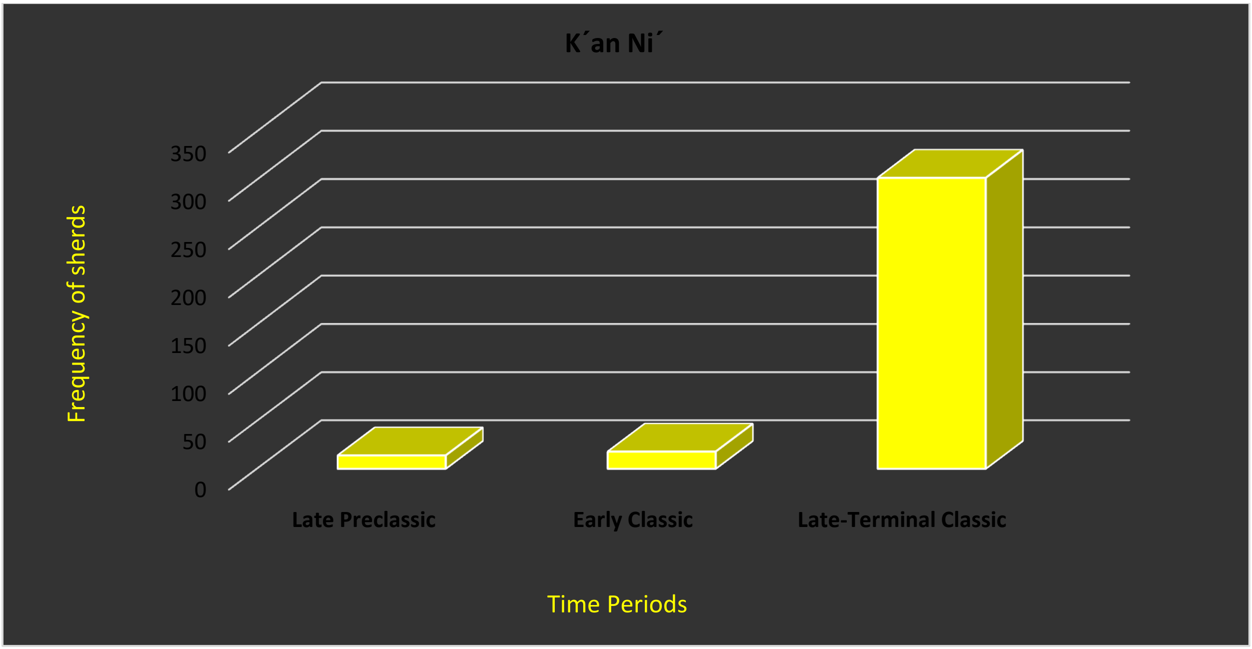


Figure 141. Frequency of sherds by chronological period at the site San Andres Norte Milpa

Table 2: San Andres Norte Milpa					
Time Period	Ceramic Horizon	Group	Type	Variety	Frequency
Posclásico 1250-1450 d.C.	Hocaba/Tases	Navula	Navula unsliped	Navula	3
Clásico Early/Terminal 600-1050 d.C.	Cehpech	Ticul	Ticul thin slate	Ticul	3
		Teabo	Teabo red	Teabo	1
			Becal incised	Becal	1
		Vista Alegre	Vista Alegre striated	Vista Alegre	6
		Muna	Muna slate	Muna	558
			Sacalum black on slate	Sacalum	11
		Chum	Yokat striated	Yokat	1167
	Tepeu	Not designated	Tepeu orange		1
Early Classic 250-600 d.C.	Cochuah	Batres	Batres red	Batres	16
		Aguila	Aguila orange	Aguila	1
		Saban	Saban unsliped	Becoob	2
Late Preclassic 300 a.C.-250 d.C.	Nabanche Early	Sierra	Sierra red	Sierra	11
		Tipikal	Tipikal red on striated	Tipikal	1
		Saban	Tancah burdo	Tancah	4
			Chancenote striated	Chancenote	6
			Chancenote striated	Chiquila	4
			Saban unsliped	Saban	57
Middle Preclassic 600-300 a.C.	Nabanche Early	Chunhinta	Chunhinta black	Ucu	4
		Dzudzuquil	Dzudzuquil cream to bay	Dzudzuquil	34
			Kuche incised	Kuche	1
			Bakxoc black sobre cream	Bakxoc	1

Table 2: San Andres Norte Milpa					
Time Period	Ceramic Horizon	Group	Type	Variety	Frequency
Posclásico 1250-1450 d.C.	Hocaba/Tases	Navula	Navula unsliped	Navula	3
	Mamom		to bay		
		Pital	Pital cream	Pital	2
		Joventud	Joventud red	Joventud	37
			Guitara incised	Guitara	1
Total					1933
			Eroded	134	
			Tejo	1	
			Piedra	1	
			Estuco	2	

a　　b

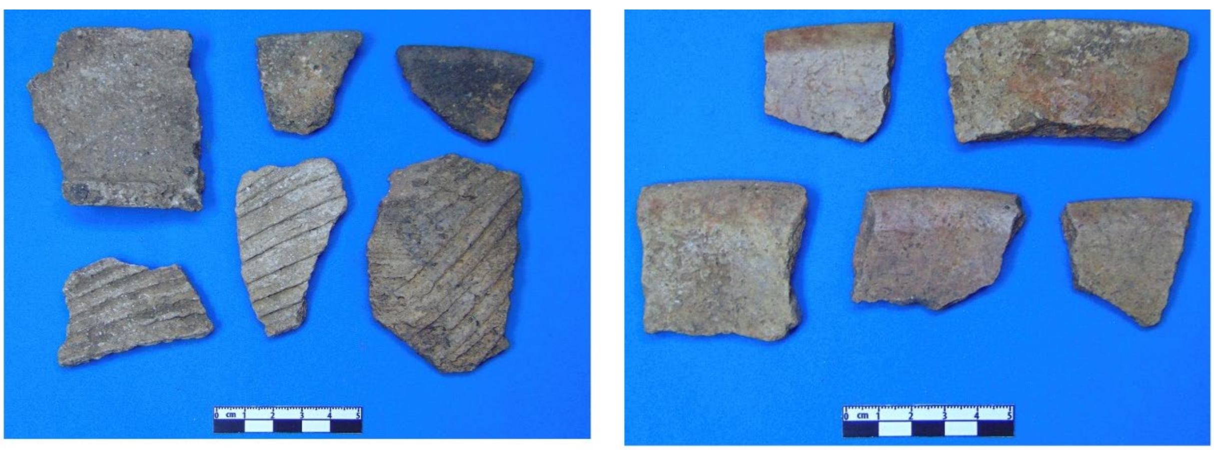
Figure 142. a) Ceramic Group Joventud; b) Ceramic Group Dzudzuquil. Middle Preclassic. San Andres Norte Milpa.

a　　b

Figure 143. a) Ceramic Group Saban; b) Ceramic Group Sierra. Late Preclassic. San Andres Norte Milpa.

a

Figure 144. a) Ceramic Group Batres. Early Classic and beginning of Late Classic. San Andres Norte Milpa.



a b

Figure 145. a) Ceramic Group Chum; b) Ceramic Group Muna. Late Classic/Terminal. San Andres Norte Milpa.

a

Figure 146. a) Ceramic Group Navula. Postclassic.
San Andres Norte Milpa.

K'an Ni'

The archeological site of K'an Ni' has a long occupation that spans from the Late Preclassic to the Late Classic/Terminal (Figure 147). The Late Preclassic was the period of least frequency in the settlement, this period is represented by the Saban and Sierra groups (Figure 148). For the Early Classic, a slight increase in the settlement's occupation was observed, with the registered groups being Triunfo and Maxcanu (Figure 149). The period of greatest frequency was the Late/Terminal Classic, where the presence of the Saxche, Chum, Muna, and Vista Alegre groups could be observed (Figure 150).

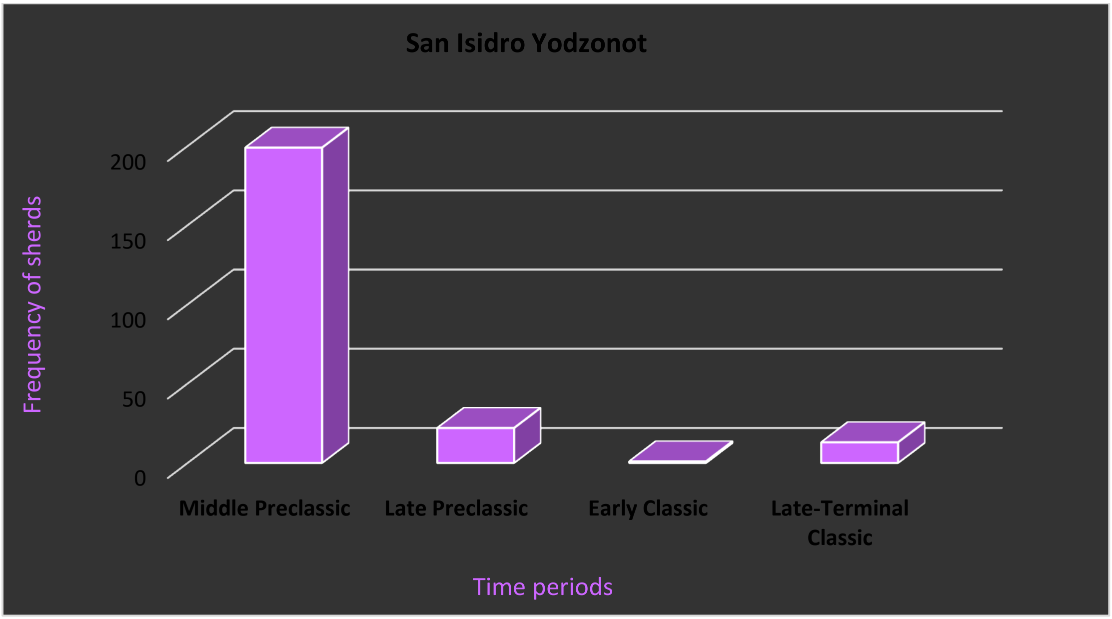


Figure 147. Frequency of pots by chronological period, K´an Ni´.

CRAS 2022 K'an Ni'					
Chronological period	Ceramic horizon	Group	Type	Variety	Frequency
Late Classic/Terminal 600-1050 d.C.	Cehpech	Vista Alegre	Vista Alegre striated	Vista Alegre	3
		Muna	Muna slate	Muna	83
		Chum	Yokat striated	Yokat	198
	Tepeu	Saxche	Saxche polychrome orange	Dzaptun	16
			Policromo Eroded		2
Early Classic 250-600 d.C.	Cochuah	Maxcanu	Maxcanu bay	Maxcanu	11
		Triunfo	Triunfo striated	Triunfo	7
Late Preclassic 300 a.C.-250 d.C.	Nabanche Early	Sierra	Sierra red	Sierra	3
		Saban	Chancenote striated	Chancenote	11
Total					334
			Eroded	16	

a b

Figure 148. a) Ceramic Group Sierra; b) Ceramic Group Saban. Late Preclassic. K'an Ni'.

a b

Figure 149. a) Ceramic Group Triunfo; b) Ceramic Group Maxcanu. Early Classic. K'an Ni'.

Figure 150. a) Ceramic Group Saxche; b) Ceramic Group Muna; c) Ceramic Group Chum. Late Classic/Terminal, K'an Ni'.

San Isidro Yodzonot

Finally, there is the site of San Isidro Yodzonot, which has an occupation ranging from the Middle Preclassic to the Late Classic/Terminal (Figure 151). The Middle Preclassic was the period with the greatest presence of material, represented by the Joventud, Pital, Dzudzuquil, Chunhinta, and Saban groups, the latter by the Saban type without slip (Figure 152).

For the Late Preclassic, the prevalence of the Saban group is observed, this time with the Chancenote striated type accompanied by the Sierra and Flor groups (Figure 153). The Early Classic was the period with the least presence at the site, with only one sherd belonging to the Tituc group. In the Late/Terminal Classic period, a slight increase is observed with the presence of the Chum and Muna groups (Figures 154).

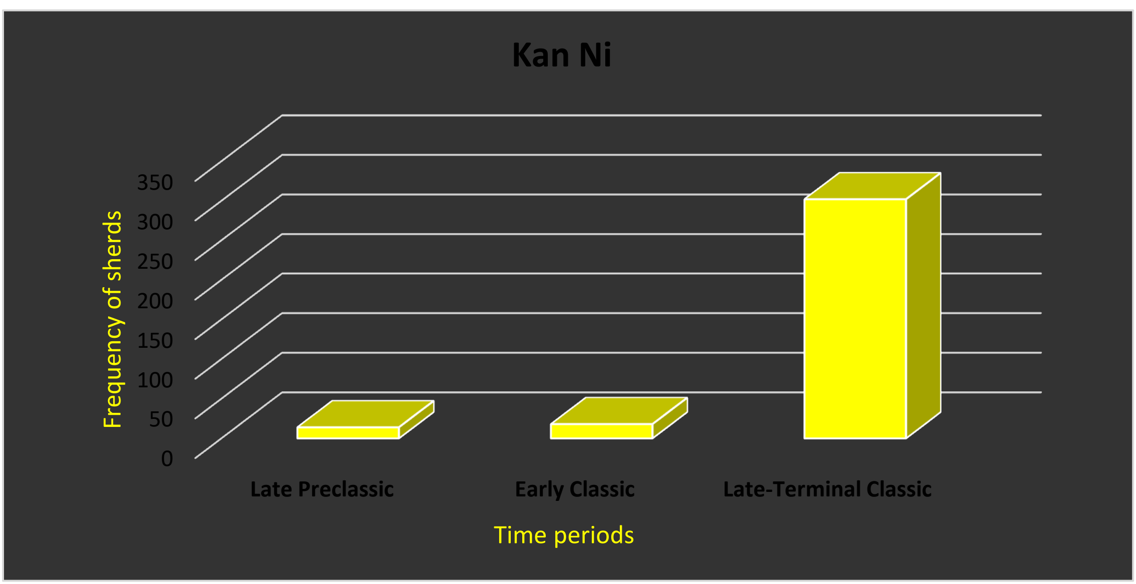


Figure 151. Frequency of sherds by chronological period at the site K´an Ni´.

Table 4 Cochuah Regional Archaeological Survey CRAS 2022 San Isidro Yodzonot					
Chronologic period	Ceramic Horizon	Group	Type	Variety	Frequency
Late Classic/Terminal 600-950 d.C.	Cehpech	Muna	Muna slate	Muna	11
		Chum	Yokat striated	Yokat	2
Early Classic 250-600 d.C.	Cochuah	Tituc	Tituc polychrome orange	Tituc	1
Late Preclassic 300a.C.-250 d.C.	Chicanel y Nabanche Early	Flor	Flor cream	Flor	6
			Mateo red on cream	Mateo	5
		Sierra	Sierra red	Sierra	6
		Saban	Chancenote striated	Chiquila	5
			Saban unsliped	Saban	65
Middle Preclassic 800-300 a.C.	Nabanche Early	Chunhinta	Chunhinta black	Ucu	7
	Mamom	Dzudzuquil	Dzudzuquil cream to bay	Dzudzuquil	45
			Bakxoc black and cream to bay	Bakxoc	3
		Pital	Pital cream	Pital	4
			Muxanal red on cream	Muxanal	2
			Special with fluted decoration		1
		Joventud	Joventud red	Joventud	72
Total					235
			Eroded	75	

a b

Figure 152. a) Ceramic Group Joventud; b) Ceramic Group Saban. Middle Preclassic. San Isidro Yodzonot.

a b

Figure 153. a) Ceramic Group Sierra; Ceramic Group Flor. Late Preclassic, San Isidro Yodzonot.

a a

Figure 154. a) Ceramic Group Tituc. Early Classic; b) Ceramic Group Muna. Late Classic/Terminal, San Isidro Yodzonot.

Part 4: Summary and Analysis

Chapter 16. Lithics of 2022 Season

Laurelyn Memmott

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The Cochuah Regional Archaeological Survey (CRAS) generally locates fewer than 30 lithics per season; however, over 300 lithics were found in 2019 and over 100 in 2022. The increase in lithic material was due to the project's 2019 and 2022 goals to investigate residential structures, which often contain more lithics than other features.

Collecting a larger amount of lithics required a re-evaluation of CRAS' existing methods so that the assemblage could better address questions regarding settlement and lithic procurement in the Cochuah Region. In particular, the project sought to determine if people made tools at their settlements or if they only retouched tools that were crafted elsewhere.

Addressing this question required a heavier emphasis on flake technomorphology than previously implemented by CRAS. This methodology is based on one included in William Andrefsky Jr.'s book, *Lithics: Macroscopic Approaches to Analysis (1998).* The project's lithicist examined each flake and noted the materials used, the stage of reduction (primary, secondary, and tertiary), and, when possible, each flake's technomorphology.

Technomorphology builds on reduction stages by identifying if the flake was a core-removal flake, a finishing or retouch flake, a blade, or a biface-thinning flake. Other technomorphological categories exist; however, none were identified during the 2022 season. This approach to studying the 2022 season's lithics also required less time as technomorphology and reduction stage are not dependent on size or size classes. Size classes and heat alterations were noted in case this information is useful for answering future questions.

CRAS recorded tools in the same way the project has always recorded them. The lithicist noted material type and heat alterations, took exact measurements of formal tools, and performed macroscopic use-wear analysis. The use-wear analysis, which did not include the use of a hand-lens or microscope, answers basic questions regarding how people used the tools found during the 2022 season. The following discussion is broken down by specific sites and assumes that silicified limestone is the only local material. Technomorphology will be referred to as morphology for the remainder of the lithics section. When size classes are noted, they include <1 cm, 1-3 cm, 3-5 cm, and 5+ cm.

Primary flakes were those with 100% dorsal cortex, secondary flakes had 1-99% dorsal cortex, and tertiary flakes had no dorsal cortex. All lithic fragments discovered were appropriately categorized and submitted to INAH Quintana Roo for preservation.

Sisal Operation 10, Level 1, Lot 1

Sisal Operation 10 Level 1 Lot 1 yielded 20 pieces of debitage and two tools. The debitage included 16 pieces of chert, three pieces of chalcedony, and one piece of silicified limestone. Of the pieces of chert, there were four secondary flakes with indeterminate morphology, two secondary core-reduction flakes, seven tertiary flakes with indeterminate morphology, and three tertiary core-reduction flakes. The chalcedony included one tertiary finishing flake, one piece of tertiary angular debris, and one tertiary core-reduction flake. The lone piece of silicified limestone was a tertiary flake with indeterminate morphology. Most flakes from this level and lot were flakes with indeterminate morphology, followed by core-reduction flakes. Six of the flakes showed signs of heat alteration, which included fire-crazing, potlid scars, and reddening.

This level included two tools: a silicified limestone flake tool and a chalcedony flake tool. Both were made from tertiary flakes with indeterminate morphology and were sorted into size classes. The silicified limestone flake tool fell into the 5+ cm size class and showed use-wear, which included micro-flaking, on one margin. The tool's function was unclear, and it lacked any signs of heat-alteration. The chalcedony flake tool was between 1-3 cm and exhibited heavier use-wear along one margin (compared to the silicified limestone tool). The lithicist determined that this tool was heat-altered, possibly during slash-and-burn agriculture, and that it was used for cutting.

Sisal Operation 10, Level 2, Lot 1

Sisal Operation 10 Level 2 Lot 1 yielded 23 pieces of debitage and 22 tools. The debitage included 17 pieces of chert, three pieces of chalcedony, two pieces of orthoquartzite, and one piece of silicified limestone. Of the pieces of chert, there were four secondary core-reduction flakes, eight tertiary core-reduction flakes, two tertiary flakes with indeterminate morphology, one tertiary piece of angular debris, one primary flake with indeterminate morphology, and one spall. Spalls are an indicator of a material that lost water during high heat, which caused part of the material to spall off. The chalcedony included two tertiary flakes with indeterminate morphology and one tertiary piece of angular debris. One orthoquartzite flake was a secondary flake with indeterminate morphology and the other was a primary core-reduction flake. The lone silicified limestone flake was a tertiary flake with indeterminate morphology. Besides the chert spall, there were three flakes that exhibited signs of heat-alteration.

This level included 20 groundstone tools and two flaked tools. All 20 of the groundstone tools were subrounded pieces of limestone that exhibited light to heavy polish. These ranged in size from 1-3 cm and were located near ceramic sherds that CRAS interpreted to be rattles. Given the context, roundness, and polish, these pieces of limestone likely functioned as the interior of the rattle. The two flaked tools included a limestone hammerstone and a chert multidirectional core. The hammerstone measured 4.2 cm by 50 cm by 42 cm and exhibited light pecking in two areas. The multidirectional core measured 3.2 cm by 1.6 cm by 2.1 cm and exhibited six flake scars. The hammerstone and core did not show any signs of heat-alteration, but the 20 interior rattle pieces showed some reddening.

Sisal Operation 10, Level 2, Lot 1 yielded one chalcedony piece of angular debris with no clear stage of reduction. It did exhibit signs of heat-alteration, which may be a result of slash-and-burn agriculture.

Sisal Operation 10, Summary

Operation 10 contained mostly tertiary core-reduction flakes (n=13) and tertiary flakes with indeterminate morphology (n=12). Overall, there were 19 core-reduction flakes and 19 flakes with indeterminate morphology. There were 24 tools, which included 20 interior pieces of a rattle, two flake tools, one hammerstone, and one core. The hammerstone, core, and 19 core-reduction flakes suggest that people manufactured their own informal tools at Sisal Operation 10 but did not produce or use any formal tools. The low amount of primary flakes (n=2) suggests that the cores were initially shaped at a different location.

Operation 11, Level 1, Lot 1

Sisal Operation 11 Level 1 Lot 1 yielded 15 pieces of debitage, one tool, and one speleothem. The debitage included 12 pieces of chert, two pieces of silicified limestone, and one piece of obsidian. Of the pieces of chert, there were six tertiary flakes with indeterminate morphology, five tertiary core-reduction flakes, and one tertiary finishing flake. The silicified limestone included one tertiary core-reduction flake and one flake with indeterminate morphology. The lone piece of obsidian was a tertiary blade. Most flakes from this level and lot were tertiary flakes with indeterminate morphology or tertiary core-reduction flakes. No secondary or primary flakes were located. Seven of the flakes showed signs of heat-alteration, which included fire-crazing, potlid scars, and reddening.

This level included one piece of groundstone and one unshaped speleothem. The groundstone was a piece of silicified limestone that measured 1.5 cm by 1 cm by 0.9 cm. It exhibited polish and flattened ridges. The speleothem measured between 1-3 cm. The function of the speleothem is unknown. Neither tool showed signs of heat alteration.

Operation 11, Level 1, Lot 4

Sisal Operation 11 Level 1 Lot yielded two tools. Both tools were two-handed hands, which were subjected to petrographic analysis to better determine the material types and their function. The first tool was a primarily quartzite or chert hand that measured 18.1 cm by 7 cm by 5.5 cm. Both ends of the hand were pecked and smoothed, which created flattened ends. The entire surface of the hand was highly polished with very light multidirectional striations. Light pecking is visible beneath the polish, which indicates that the tool was rejuvenated at least once. The second hand was a stone described as a mixture of calcium carbonate and quartz. This hand measured 15.9 cm by 6.2 cm by 4.3 cm. The use-wear on this tool matched the use-wear of the first hand; however, this hand was less polished with one area that was worn until nearly flat. Only the second hand showed signs of heating. Based on the petrographic analysis, it was suggested that both hands were used to crush sascab and/or create stucco.

Operation 11, Level 2, Lot 1

Sisal Operation 11 Level 2 Lot 1 yielded two small pieces of groundstone. The first piece of groundstone measured 8 cm in diameter while the second measured 12 cm in diameter. Both pieces exhibited the same use-wear and reddening as the interior rattle pieces located in Operation 10 Level 2 Lot 1. It is likely these two pieces of groundstone served the same purpose.

Operation 11, Summary

Operation 11 contained mostly tertiary flakes with indeterminate morphology (n=7) and tertiary core-reduction flakes (n=6). CRAS also located one tertiary obsidian blade and one tertiary chert finishing flake. There were five tools, which included two interior pieces of a rattle, two hands, one indeterminate piece of groundstone. In addition, Level

1 Lot 1 yielded one unshaped speleothem. The assemblage suggests that people did not invest time in the production or use of flaked stone tools. Rather, the activities at Operation 11 included processing other materials, such as sascab.

K'an Ni'

K'an Ni' yielded two pieces of debitage: a piece of tertiary chert angular debris and one tertiary silicified limestone core-reduction flake. Neither piece of debitage exhibited signs of use or of heat-alteration. Lithic use in the section of K'an Ni' that CRAS excavated in 2022 was light and does not add to the activities at the site in the Terminal Classic.

San Isidro Yodzonot

San Isidro Yodzonot yielded six pieces of chert debitage, one tool, and six unshaped speleothems. This included four tertiary core-reduction flakes and two secondary flakes with indeterminate morphology. The tool, a chert scraper, measured between 1-3 cm. Use-wear included micro-flaking along a steep edge angle. All six speleothems measured between 3-5 cm. The function of the speleothems is unknown. None of the lithic artifacts at San Isidro Yodzonot exhibited signs of heat-alteration. The assemblage suggests that people did not invest time in the production or use of formal tools at this site in the Terminal Classic.

San Andres Norte Milpa (SANM), Operation 1, Level 1, Lot 1

Operation 1 Level 1 Lot 1 yielded 11 pieces of debitage and two tools. Of the pieces of chert, there were three tertiary pieces of angular debris, two tertiary flakes with indeterminate morphology, one tertiary core-reduction flake, and one tertiary finishing flake. The remaining flakes included two tertiary silicified limestone flakes with indeterminate morphology, one tertiary silicified limestone core-reduction flake, and one secondary chalcedony flake with indeterminate morphology. The tools included one limestone hand and one chalcedony scraper. The hand measured 8.9 cm by 7.2 cm by 6.7 cm and exhibited grinding and heavy pecking across the entire tool. The edges were shaped and the entire tool was roughened to provide a fresh grinding surface. The scraper measured 3.1 cm by 4.4 cm by 1.9 cm and exhibited micro-flaking and crushing along a steep distal margin. Two flakes showed signs of heat-alteration, which may be due to slash-and-burn agriculture.

San Andres Norte Milpa (SANM), Operation 1, Level 1, Lot 2

Operation 1 Level 1 Lot 2 yielded three pieces of debitage and one tool. The debitage included a chert tertiary flake with indeterminate morphology, a chert tertiary core-reduction flake, and a chalcedony tertiary piece of angular debris. The tool was an exhausted multidirectional chalcedony core that measured 2.5 cm by 2.8 cm by 2.1 cm and exhibited 16 flake scars and five percent cortex. None of the lithic artifacts in Lot 2 showed signs of heat-alteration.

San Andres Norte Milpa (SANM), Summary

SANM Operation 1 contained mostly tertiary flakes with indeterminate morphology (n= 5). The Operation included a small amount of angular debris (n=4), core-reduction flakes (n= 3), a chalcedony scraper, and an exhausted chalcedony core. This suggests that the occupants of SANM Operation 1 brought in at least one core to manufacture simple, informal tools. The remaining tool was a limestone hand, which was associated with processing food or other materials.

San Andres Norte Milpa (SANM), Operation2, Level 1, Lot 1

Operation 2 Level 1 Lot 1 yielded ten pieces of debitage and one tool. The debitage included eight pieces of chert, one piece of chalcedony, and one piece of silicified limestone. Of the pieces of chert, there were four secondary flakes with indeterminate morphology, one secondary core-reduction flake, one secondary finishing flake, one tertiary flake with indeterminate morphology, and one tertiary finishing flake. The piece of chalcedony was a secondary flake with indeterminate morphology and the silicified limestone was a tertiary blade. The tool was a piece of silicified limestone groundstone that measured 7 cm by 5.4 cm by 5 cm. It exhibited unidirectional striations and grinding over a pecked and roughened surface. Based on the size, shape, and use-wear, this groundstone was likely used as a hand. Two flakes and the groundstone showed evidence of heat-alteration, which may be a result of slash-and-burn agriculture.

Summary

SANM Operation 2 contained mostly secondary flakes with indeterminate morphology (n=5). Other flakes indicate a low amount of core-reduction and finishing activities. The tool was a probable silicified limestone hand, which was associated with processing food or other materials. The assemblage indicates that people did not invest time in the production or use of formal flaked tools at this site in the Terminal Classic.

Final Thoughts

Overall, the lithics retrieved by CRAS in 2022 show a preference for non-local materials and a lack of formal flaked tools. Of the season's 91 pieces of debitage, only five were from a local silicified limestone. The 12 tools listed above included three pieces of silicified limestone and two pieces of local limestone. All 24 interior rattle pieces were formed from silicified limestone. Seven tools were informal flaked tools while the others included a hammertstone, two two-handed hands, and two one-handed hands. Besides the two-handed hands, the groundstone materials included silicified limestone and limestone. Clearly, the Terminal Classic occupants favored the coarser local material for groundstone and interior rattle pieces while reserving finer-grained, more homogeneous materials for informal flaked tools.

The absence of formal tools does not preclude their use outside of residential structures. Likewise, the low amount of tool manufacture and retouch at all of the sites does not indicate that tools were manufactured and refurbished outside of these homes. It is possible that future work in the Cochuah Region could yield evidence of small lithic workshops. At this stage of investigation, the most likely scenario is that the Terminal Classic Maya of Cochuah brought in non-local lithic material through trade or scavenging. Either through lack of specialized skill or through expediency, the residents produced simple, informal tools when they were needed (Horowitz and McCall 2019).

The origin of the project's chert, chalcedony, orthoquartzite, and obsidian is unknown. Of these materials, CRAS feels that the obsidian is a good candidate for future

X-Ray Fluorescence (XRF). XRF would narrow down the obsidian's origin, which would shed light on local trade-routes. Another line of inquiry would be to determine the food or materials the Terminal Classic Maya processed near these structures. As such, CRAS suggests that future investigations include residue analysis.

Table 1. Sisal, Operation 10, Level 1, Lot 1, Debitage

SubOp	Material	Local material	Flake or AD	Primary, Secondary, Tertiary	Reduction Technology	Size/Class	Thermic Treatment	Notes
h12	Chert	Yes	Flake	T	No	3-5 cm	No	
i14	Chert	No	Flake	S	Core removal	1-3 cm	No	
i14	Chalcedony	AD	Flake	T	No	3-5 cm	No	

Table2. Sisal, Operation 10, Level 1, Lot 1, Tools

SubOp	Material	Tool	Local material	Primary, Secondary, Tertiary	Reduction Technology	Size clase	Thermic Treatment	Use or retouch	Notes	Description
a3	Limestone silicified	Flake Tool	Yes	T	Indeterminate	5cm+	No	Use		Single-edged flake, tool with use on the dorsal side
L3	Chalcedon y	Flake Tool	No	T	Indeterminate	1-3cm	Yes	Use	Probable cutter	Single-edged flake, tool with use on the dorsal side

Table3. Sisal, Operation 10, Level 2, Lot 1, Debitage

SubOp	Material	Tool	Local material	Primary, Secondary, Tertiary	Reduction Technology	Size clase	Thermic Treatment	Notes
a1	Quartzite	No	Flake	S	No	1-3cm	No	
c12	Limestone silicified	Yes	Flake	T	No	3-5cm	No	

SubOp	Material	Tool	Local material	Primary, Secondary, Tertiary	Reduction Technology	Size clase	Thermic Treatment	Notes
c5	Chert	No	AD	T	No	1-3cm	No	
e4	Chert	No	Flake	T	Core reduction	3-5cm	No	
f13	Chalcedony	No	Flake	T	No	1-3cm	Yes	
f15	Chalcedony	No	Flake	T	No	1-3cm	No	
f15	Chert	No	Flake	T	Core reduction	1-3cm	No	
f4	Chert	No	spall	T	No	3-5cm	No	
f4	Chert	No	Flake	S	Core reduction	1-3cm	Yes	
g15	Chert	No	Flake	S	Core reduction	1-3cm	No	
g2	Chert	No	Flake	T	No	1-3cm	Yes	
i2	Chert	No	Flake	T	Core reduction	1-3cm	No	
i2	Chert	No	Flake	T	Core reduction	1-3cm	No	
i2	Chert	No	Flake	S	Core reduction	1-3cm	No	
j15	Quartzite	No	Flake	P	Core reduction	5+	No	

SubOp	Material	Tool	Local material	Primary, Secondary, Tertiary	Reduction Technology	Size clase	Thermic Treatment	Notes
j18	Chert	No	Flake	P	No	3-5cm	No	
k7	Chert	No	Flake	T	No	1-3cm	No	
L1	Chert	No	Flake	T	Core reduction	1-3cm	No	
L2	Chert	No	Flake	S	Core reduction	1-3cm	No	
L4	Chert	No	Flake	T	Core reduction	1-3cm	No	
m3	Chert	No	Flake	T	Core reduction	1-3cm	Yes	
m4	Chert	No	Flake	T	Core reduction	1-3cm	No	
m9	Chalcedony	No	AD	T	No	1-3cm	No	

Table4. Sisal, Operation 10, Level 2, Lot 1, Possible rattles

SubOp	Material	Local materia l	Large (mm)	Wide (mm)	Thickness (mm)	Thermic Treatment	Description
c7	Limestone	Yes	14	13	15	No	Round, with a slightly polished surface, probably a rattle
c7	Limestone	Yes	16	14	9	No	Round, with a slightly polished surface, probably a rattle
f13	Limestone	Yes	23	16	14	No	Round, with a slightly polished surface, probably a rattle natural edges flattened on all pieces.

SubOp	Material	Local materia l	Large (mm)	Wide (mm)	Thickness (mm)	Thermic Treatment	Description
f13	Limestone	Yes	18	15	16	No	Round, with a slightly polished surface, probably a rattle
f15	Limestone	Yes	31	26	29	No	Round, unpolished surface, with somewhat flattened edges, likely the inner part of a rattle.
f15	Limestone	Yes	21	16	19	No	Round, unpolished surface, with somewhat flattened edges, likely the inner part of a rattle.
f15	Limestone	Yes	18	15	17	No	Round, with a slightly polished surface, probably a rattle
h13	Limestone	Yes	22	20	16	No	Round, polished surface, possibly a rattle
i11	Limestone	Yes	15	13	15	No	Round, with a slightly polished surface, probably a rattle
i9	Limestone	Yes	20	15	19	No	Round, polished surface, possibly a rattle
i9	Limestone	Yes	21	20	15	No	Round, polished surface, possibly a rattle
i9	Limestone	Yes	21	17	12	No	Round, polished surface, possibly a rattle
i9	Limestone	Yes	21	17	12	No	Round, polished surface, possibly a rattle
i9	Limestone	Yes	47	24	21	No	Rounded; light polish in one area, probably natural.
j8	Limestone	Yes	16	15	17	No	Rounded, without polished surfaces, flattened edges, probable rattle
k11	Limestone	Yes	23	22	20	No	Rounded, without polished surfaces, flattened edges, probable rattle
k11	Limestone	Yes	22	16	15	No	Rounded, without polished surfaces, flattened edges, probable rattle
k13	Limestone	Yes	15	11	10	No	Round, polished surface, possibly a rattle
k17	Limestone	Yes	19	17	14	No	Round, polished surface, possibly a rattle
k7	Limestone	Yes	17	13	12	No	Round, polished surface, possibly a rattle
c7	Limestone	Yes	14	13	15	No	Round, with a slightly polished surface, probably a rattle

Table 5. Sisal, Operation 10, Level 2, Lot 1, Tools

SubOp	Material	Tool	Local material	Size clase	Large (mm)	Wide (mm)	Thickness (mm)	Thermic Treatment	Use or retouch	Notes
L4	Limestone	hammer	Yes	No	42	50	42	No	Use	Pecked in two areas, probably by a hammer.
j15	Chert	core, multidireccional	No	No	32	16	21	No	No	6 flakes scars

Table 6. Operation 10, Level 2, Lot 1, Debitage

SubOp	Material	Local material	Flake	Primary, Secondary, Tertiary	Reduction Technology	Size/Class	Thermic Treatment	Notes
j17	Chalcedony	No		No	Core reduction	1-3cm	Yes	No

Table 7. Sisal, Operation 11, Level 1, Lot 1, Debitage

SubOp	Material	Local material	Flake	Primary, Secondary, Tertiary	Reduction Technology	Size/Class	Thermic Treatment	Notes
a2	obsidian	No	blade	T	blade	1-3cm	No	No
b2	Chert	No	Flake	T	core reduction	3-5cm	Yes	No
bb17	Chert	No	Flake	T	core reduction	3-5cm	Yes	No
bb20	Chert	No	Flake	T	No	1-3cm	No	No
c3	Chert	No	Flake	T	core reduction	3-5cm	No	No

SubOp	Material	Local material	Flake	Primary, Secondary, Tertiary	Reduction Technology	Size/Class	Thermic Treatment	Notes
cc2	Chert	No	Flake	T	core reduction	3-5cm	No	No
dd17	Limestone silicified	Yes	Flake	T	core reduction	3-5cm	Yes	No
dd2	Chert	No	Flake	T	No	1-3cm	No	No
dd22	Chert	No	Flake	T	No	3-5cm	No	No
e13	Chert	No	Flake	T	No	1-3cm	Yes	No
e13	Chert	No	Flake	T	No	1-3cm	Yes	No
f19	Chert	No	Flake	T	core reduction	3-5cm	Yes	No
j8	Chert	No	Flake	T	No	1-3cm	Yes	No
O11	Limestone silicified	Yes	Flake	T	No	1-3cm	No	No
q15	Chert	No	Flake	T	finishing/reforming	1-3cm	No	No

Table 8. K'an Ni', Debitage

Op	Material	Local material	Flake	Primary, Secondary, Tertiary	Reduction Technology	Size/Class	Thermic Treatment	Notes
2	Chert	No	Angular waste	No	No	3-5cm	No	No
2	Limestone silicified	Yes	Flake	T	Core reduction	3-5cm	No	No

Table 9. Sisal, Operation 11, Level 1, Lot 1, Speleothem

SubOp	Material	Local material	Type	Large (mm)	Wide (mm)	Thickness (mm)	Thermic Treatment	Notes
q15	Calcium carbonate	No	manuport	31	15	10	No	No

Table 10. Sisal, Operation 11, Level 1, Lot 1, Tools

SubOp	Material	Tool Type	Local material	Size/Class	Large (mm)	Wide (mm)	Thickness (mm)	Thermic Treatment	Use or retouch	Notes
bb18	Limestone silicified	Grinding stone	Yes	1-3cm	15	10	9	No	Use	Clear signs of polishing and thinning at the edges.

Table 11. Sisal, Operation 11, Level 1, Lot 4, Tools

No. de hand	Material	Tool Type	Local material	Large (mm)	Wide (mm)	Thickness (mm)	Thermic Treatment	Notes
1	Mixture of calcite and quartz	Metate handstone	No	159	62	43	Yes	Petrographic analysis revealed evidence of use for crushing sascab/making stucco. Both ends were pecked and then smoothed until they were almost flat. The entire work surface was pecked (to rejuvenate it) and then sanded/smoothed. One face is almost completely smoothed, with unidirectional striations.

2	Primary quartz or Chert	Metate handstone	No	181	70	55	Yes	The petrographic analysis showed that there is evidence of use for crushing sascab/making stucco. Both ends were pecked and smoothed to create flattened ends. The entire used surface is highly polished. Very light, visible scratches (multidirectional). Light pitting below the polished surface.

Table 12. Sisal, Operation 11, Level 2, Lot 1, Possible rattles

SubOp	Material	Local material	Large (mm)	Wide (mm)	Thickness (mm)	Thermic Treatment	Description
h17	Limestone	Yes	8	8	8	Yes	Round, with an unpolished surface, slightly flattened edges, probably a jingle bell.
h17	Limestone	Yes	12	11	12	Yes	Round, polished surface, possibly a rattle

Table 13. San Isidro Yodzonot Debitage

SubOp	Material	Local material	Flake	Primary, Secondary, Tertiary	Reduction Technology	Size/Class	Thermic Treatment	Notes
Op3b N1 L1	Chert	No	Flake	T	Core reduction	1-3cm	No	No
Op4 N1 L3	Chert	No	Flake	S	No	1-3cm	No	No
Op4 N1 L3	Chert	No	Flake	T	Core reduction	3-5cm	No	No

Op4 N1 L3	Chert	No	Flake	T	Core reduction	1-3cm	No	No
Op4 N1 L3	Chert	No	Flake	T	Core reduction	1-3cm	No	No
Op4 N2 L1	Chert	No	Flake	S	No	3-5cm	No	No

Table 14. San Isidro Yodzonot Tools

SubOp	Material	Tool Type	Local material	Large (mm)	Wide (mm)	Thickness (mm)	Thermic Treatment	Use or retouch	Notes
Op4 N2 L1	Chert	scraper	No	20	25	6	No	Use	Stepped edge with micro-flakes

Table 15. San Isidro Yodzonot, Speleothems

SubOp	Material	Local material	Type	Large (mm)	Wide (mm)	Thickness (mm)	Thermic Treatment	Notes
Op4 N2 L1	Calcium carbonat e	No	manuport	45	19	21	No	6 speleothems, all in the 3–5 cm size range.

Table 16. San Andres Norte Milpa, Operation1, Level 1, Lot 1, Debitage

SubOp	Material	Local material	Flake	Primary, Secondary, Tertiary	Reduction Technology	Size/Class	Thermic Treatment	Notes
a18	Chert	No	AD	No	No	1-3 cm	No	No
b25	Chert	No	Flake	T	finished/remanufactured	3-5 cm	No	No
d24	Chert	No	Flake	T	No	1-3 cm	Yes	No
f4	Chert	No	Flake	T	No	3-5 cm	No	No
j15	Limestone silicified	Yes	Flake	T	No	1-3 cm	No	No
j21	Chert	No	Flake	T	Core removal	1-3 cm	No	No
k6	Chert	No	AD	No	No	1-3 cm	Yes	No
L16	Chert	No	AD	No	No	3-5 cm	No	No
L17	Limestone silicified	Yes	Flake	T	No	3-5 cm	No	No
L18	Limestone silicified	Yes	Flake	T	finished/remanufactured	3-5 cm	No	No
L7	Chalcedony	No	Flake	S	No	1-3 cm	No	No

Table 17. San Andres Norte Milpa, Operation1, Level 1, Lot 1, Tools

SubOp	Material	Tool Type	Local materia l	Large (mm)	Wide (mm)	Thickne ss (mm)	Thermic Treatment	Use or retouch	Notes
d17	Limestone	hand	Yes	89	72	67	No	Use	Left half rough, with formed edges. Edges shaped by scraping and heavy pecking. It probably wasn’t used much after the surface became rough again. More intense pecking on the sides.

j6	Chalcedony	scraper	No	31	44	19	No	Use	Scraper made on the edge of an early-stage bifacial flake or AD, with micro-flaking and thinning along the 40 mm distal edge. Edge angle >60°

Table 18. San Andres Norte Milpa, Operation1, Level 1, Lot 2, Debitage

SubOp	Material	Local material	Flake	Primary, Secondary, Tertiary	Reduction Technology	Size/Class	Thermic Treatment	Notes
h12	Chert	Yes	Flake	T	No	3-5 cm	No	No
i14	Chert	No	Flake	S	Core removal	1-3 cm	No	No
i14	Chalcedony	indeterminate	Flake	T	No	3-5 cm	No	No

Table 19. San Andres Norte Milpa, Operation1, Level 1, Lot 2, Tools

SubOp	Material	Tool Type	Local material	Large (mm)	Wide (mm)	Thickness (mm)	Thermic Treatment	Use or retouch	Notes
f14	Chalcedony	core	No	25	28	21	No	No	Multidirectional, core exhausted with a 16-flake scar

Table 20. San Andres Norte Milpa, Operation 2, Level 1, Lot 1

SubOp	Material	Local material	Flake	Primary, Secondary, Tertiary	Reduction Technology	Size/Class	Thermic Treatment	Notes
b11	Chert	No	Flake	S	Core reduction	1-3cm	Yes	No

SubOp	Material	Local material	Flake	Primary, Secondary, Tertiary	Reduction Technology	Size/Class	Thermic Treatment	Notes
c9	Chert	No	Flake	S	finished/remanufactured	3-5cm	No	No
d11	Chert	No	Flake	T	finished/remanufactured	1-3cm	No	No
d12	Chert	No	Flake	S	No	1-3cm	Yes	No
d12	Limestone silicified	Yes	Flake	T	blade	1-3cm	No	No
d8	Chert	No	Flake	S	No	1-3cm	No	No
f4	Chert	No	Flake	S	No	1-3cm	No	No
g3	Chert	No	Flake	T	No	1-3cm	No	No
h8	Chert	No	Flake	S	No	1-3cm	No	No
n12	Chalcedony	No	Flake	S	No	1-3cm	No	No

Table 21. San Andres Norte Milpa, Operation 2, Level 1, Lot 1, Tools

SubOp	Material	Tool Type	Local materia l	Large (mm)	Wide (mm)	Thickne ss (mm)	Thermic Treatment	Use or retouch	Notes
a3	Limestone silicified	Grinding stone	Yes	70	54	50	Yes	Use	Unidirectional striations and polishing on the pitted/rough surface; the remaining edge is pitted/rounded and slightly burned/blackened.

Part 4: Summary and Analysis

Chapter 17. Soil analysis of 2022 Season

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Soil analyses, known as spot tests, were performed to better understand the four circular structures investigated this season at the Sisal and San Andrés Norte Milpa sites (see Chapters 6, 7, 13, and 14). These chemical analyses have been widely used to identify potential activity areas, which can provide insight into the function of these perishable structure foundations.

Geochemical analysis

This type of analysis in archaeological contexts began to be used more than three decades ago and was derived from other disciplines such as agronomy and geochemistry, two fields that possess specialized knowledge in soil enrichment and qualities (Barba 1990; Holliday 2004; Middleton et al. 2010: 185–85). Currently, the use of this type of geochemical analysis has spread in archaeological studies with quite successful results (Barba et al. 2014; Terry et al. 2015).

The principle on which this type of analysis is based is that floors and occupation surfaces can preserve chemical traces of the human activities that were carried out on them (Barba 2007: 440–41; Barba et al. 2014: 202–03; Middleton et al. 2010: 185–86). This is because many activities use or produce liquids, which, when spilled, are absorbed through the pores of the surface on which they fall, resulting in an area rich in the liquids' components.

Because they are absorbed into the surface, these residues can be preserved for long periods after their deposition and are often imperceptible to the naked eye, or they may appear as stains on the surface. Another feature of these residues is that, as they filter through the pores of the areas where they fall, they remain in the same location where they were spilled, making them difficult to remove, unlike other archaeological traces (Barba 1990: 197; 2007: 440–42; Barba et al. 2014: 202–03). For this reason, these residues can be considered a reliable indicator of the human activities that took place in the area, which is essential for understanding the function of the investigated areas/structures and their immediate contexts.

In summary, these residues exhibit the essential characteristics of being invisible, intangible, persisting for extended periods within the pores of soils, floors, or ceramic containers, and are generally difficult to remove (Barba et al. 2014: 204), characteristics that are very helpful in understanding the activities that may have produced this type of remains.

The chemical elements that have been identified in the residues of many human activities include phosphorus (P), associated with the preparation, consumption, and disposal of food; sodium (Na) and potassium (K) with the generation of ash in hearths (Middleton and Price 1996; Terry et al. 2000); iron (Fe) and mercury (Hg) in the use of ritual pigments (Wells 2000); manganese (Mn), zinc (Zn), and copper (Cu) related to garbage dumps, tombs, ceremonial activities, and celebrations or banquets; while fatty acids, carbonates, phosphates, pH, protein residues, and soil and floor colorimetry have been used to identify different activity areas related to food activities, preparation, rituals, among others (Anderson et al. 2012; Bair 2010; Barba et al. 1996; Chase et al. 2015; Coronel et al. 2015; Dahlin et al. 2007; 2010; Manzanilla and Barba 1990; Ortiz and Barba 1992; Parnell et al. 2001; 2002; Pecci 2000; Terry et al. 2004; Wells 2004).

It is important to consider that these geochemical analyzes should not be viewed in isolation, but rather analyzed together with the rest of the archaeological evidence, such as the organization of the settlement, the architectural remains, as well as the information and distribution of other traditional materials like ceramics or lithics, among others (Barba et al. 2014: 203; Coronel et al. 2015: 92). In addition to the foregoing, it is necessary to compare the obtained results to information from experimental archaeology and ethnoarchaeological studies, which are critical for understanding and identifying which activities can leave residues on surfaces (Barba et al. 2014; Coronel 2011; Dahlin et al. 2007; Fernández et al. 2002; Middleton and Price 1996).

Use of Geochemical Analysis in Archaeology

There are several archaeological investigations that have applied geochemical studies for the identification of activity areas related to food, food production, and consumption, as well as for the identification of markets or exchange areas, in addition to the study of ritual practices, among other topics (Barba et al. 2014; Terry et al. 2015).

Notable examples of research related to food include those conducted in the Oztoyahualco and Teopancazco complexes in the Valley of Teotihuacán (Barba et al. 2014; Pecci 2000; Pecci et al. 2010), where areas for food preparation, cooking, and consumption were identified, as well as those carried out at Site El 16 in Chihuahua, where areas for storage, waste disposal, rituals, food preparation, and consumption were located, among others (Barba et al. 2014: 216–17).

An example of the application of these techniques in ceramic tableware is the research on Axotlan ceramics or the so-called pulque cups, in which beverages rich in phosphates and protein residues were identified, among other examples (Barba et al. 2014; Pecci et al. 2017). These analyses have been complemented with other indicators such as starch residues and phytoliths, which have helped identify areas of food preparation and consumption, as has been the case in several sites in Yucatán (Herrera 2018; Matos and Acosta 2016). Another recurring theme in which this type of geochemical analysis has been applied is the identification of markets or exchange areas (Dahlin et al. 2007; Terry et al. 2015), based on the premise that markets generate a large amount of organic waste and that evidence of this should remain on the floors of the plazas or surfaces where they were established.

One of the residues that has been associated with the presence of markets is phosphates, as they are indicators of organic matter, whether it has been processed, consumed, or disposed of in those areas (Barba 1986; Barba and Ortiz 1992; Middleton and Price 1996; Parnell et al. 2001; Terry et al. 2000). Phosphate is characterized by being insoluble and resistant to oxidation, reduction, and leaching (Holliday and Gartner 2007; Parnell et al. 2001; Wells 2004), being a fundamental element of living tissues, in the form of nucleic acids, phospholipids, nucleotides, among others (Coronel 2011: 92; Terry et al. 2000).

Therefore, phosphates are associated with the presence of plants, wood, bones, meat, and, in general, any other organic element. Its presence is related to the consumption and disposal of animal and plant products. Examples of research related to the identification of markets include those conducted at sites such as Caracol (Chase et al. 2015) Ceibal (Bair 2010), Chunchucmil (Dahlin et al. 2007), Cobá (Coronel et al. 2015), Mayapán (Bair 2010), Trinidad de Nosotros (Dahlin et al. 2010), Sayil (Terry et al. 2015), among others.

Another topic that has received much attention in this type of analysis is related to the search for residues of ritual activities, such as the case of the investigations in Oztoyahualco and Teopancazco, in the Valley of Teotihuacán (Ortiz and Barba 1992; Pecci 2000; Pecci et al. 2010), or those carried out in the House of the Eagles, in the Templo Mayor of Tenochtitlán (Barba et al. 1996), where high levels of fatty acids and protein residues associated with altars have been found, as well as in other areas near sculptures (of Mictlantecuhtli in the case of Templo Mayor), perhaps related to self-sacrifice rituals.

Additionally, it has also been proposed that elevated levels of certain chemical elements may be related to ritual activities, pilgrimages, or religious ceremonies, which were occasionally carried out in some of the plazas associated with non-permanent or low-intensity markets (Coronel et al. 2015; Dahlin et al. 2010; Terry et al. 2015). In summary, this type of chemical residue analysis is very useful for complementing the traditional archaeological information of the investigated archaeological contexts, being a highly valuable tool for identifying activities that took place on the surfaces.

Spot test analysis methodology

The term spot test refers to a series of semi-quantitative tests that are characterized by being relatively simple and low-cost, which allows for the analysis of a large number of samples. Barba and colleagues developed the methods for these tests (Barba 2007; Barba et al. 1991; 2012), which have been widely used in various archaeological investigations (Barba et al. 2014; 1996; Ortiz and Barba 1993; Pecci 2000; Pecci et al. 2010), as described in the previous section. Although there are other tests that are more precise and complex, such as mass spectrometry (GC-MS or ICP-OES) and X-ray fluorescence, these have a higher cost and, therefore, the sampling areas are more limited. In contrast, spot tests have a greater advantage as they can provide broader area coverage at an affordable cost for almost any research. It is worth noting that the results of these analyzes should be accompanied by other indicators of traditional archaeology, such as architectural elements and ceramics, lithics, among others.

Fatty acids

It is an organic residue that remains on the floors or surfaces where substances containing fat were poured or spilled. This type of waste could have had an animal or plant origin and is extracted through the hydrolysis of fats with ammonium hydroxide, which produces foam (ammonium soaps), which can be quantified according to its intensity (Barba 2007; Barba et al. 1991; 2012). The procedure basically consists of heating the sample in a test tube with chloroform, which is then poured onto a microscope slide to which a few drops of ammonium hydroxide are added, resulting in the formation of bubbles that later condense into foam (see Figure 155).

Carbonates

Carbonates (Figure 156) are inorganic residues that can be easily detected and indicate the use of lime, which may have been used in food preparation or as a construction material. These indicators can indicate areas that were plastered or zones where substances enriched with lime were poured or spilled, such as in the case of nixtamal. The procedure for this test consists of taking part of the sample and placing it inside a test tube, to which a hydrochloric acid solution is added, causing effervescence. This effervescent reaction can be measured on a 5-level scale, although an additional number (6-level scale) can be added for those samples that exhibit a very violent effervescent reaction (Barba 2007; Barba et al. 1991; 2012).

Phosphates

Phosphate tests have been successfully used in various archaeological studies (Barba et al. 1991; Mejía and Barba 2010), because they are very stable and can remain for a long time in the places where they were deposited, making them very useful for detecting organic matter residues that are abundant in phosphorus, such as human tissues, meat waste, skin, feces, urine, among others.

Regarding the procedure, this test was carried out using a portable HANNA colorimeter, model Checker HC, which employs the heteropolyblue method that records the amount of phosphates present in the sample, measured in parts per million (ppm). The procedure consists of comparing a sample of soil dissolved in distilled water, which is introduced into the device to take an initial reference reading.

Subsequently, once the first parameter is recorded, the sample is removed and two reagents (one in powder form and the other liquid) are added, and it is reintroduced into the colorimeter which, after five minutes, returns the reading of the ppm found in the sample, which translates into the presence of a blue coloration measured on a scale from 0 to 30, with the highest value indicating a more intense and concentrated blue color (Barba 2007: 442; Barba et al. 1991) (Figure 157).

pH (potential of hydrogen)

According to Barba et al. (Barba et al. 1991: 24–26; Barba and Córdova 1991: 85–88), high pH levels are related to the location of ashes, as they increase the content of hydroxyl ions. This is an indicator of the places where the combustion of a material took place, as well as its immediate surroundings and the trajectory they follow if they are swept or spread. These values decrease as the distance from the point of combustion increases, so the highest values would suggest the area where the fire had the greatest intensity.

Barba and Córdova (1991: 88) also points out that the area where a human settlement is located presents higher pH levels than a terrain with little human activity, because in these sites various activities involving fire and ashes are carried out, which are spread in the vicinity and cause an increase in these indicators. The procedure for measuring pH involves mixing a sample with distilled water, which is then agitated and left to rest for a short period, after which a pH meter is used to provide a reading on a scale from 1 to 14 (Figure 158).

Protein residues

This type of waste is also caused by organic matter and is achieved by identifying the amino groups of proteins, which can be found in liquids like blood and in some prepared foods containing animal or plant proteins. This measurement is derived from the decomposition of amino groups via an alkaline reaction involving ammonia gas (Barba 2007: 14; Barba et al. 1991: 21–22). The procedure for this test consists of heating a sample mixed with calcium oxide and a few drops of distilled water in a test tube, to which two small strips of pH indicator paper are added. The results are measured with the pH paper indicator, within a scale of 7 to 12, with values of 7-7.5 indicating areas where this type of residue is not found (Figure 159).

Absence of chemical residues or "empty" spaces

While the possible implications of waste concentrations have been mentioned, it is also important to highlight that the absence of indicators is useful for interpreting activity areas in past contexts. In this sense, plazas, roads, transit areas, or other surfaces that were constantly swept or cleaned should have fewer residues and should appear as "blank" spaces, where enrichment levels would be very low or null (Barba 1990: 200; Coronel et al. 2015: 94; Middleton et al. 2010: 185–86; Terry et al. 2000; 2004; Wells 2004).

This "absence of enrichments" is due to the fact that they were areas with constant cleaning, and in these spaces, mainly those designated for transit, activities involving food preparation, placement of offerings, etc., were not carried out constantly. Instead, these areas were intended for pedestrian passage and should have been free or "empty" to allow for the flow of pedestrians. Additionally, the resting areas also show low levels of chemical compounds, as this activity does not generate much waste, nor even high concentrations of phosphates (Barba 2007: 446; 1990: 200; Barba and Ortiz 1992: 77–79).

Results of the analysis of Operation 1, Structure N1W1-4, San Andrés Norte Milpa

Regarding the fatty acid test, eight areas with high values were detected (Figure 155). These areas are mostly located within the circular structure, although there is a significant concentration near the wall located to the southeast, which we believe was a perimeter wall. It is noteworthy that the areas with fatty acid enrichments are located near the center of the circular structure or near the walls that compose it. Two of these areas are located in what we consider could have been the entrance areas, while another one is located almost at the center. These concentrations may be reflecting the continuous use of substances with high fat content at the entrances and the center, such as some resins or fatty foods.

Similarly, it is worth highlighting the concentration found in the exterior wall, which is located to the southeast of the excavated area and which we consider to have been a wall that limited the southern part of the open area adjacent to the circular structure. peripheral in this area is located parallel with three concentrations of protein residues. These concentrations may indicate the use of resins that were burned there or it could also be a garbage dump.

Regarding the carbonates (Figure 156), the results show homogeneity throughout the excavation, with values ranging from 1.5 to 2. This may indicate that the entire area had a layer of sascab or stucco, which is consistent with the dozens of stucco fragments discovered throughout the excavation area.

It was interesting that in the area where the metate is located, no increase in carbonate residue levels was recorded, contrary to what we had assumed, as higher levels were expected due to the anticipated grinding context that would include the use of lime. The absence of enrichments in this area may be due to the metate being moved from its original context, or the metate was not used for grinding corn, but for another type of material.

Regarding the phosphate analysis (Figure 157), it is notable that the interior of the structure lacks significant concentrations, with the exception of an increase in the northwest section. This finding is relevant, as it is located near the main access and spatially coincides with the previously detected increase in fatty acids. However, it is noteworthy that most of the anomalous values are located on the exterior of the structure, where they form a semicircular arrangement. This pattern suggests that this area may have been used for the processing of organic matter or, given its location at the back of the building, for waste disposal (garbage dumps). Although the detected levels do not represent the maximum values, clear concentrations are identified in at least five specific areas.

Regarding the pH values (Figure 158), a pattern consistent with previous findings is observed: the anomalies are predominantly located on the exterior of the structure, at a distance of between two and three meters, with greater emphasis on the southern sector. A notable exception is the enrichment detected in what we consider the access area, right where a missing section in the foundation is identified. This data suggests the possible presence of a modestly sized hearth or brazier that would have served to illuminate or to mark the entrance and exit of this construction. Although the values are not high enough to confirm areas of intensive burning, the specific concentrations reinforce the hypothesis that the southern courtyard was the main setting for domestic activities, keeping the interior of the construction free from activities involving the use of fire.

Regarding the protein residues (Figure 159), it is noteworthy that the highest concentrations are located outside the structure, particularly in the southeast area, near the embankment. However, two areas with elevated values (level 9) were identified near the access points. It is significant that these points spatially coincide with the previously reported increases in fatty acids and phosphates. This triple correlation suggests the systematic manipulation of matter from some organic substance, with fat and protein content.

Analysis of activity areas, Structure N1W1-4

The results of the chemical analysis reveal a trend in the interior of the circular structure remaining mostly free of chemical concentrations, suggesting a residential use. The most notable enrichment is that of fatty acids found near the entrances, which coincide with the missing sections in the circular foundation wall. At these points, the combined presence of high levels of fatty acids and pH suggests the existence of small hearths or incense burners that would have served as light or symbolic markers for entering or exiting this construction.

In contrast to the absence of elevated values in the interior part of the structure, on the exterior, the southern area exhibits intense geochemical activity. These increases are concentrated in the section adjacent to the southeast wall that delimits the excavation, which was possibly used as a barrier or as a protective wall by the inhabitants of the circular structure.

According to the results, the area between the circular structure and the wall functioned as a multifunctional workspace. Located behind the main entrance, this area would have allowed for the processing of organic matter and the disposal of waste without interfering with circulation, the internal space, or access to the circular structure (N1W1-4).

Results of the analysis of Operation 2, Structure N1W1-3, San Andrés Norte Milpa

Four areas of high fatty acid concentration were identified, distributed in the sectors to the north and south of the foundations (Figure 160), although an area with enrichments stands out in the central part of the area delimited by the foundation of the perishable structure. While the concentrations in the northeast and southeast are located over outcrops of bedrock and debris (suggesting external activities), inside the structure, a series of aligned enrichments are observed running from north to south and parallel to a section of the foundation of the perishable structure.

On the other hand, the carbonate analysis (Figure 161) showed discrete levels (maximum of 3) in the southeast and the center. Although these results are not decisive for food production, the presence of calcium carbonate remains could be linked to the preparation of stucco or the maintenance of the sascab occupation surface of the structure.

Regarding the phosphates (Figure 162), three zones with levels between 14 and 16 were detected in the interior, which were near the southern wall, indicating the handling of organic matter within the area with a perishable roof. On the exterior, the most intense concentration of the entire unit was located over the bedrock outcrop, clearly identified as a deposit of organic waste (possibly a dump).

It is relevant that the pH anomalies (Figure 163) are concentrated precisely in the fill areas used to level the bedrock and create a surface for occupation. Two areas with significant enrichments were identified: one in the center of the structure and another in the eastern sector, very close to the foundation wall. If this construction was a roofed structure with the front open, the central enrichment suggests the presence of a hearth or area where ashes were produced. The absence of pH variations in the exposed bedrock areas indicates that these zones were not linked to activities involving fire.

Regarding the protein residues (Figure 164), their absence in most of the structure and the bedrock is notable. The only significant concentration is located in the southeast corner of the excavation, adjacent to the foundation wall of the perishable structure, on its exterior side, which reinforces the idea of a highly focused activity outside the interior area of the building.

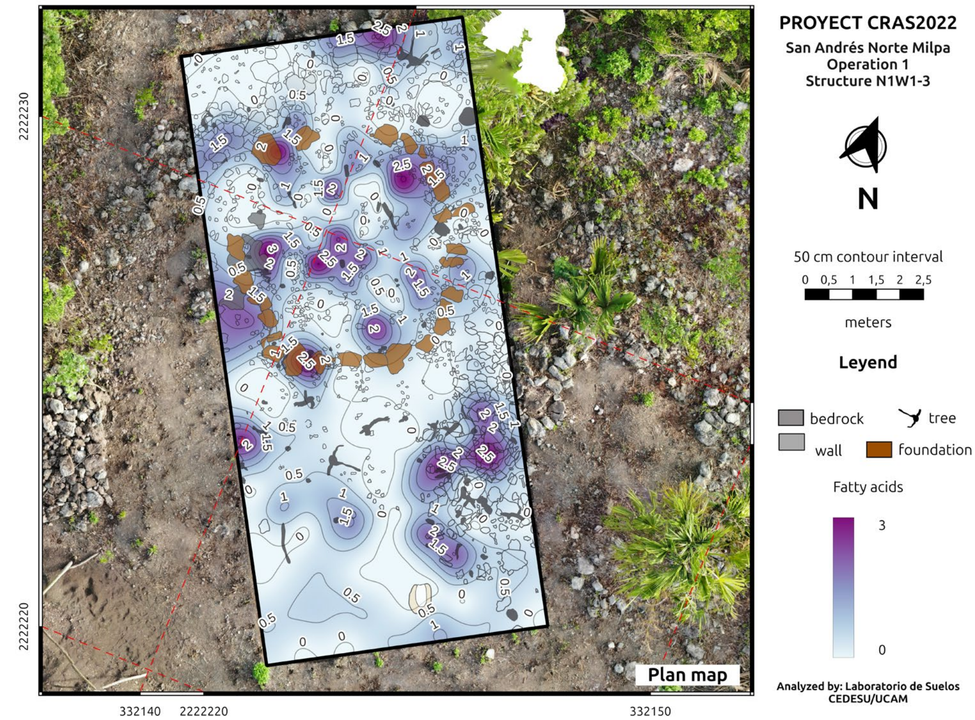

Figure 155. Results of spot test analysis, fatty acids, Structure N1W1-3

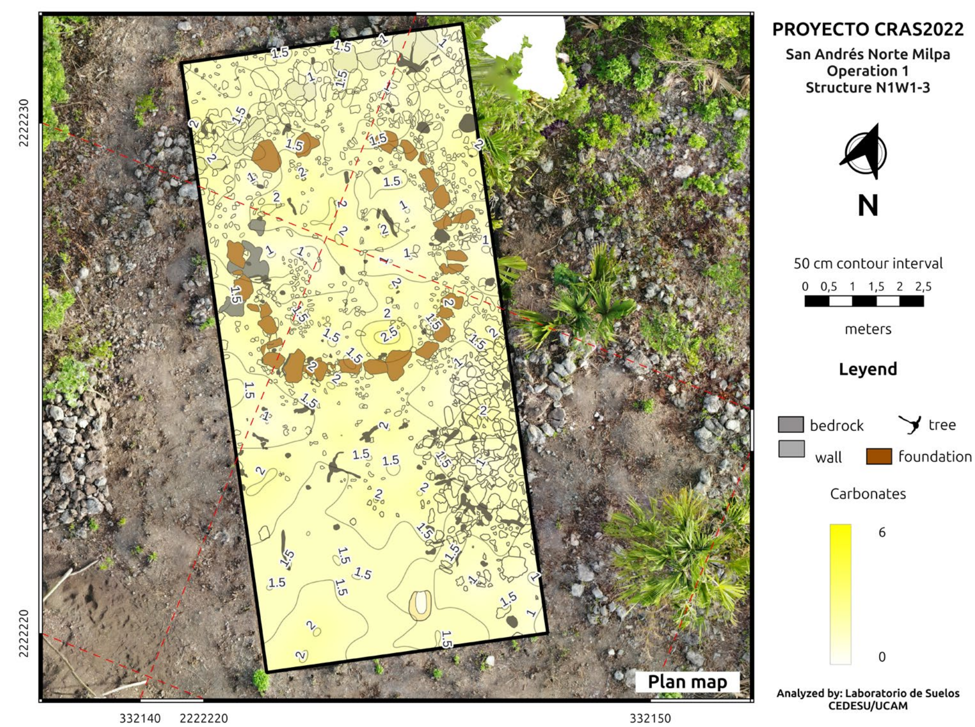

Figure 156. Results of spot test analysis, carbonates, Structure N1W1-3

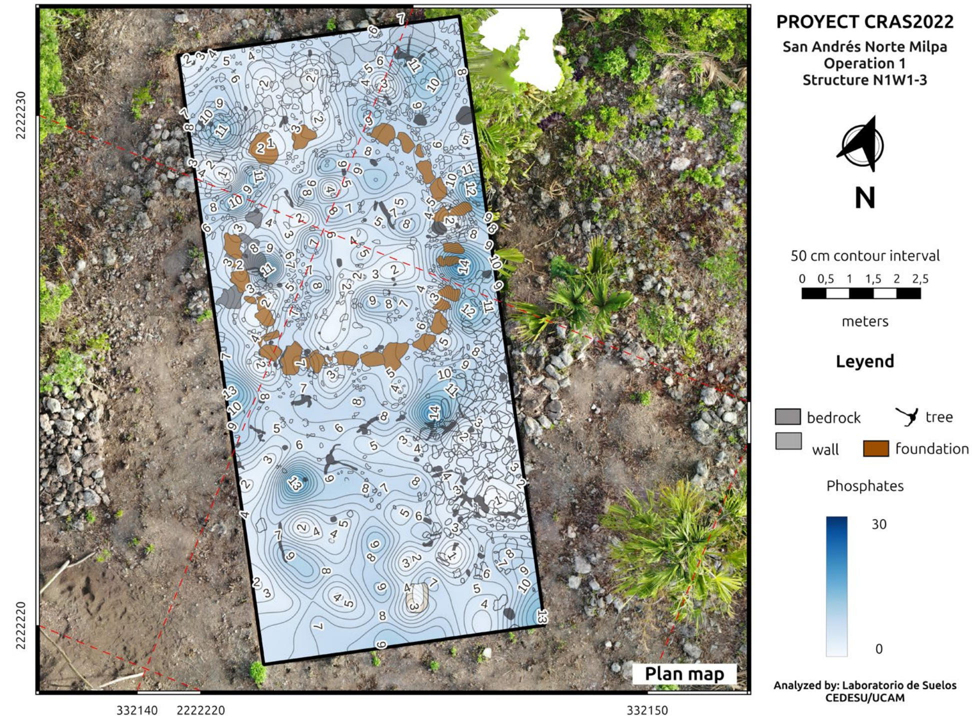

Figure 157. Results of spot test analysis, phosphates, Structure N1W1-3

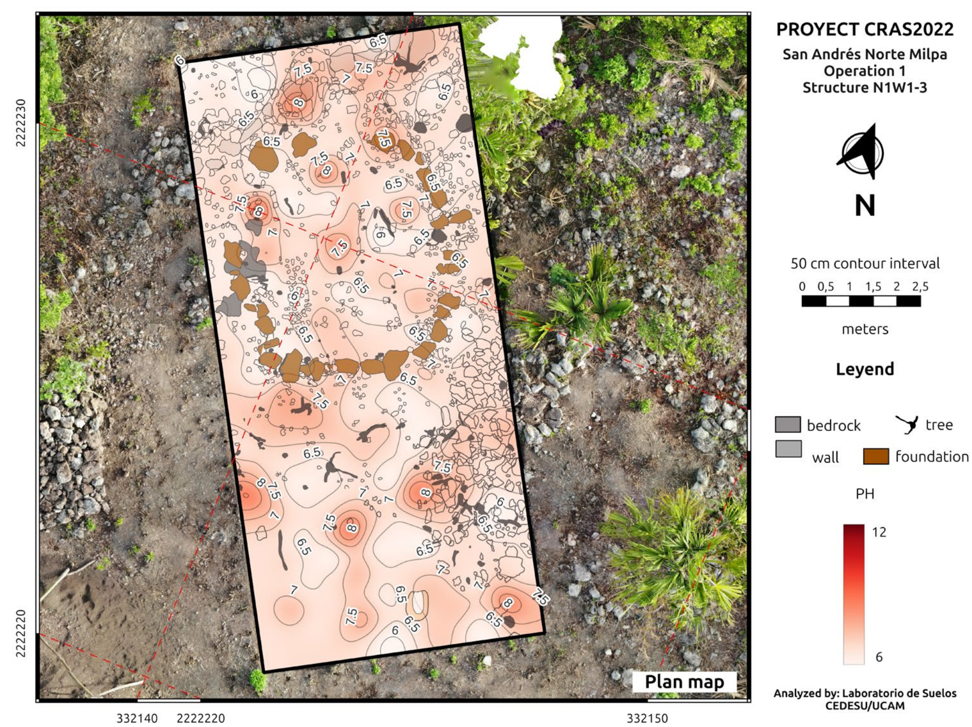

Figure 158. Results of spot test analysis, pH, Structure N1W1-3

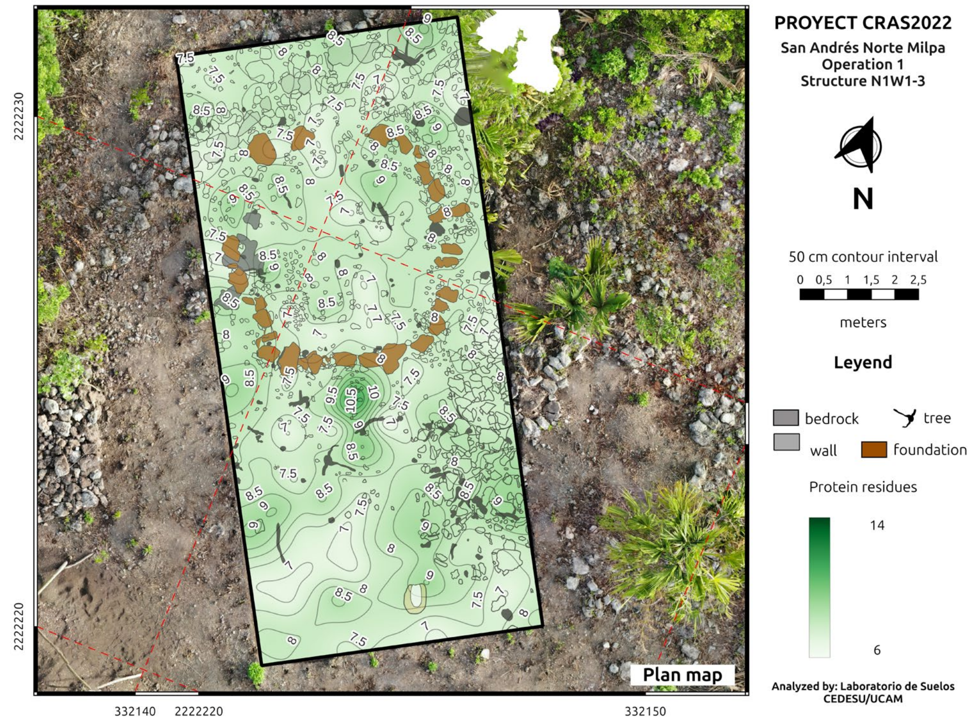

Figure 159. Results of spot test analysis, protein residues, Structure N1W1-3

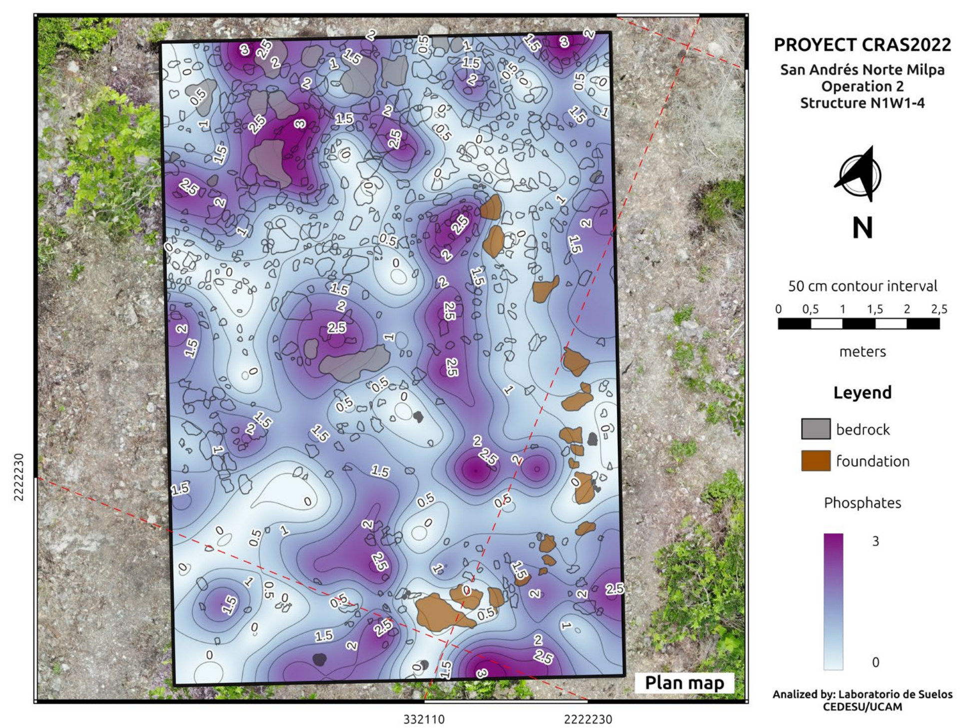

Figure 160. Results of spot test analysis, fatty acids, Structure N1W1-4

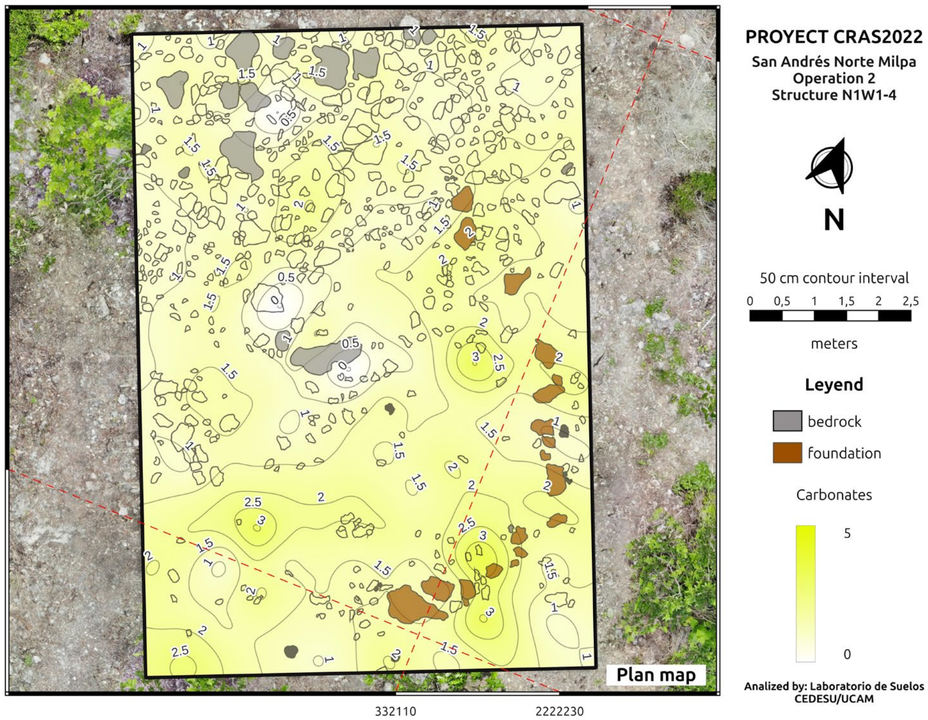

Figure 161. Results of spot test analysis, carbonates, Structure N1W1-4

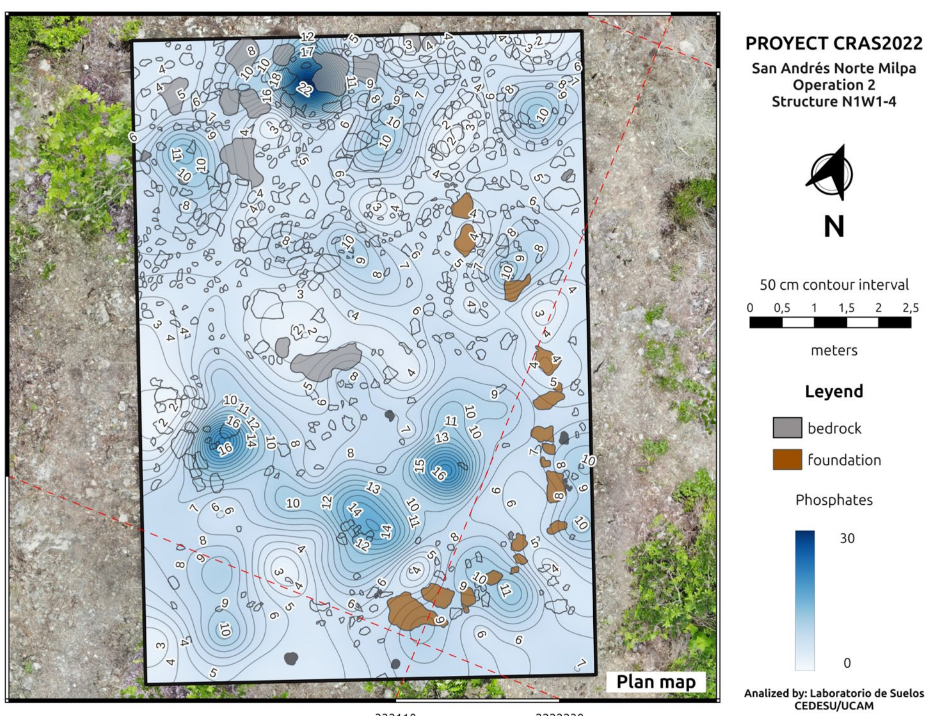

Figure 162. Results of spot test analysis, phosphates, Structure N1W1-4

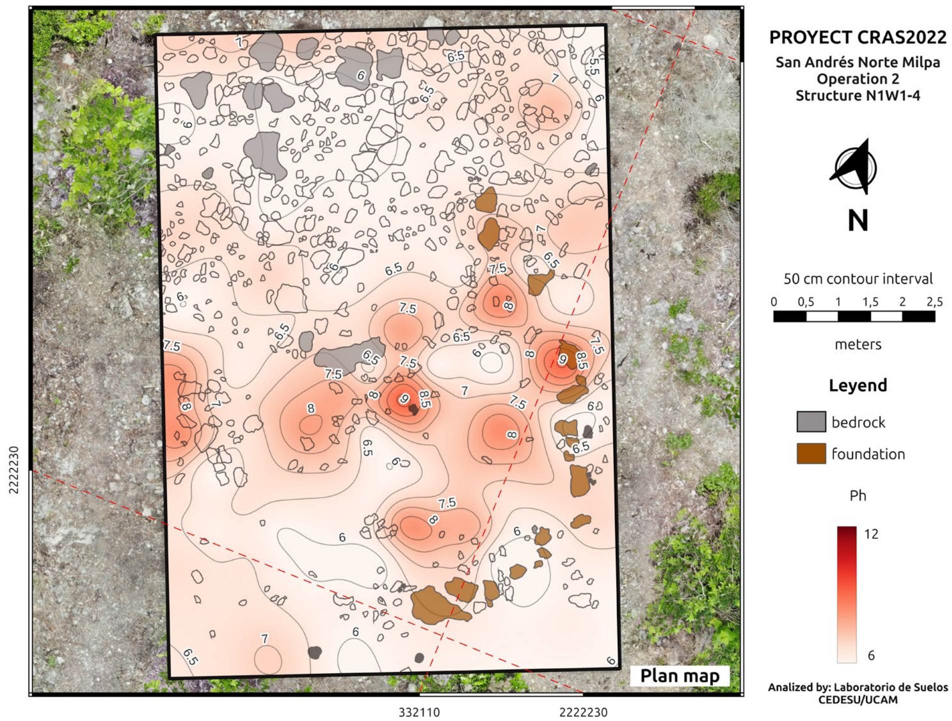

Figure 163. Results of spot test analysis, pH, Structure N1W1-4

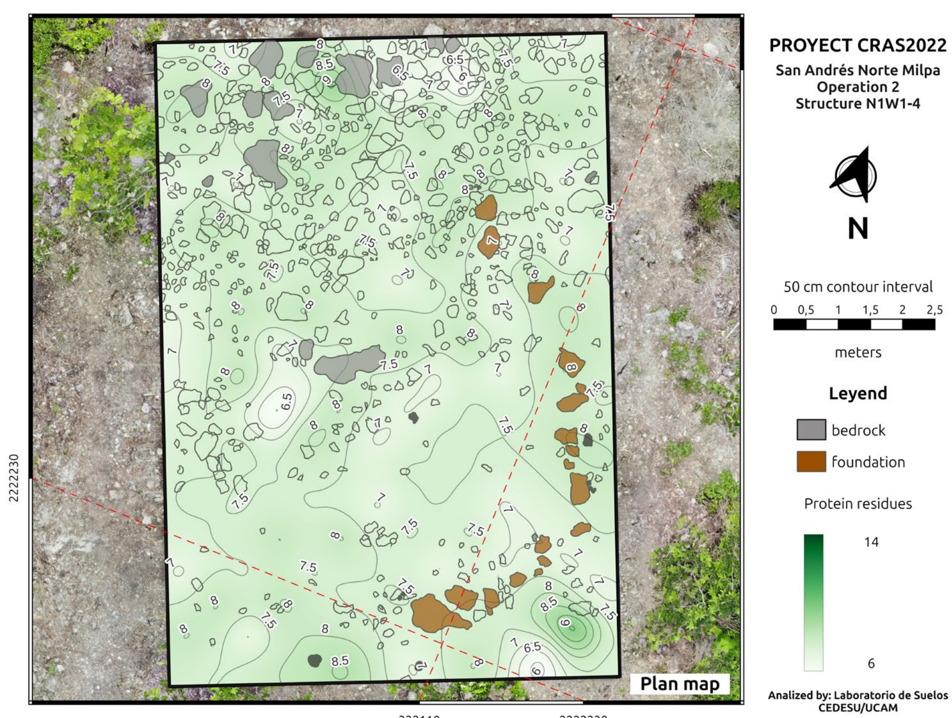

Figure 164. Results of spot test analysis, protein residues, Structure N1W1-4

Analysis of Activity Areas, Structure N1W1-3

After integrating the five chemical indicators, it is proposed that the structure did not serve a residential or food preparation function, but rather functioned as an open work area (possibly a palapa). The combination of elevated levels of fatty acids and pH near the walls suggests the burning of resins or other compounds with high fat content.

This foundation seems to have been designed to support a roof made of perishable material that would protect these work activities carried out in the area, for which the ground was partially leveled to reach the level of the bedrock. The waste and processing activities of protein substances were carried out outdoors, specifically on the outcrops of bedrock and the areas adjacent to the southern part of the perishable structure foundation, right where the terrain begins to slope down.

Results of the analysis of Operation 10, Structure N2W2-3, Sisal

The analysis of fatty acids is of particular interest (Figure 165), as one of the high concentrations of residues is located in a missing section of the foundation, in the eastern part of the operation, which we believe may have been the entrance to the perishable-type construction. Likewise, another high level of residues was detected in the southeast corner of the excavation unit. Both areas suggest soil enrichment thru resins or other organic substances that leave greasy residues.

On the other hand, the carbonates (Figure 166) show a more or less homogeneous distribution, with slight elevations toward the south. This suggests the presence of a courtyard or surface with concentrations of sascab or stucco. It is relevant to note that this area coincides with the entrance of the circular structure and toward the area where there are other platforms and buildings, which suggests that the surface between them may have had a fill or tamped sascab.

Regarding the phosphates (Figure 167), six areas with intense enrichment (levels above 20) were identified. Most are located outside the circular structure, although two points are situated on the foundation wall. A concentration stands out again right in the access area, to the east of the unit, which coincides with the results obtained in the fatty acid test.

Regarding the pH (Figure 168), the highest levels are mostly found outside the structure, with two notable exceptions; one concentration on the northeast wall and the second right in the center of the circular structure, where the highest value of the entire context was recorded.

Regarding protein residues (Figure 169), an increase is observed in the same areas where phosphates and fatty acids were reported, corresponding to the missing section on the eastern side of the structure, which we believe could have been the main access point. There is also another elevation of protein residues in the southern part, adjacent to a large rock, while the rest of the units maintain homogeneous levels. This enrichment in the central part is interesting, as it suggests the presence of a hearth or an element that involved constant combustion and ash production, in the center of what was once the structure with a perishable roof.

Analysis of activity areas, Structure N2W2-3

It is significant that three of the five chemical indicators (fatty acids, phosphates, and protein residues) converge in the eastern access area. This correlation indicates intense activity related to the handling of organic matter—probably plants or animal products high in fat and protein—right at the entrance of Structure N2W2-3.

Results of the analysis of Operation 11, Structure N1W3-1, Sisal

Regarding the carbonate levels (Figure 170), a concentration was detected in the eastern area of the structure, right where another wall is located, which is possibly part of a superstructure of the platform on which Structure N1W1-3 is built. This increase could be due to the fact that this superstructure had a stucco finish or a layer of sascab. Likewise, another concentration of carbonates in the southeast area of the excavation unit is interesting, which coincides with the discovery of two metates along with their respective manos. It is likely that this area was designated for the processing of food or materials involving grinding and the use of lime, which resulted in a greater presence of this type of waste.

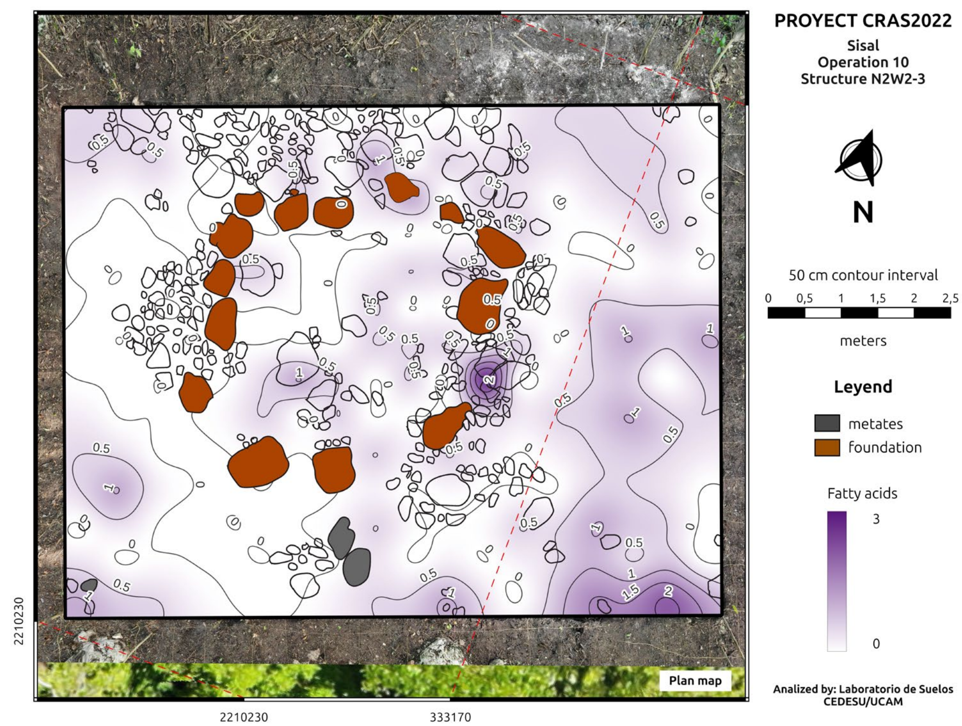

Figure 165. Results of spot test analysis, fatty acids, Structure N2W2-33

Regarding the phosphates (Figure 171), six areas with values above 20 were identified. Four of them are located outside the circular structure and are probably related to areas of external activity. The concentration in the southeast sector of the excavation stands out, precisely where the increase in phosphates coincides with the location of the metates and manos, reinforcing the hypothesis that this space was used for the preparation of food or other organic substances.

The pH results (Figure 172) show a similar pattern. As with the previous tests, an increase of 8.5 was recorded in the southeast area associated with the metates. The rest of the high levels are located outside, although some points identified on the rear wall and the center of the unit reached values of 8 and 8.5. The latter could indicate the presence of fire or activities that involved the production of ashes. Of these interior concentrations, the one that stands out is the one located to the southeast, which is adjacent to the wall of the perishable circular foundation.

Regarding the protein residues (Figure 173), an increase was detected in the eastern area, specifically where a missing section of the wall is observed. On the other hand, both the interior and exterior of the structure show low levels, although there is a slight increase in the western part, near the superstructure wall and the superstructure that crowned the platform.

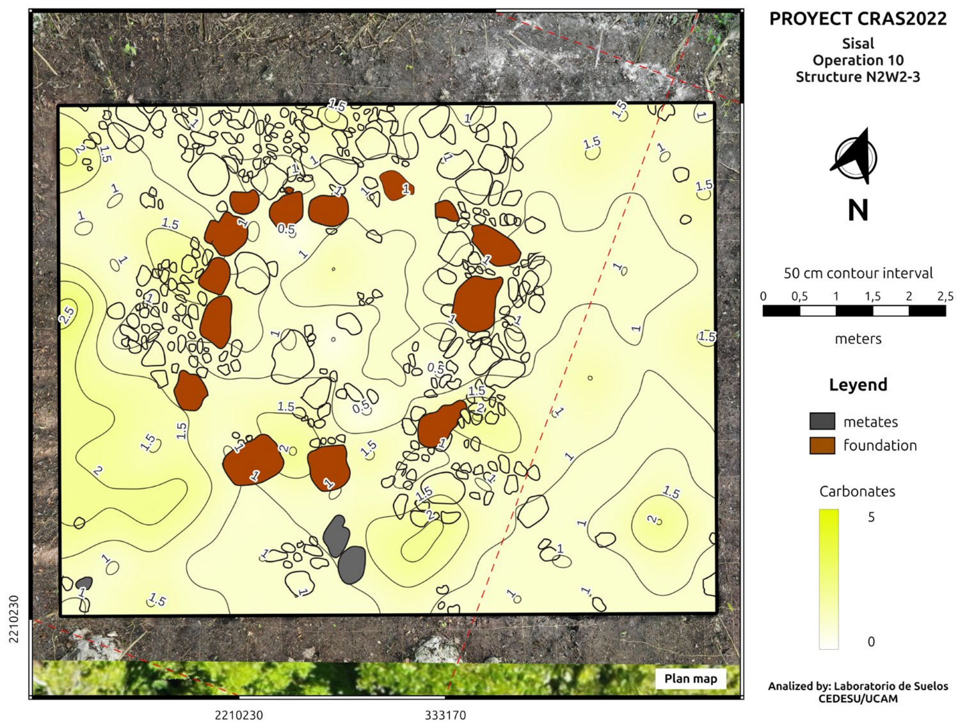

Figure 166. Results of spot test analysis, carbonates, Structure N2W2-3

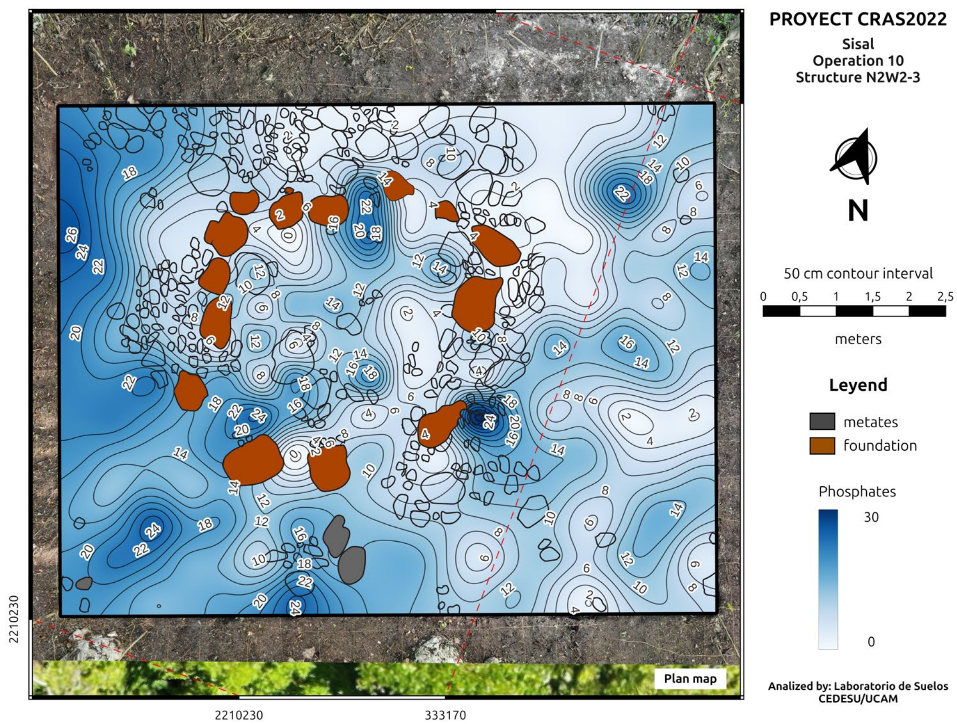

Figure 167. Results of spot test analysis, phosphates, Structure N2W2-3

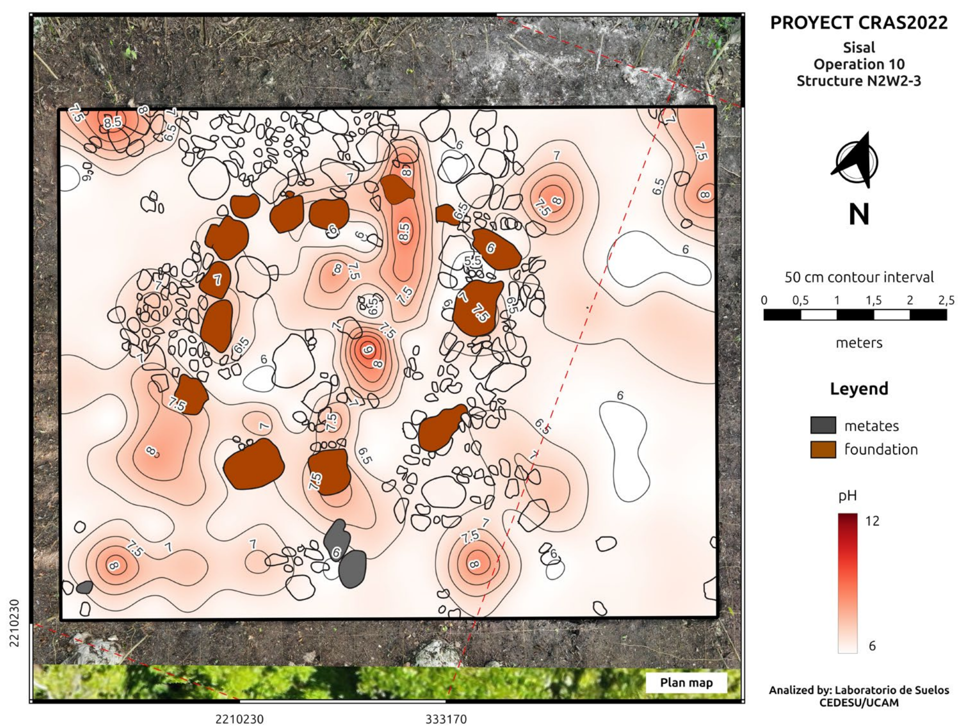

Figure 168. Results of spot test analysis, pH, Structure N2W2-3

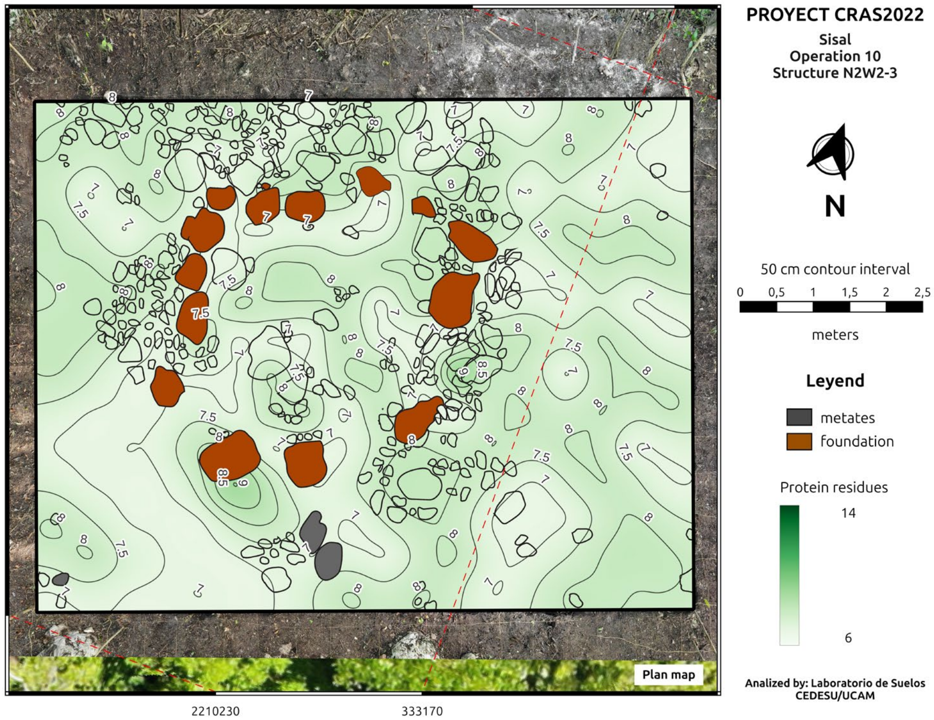

Figure 169. Results of spot test analysis, protein residues, Structure N2W2-3

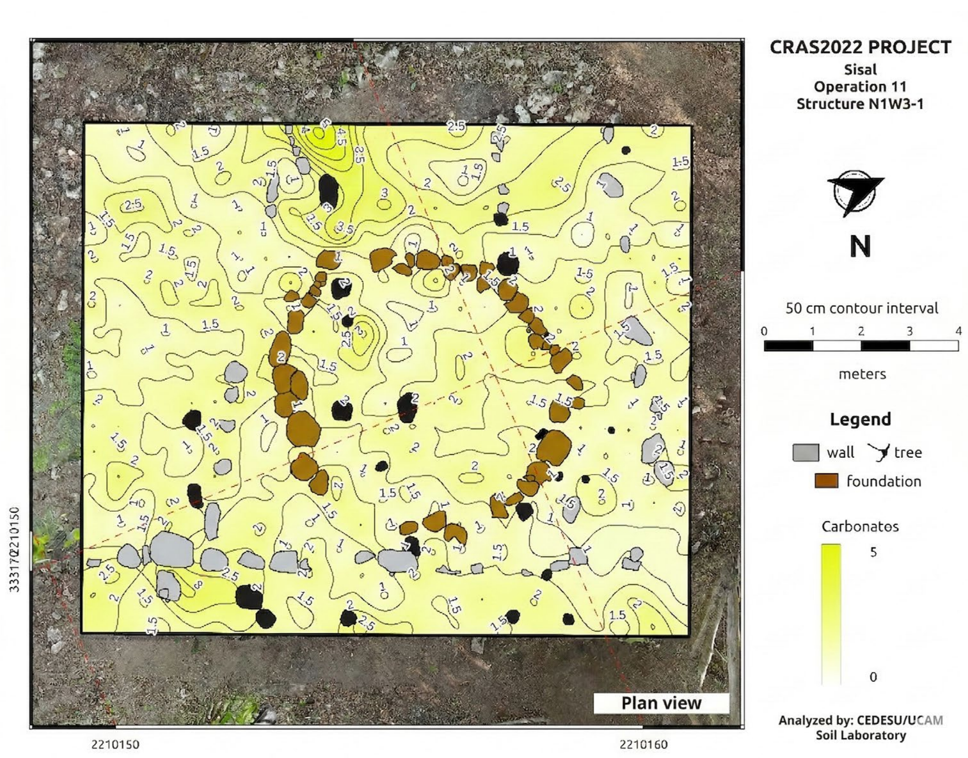

Figure 170. Results of spot test analysis, carbonates, Structure N1W3-1

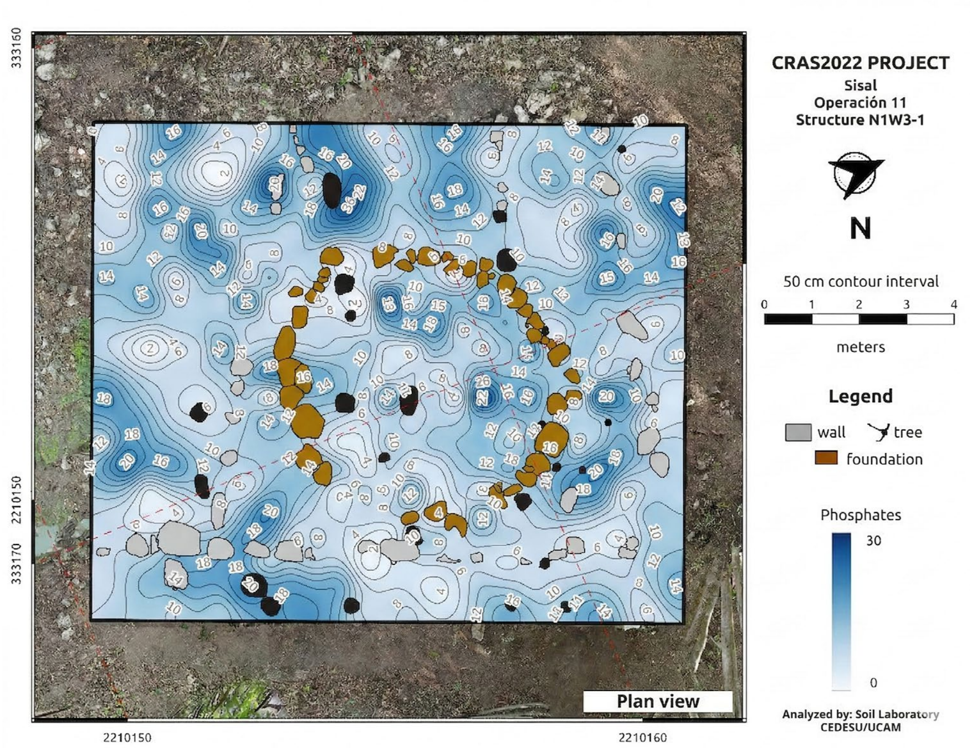

Figure 171. Results of spot test analysis, phosphates, Structure N1W3-1

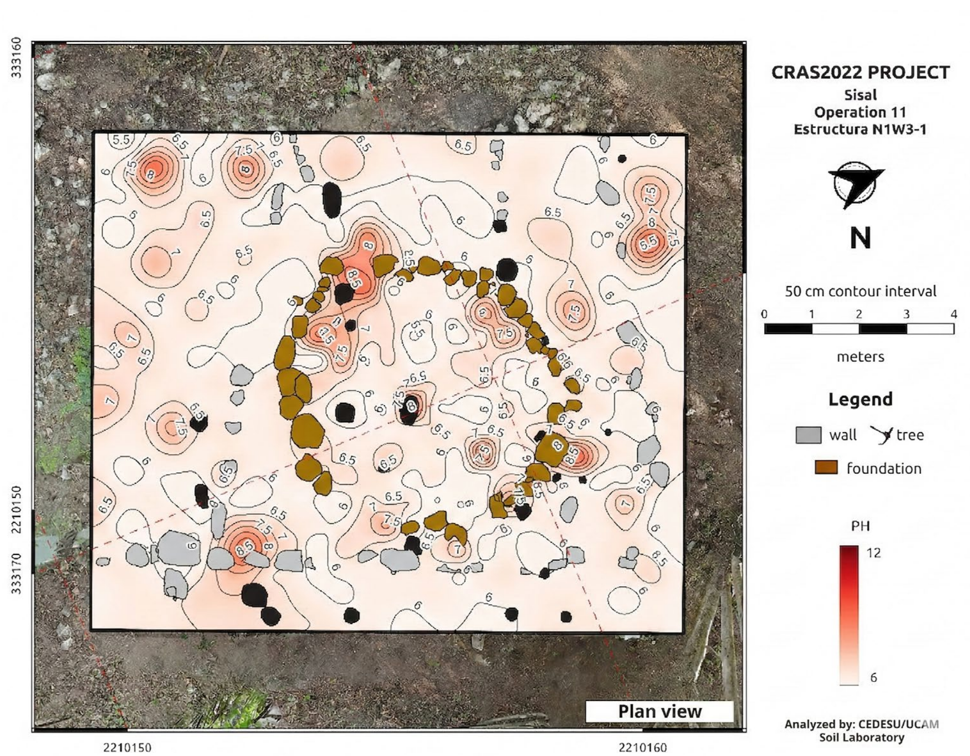

Figure 172. Results of spot test analysis, pH, Structure N1W3-1

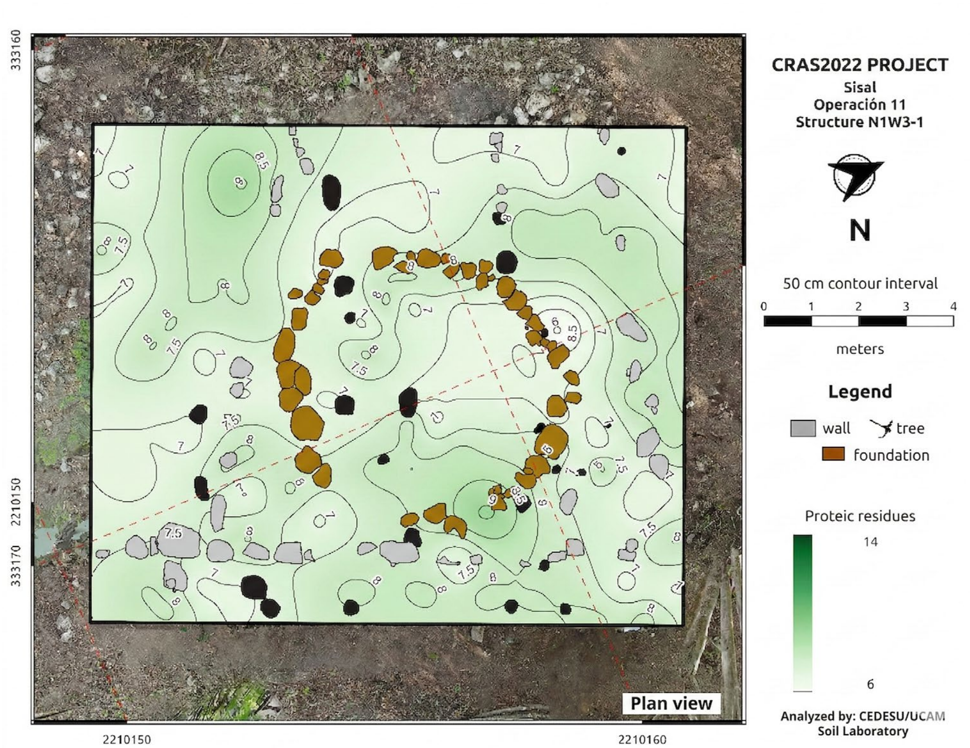

Figure 173. Results of spot test analysis, protein residues, Structure N1W3-1

Analysis of activity areas, Structure N1W3-1

Two areas within this excavation unit are extremely interesting; the first is the area where the metates were found, to the southeast, while the second was located to the west, where a wall of another superstructure was discovered. In the first of these, the one located to the southeast, where the metates were found, concentrations of carbonates, phosphates, and pH were documented. The archaeological context, with the presence of a large metate and two manos, suggests that it was an area dedicated to food preparation for the inhabitants of the surrounding circular structures.

On the other hand, the data from the western area, where the superstructure wall is located, included elevated levels of phosphates, carbonates, and protein residues. Since it coincides with the location of the previous superstructure, one possibility is that these are the result of the processing of organic substances or a dump that included the use of fire.

Final thoughts

In general terms, the geochemical analyses conducted on the foundations of perishable structures in San Andrés Norte Milpa (Operations 1 and 2) and Sisal (Operations 10 and 11) suggest that these are domestic contexts intended for food preparation and daily tasks. The results show no specialization based on the predominance of a specific residue; rather, they present a combination of the five indicators evaluated using spot tests (fatty acids, carbonates, phosphates, pH, and proteins). The constant presence of these residues allows us to rule out transit or storage functions, where the absence of certain chemical substances would be expected. In summary, the evidence points to a residential life dynamic, where domestic groups engaged in subsistence and work activities without a specialization that transcended the household sphere.

Part 4: Summary and Analysis

Chapter 18. Characterization analysis of two *metate manos* stone pieces, Operation 11, Sisal

Analyzed by: Dr. Miguel Pérez, Physicist. Alan Nagaya and Arqlga. Thania Ibarra
Thania Ibarra

Reviewed by: Dr. Oscar G. de Lucio and Dr. Soledad Ortiz Ruiz

The analysis was conducted to characterize two *manos de metate* found in Operation 11 at the Sisal site, Quintana Roo, by the Cochuah Regional Archeological Survey (CRAS) project during the 2022 field season. The objective of the study was to determine the materials used for the manufacture of these tools, which have been associated with a domestic context. This study will provide information about the raw materials used for artisanal production at the Sisal site. The artifacts have been dated by association with ceramic material to the Late-Terminal Classic period, and were found in context with a metate, outside the Structure N1W3-1, which is a residential context. The two pieces were named Mano 1 and Mano 2, both of which are chipped stone artifacts.

The analysis techniques proposed by LANCIC-IF for the characterization of the archeological pieces in question were optical microscopy (OM), fiber optic reflectance spectroscopy (FORS), X-ray diffraction spectroscopy (XRD), X-ray fluorescence spectroscopy (XRF), and Fourier Transform infrared spectroscopy (FTIR). The implementation of these techniques was carried out directly on the piece, without requiring any sampling.

Analysis of Materials

FTIR

Fourier Transform Infrared Spectroscopy (FTIR) is based on the interaction of infrared radiation with matter, given that this radiation is considered low energy, it only causes the molecules that make up the object to vibrate or rotate. FTIR spectroscopy only detects the vibration of molecules. The resulting spectrum will have different bands at positions corresponding to the natural vibrational frequencies of the molecule, which directly depend on the number of atoms that compose it. This technique allows the identification of functional groups in the molecules that make up an object.

The limits of this spectroscopy are in the mid-infrared (4000 cm^{-1} − 400 cm^{-1}), and correspond to the working range of the Bruker Alpha II spectrometer used. There are different FTIR techniques; however, in mineral analysis, reflection spectroscopy is the most common. In this technique, no prior sample preparation is required, and it is non-intrusive and non-destructive. The reflection module used has an approximate focal distance of 2 cm, and an effective analysis area of 4 mm in diameter. With the collimator mounted, the spectra are presented in reflectance mode, with a resolution of 4 cm^{-1}.

XRD

X-Ray Diffraction Spectroscopy allows for the identification, and sometimes quantification, of crystalline phases present in the studied objects. It is based on the detection of interference patterns generated by the diffraction of X-rays on the atoms that form a crystalline structure. This technique allows for the identification of minerals present in the sample by comparing the diffraction peaks against a previously established database.

The laboratory is equipped with the ARL Equinox 100 system from Thermo Fisher Scientific. This system contains a position-sensitive curved detector (CPSD) for static and simultaneous analysis of the diffraction pattern in the 2θ range between 5º and 110º. Its configuration allows the technique to be applied to solid objects without the need to take samples, unlike similar equipment focused on powder studies.

FORS

Fiber Optic Reflectance Spectroscopy involves illuminating the object and recording the diffuse reflection of light from it in the UV-Vis-NIR region, which is typically associated with absorption processes due to electronic transitions (UV-Vis), overtones, and combination bands of rotations and vibrations (NIR). In the visible region, it allows the identification of compounds related to color, such as semiconductors, compounds with transition metals, or chromophore groups. In the infrared region, it allows the identification of molecular groups such as OH, AlOH, FeOH, MgOH, CO3, and NH3 associated with mineral groups like phyllosilicates, sulfates, carbonates, etc. This technique also allows for a colorimetric analysis of the studied materials. The equipment available in the laboratory is the Field Spect 4 from the brand ASD, a portable system with a non-contact acquisition mode, which allows in situ acquisition in the range of 350 nm to 2500 nm.

XRF

X-ray fluorescence spectroscopy (XRF) is based on the interaction of X-rays with the atoms that make up a material. If the photon has sufficient energy, it causes an electron from an inner shell of the atom to be ejected, and in turn, an electron from an outer shell fills that vacancy. This transition results in the emission of another photon whose energy is characteristic of each element. This results in a spectrum where the chemical elements present in the studied object are simultaneously displayed, allowing for the provision of information about its chemical composition.

The technique does not require sample preparation, and the acquisition of the spectra is also performed without contact with the object. For XRF spectroscopy, the XRF SANDRA system is used, which features a variable high-voltage source.

FTIR Results

FTIR spectroscopy allowed us to identify the mineral composition of the pieces. It is observed that Mano 1 corresponds to a limestone rock (a rock composed of silicate minerals such as quartz SiO2, iron carbonates FeCO3, and calcium CaCO3, and iron oxides FeO2), while Mano 2 corresponds to a combination of flint (quartz polymorphs) and a rock rich in calcium carbonates.

In the FTIR spectrum of Mano 1 (Figure 174), the overlap of characteristic bands of flint and those of a calcium carbonate is observed. The bands at 2448 cm-1 and 2634 cm-1 correspond to the reststrahlen bands of calcium carbonate, the band at 1415 cm-1 corresponds to v3 of the calcium carbonate spectrum, the v2 and v4 bands are superimposed with the flint bands. The bands at 1212 cm-1 and 1021 cm-1 correspond to the reststrahlen bands of the flint spectrum, the bands at 870 cm-1, 533 cm-1, and 458 cm-1 correspond to the bending of the oxygen atoms in the flint molecule.

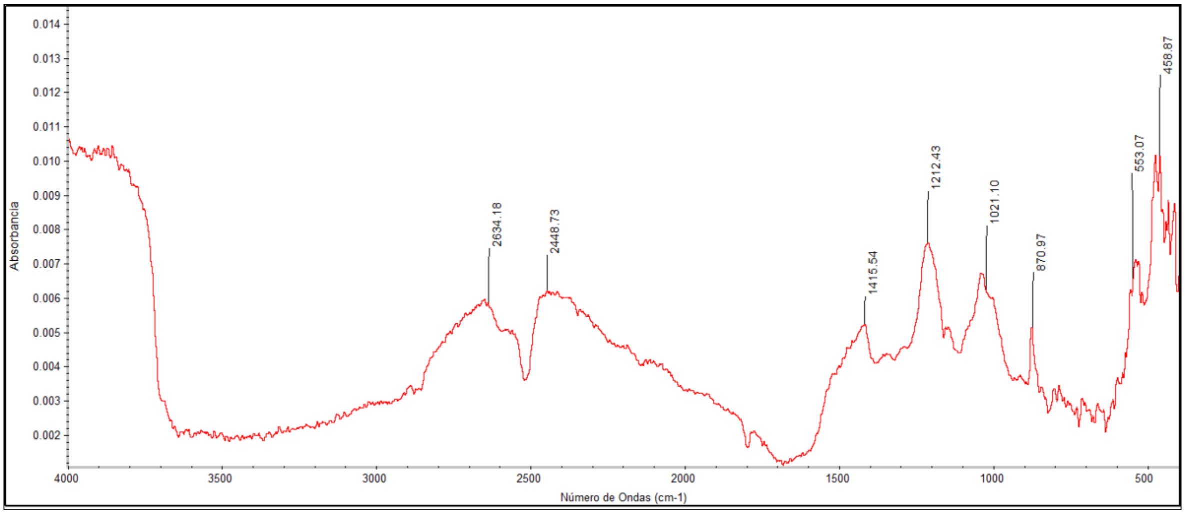

Figure 174. Representative spectrum of Mano 1. Analysis point 2 of face 1

As a reference, the FTIR spectra corresponding to a synthetic calcium carbonate (Figure 175) and a geological flint sample (Figure 176) are shown, highlighting the main spectral features. The molecular vibrations of iron oxide are not detectable with FTIR spectroscopy, but XRF data confirm its presence in the rock. In Mano 2, two types of spectra are presented. In the regions where the rock is polished, we only have the presence of silicate minerals (flint), with spectra like the one shown in Figure 177, which is similar to the spectrum of Flint.

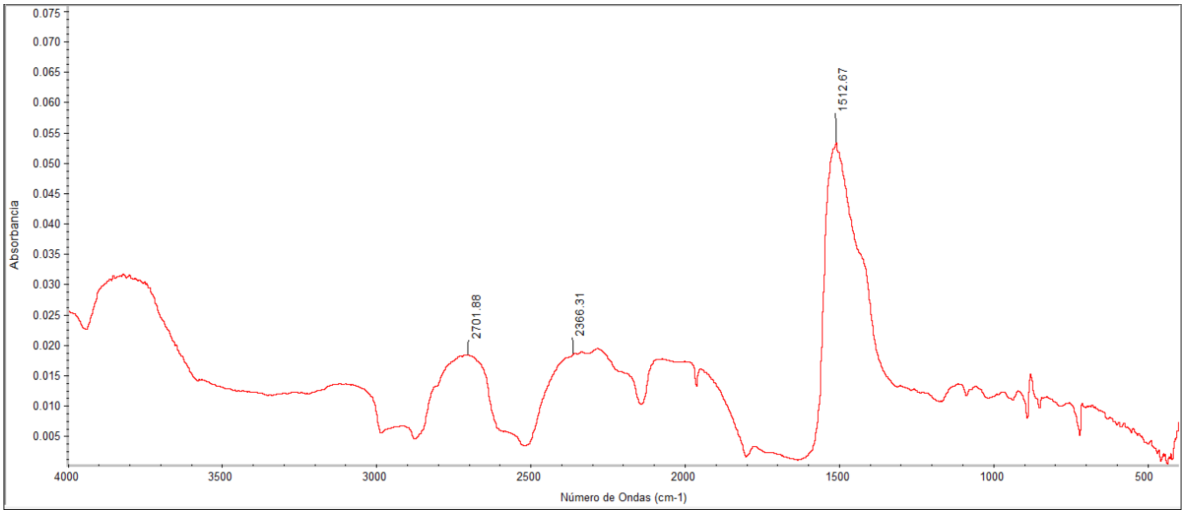

Figure 175. FTIR spectrum of synthetic calcium carbonate, highlighting the spectral features identified in the hands

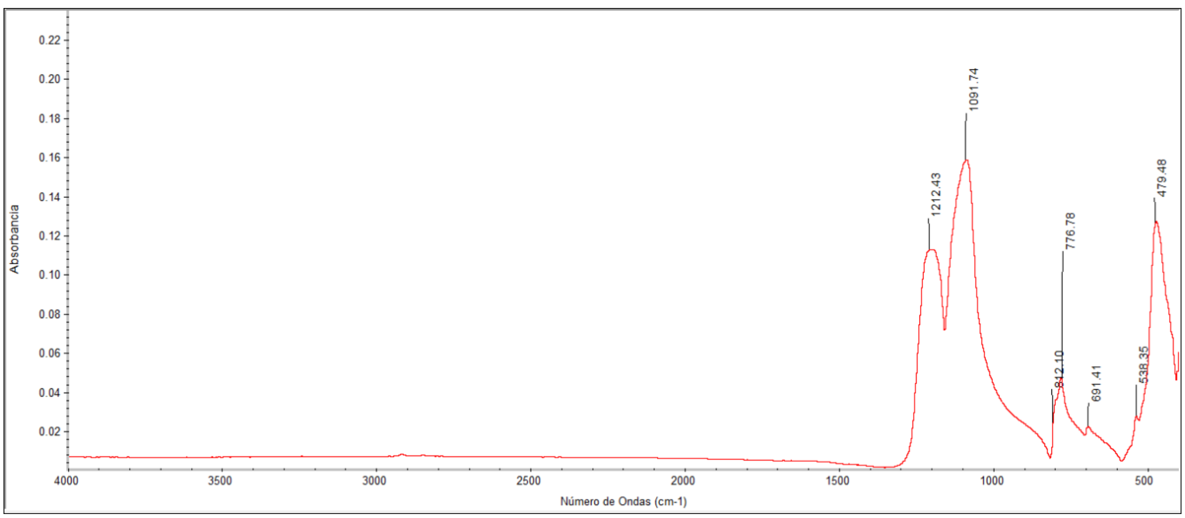

Figure 176. FTIR spectrum of geological flint, the main spectral features are indicated

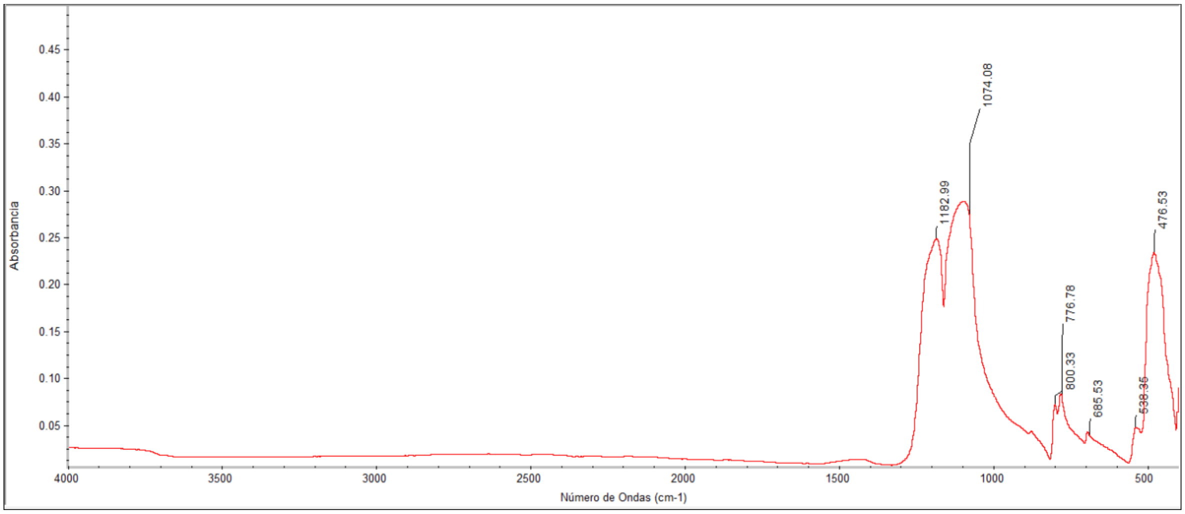

Figure 177. Representative spectrum of Mano 2. Analysis point 3 of face 1

On the other hand, in the regions where the piece is not polished, and the texture shows irregularities, the rock behaves like calcium carbonate as shown in Figure 178.

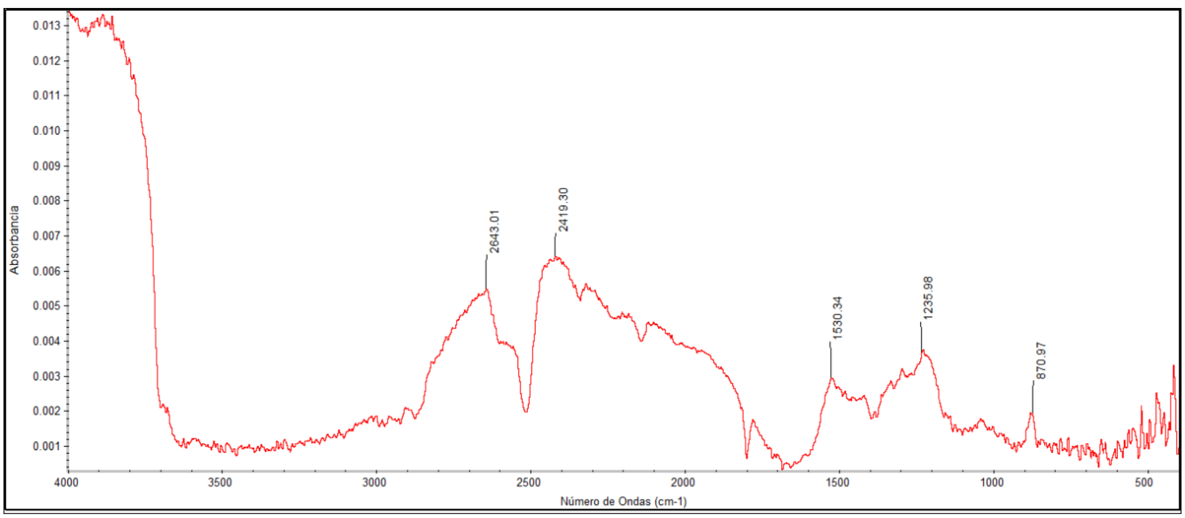

Figure 178. Representative spectrum of Mano 2. Analysis point 2 of face 1

Additionally, there are transition regions in the rock where both spectra overlap. As shown in Figure 179.

XRD Results

As mentioned before, Mano 1 shows spectral characteristics typical of calcium carbonate (CaCO3) and quartz (SiO2). The spectrum corresponding to XRD is shown in Figure 180. The difference in the intensity of the peak near 50° may be due to a preferred orientation of the material that composes the object, or to an overlap between the crystalline phases. The spectrum was attempted to be approximated using cards

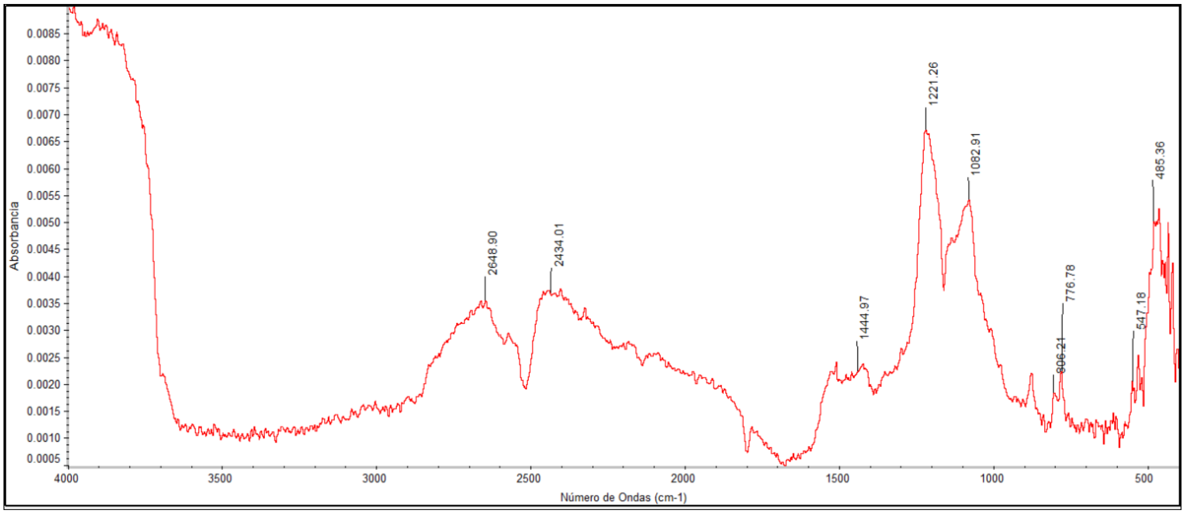

Figure 179. Representative spectrum of Mano 2. Analysis point 4 of face 3

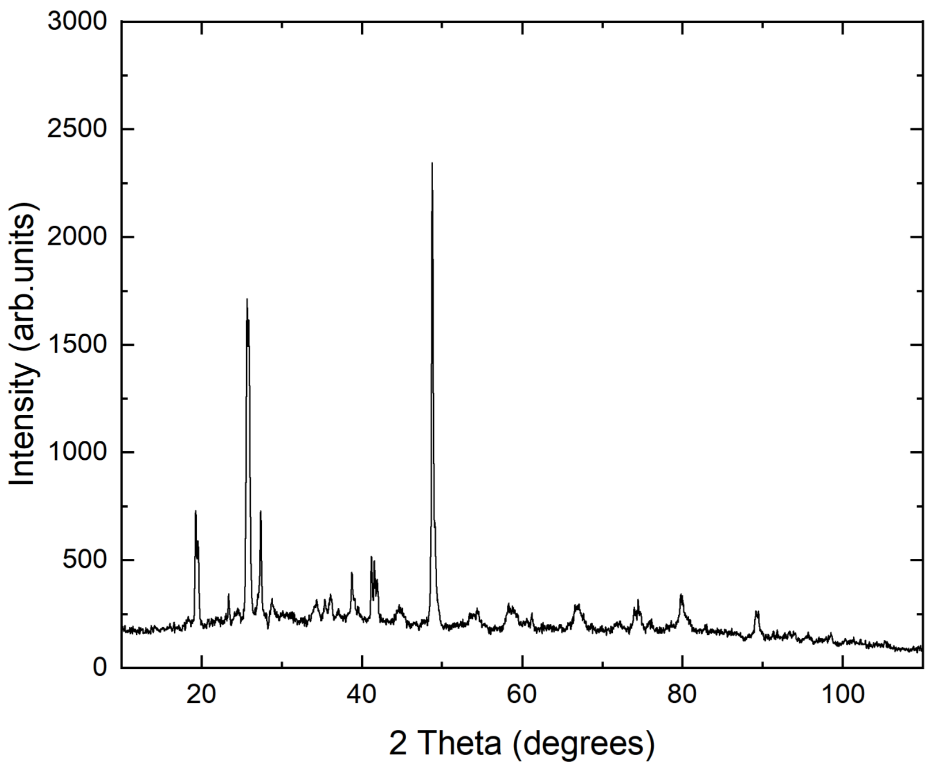

Figure 180. XRD spectrum of Mano 1

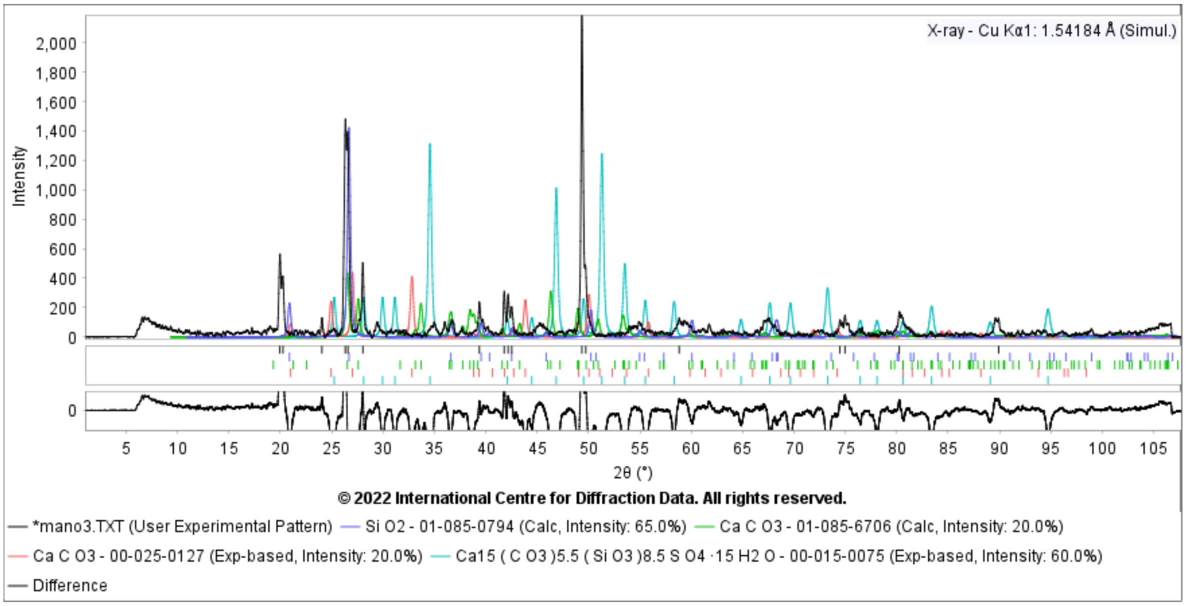

Figure 181. XRD spectrum of Mano 1 showing the experimental information (black) and the corresponding to quartz (purple), aragonite (green), vaterite (red), and Birunite (cyan).

corresponding to quartz and different crystalline phases of calcium carbonate, corresponding to aragonite, vaterite, and birefringent, the result is shown in Figure 181. While for Mano 2 an XRD spectrum (Figure 182) very similar to quartz (Figure 183) is observed, which could indeed be approximated using the PDF4 code, as shown in Figure 184.

FORS Results

The analysis of diffuse reflectance spectroscopy in the SWIR region allowed for the identification of differences between Mano 1 and Mano 2, which are mainly distinguished by absorptions at wavelengths of 2212 nm, 2252 nm, and 2350 nm. Colorimetric analysis was performed for various points on both pieces, based on the reflectance information in the visible region of the spectrum. The results are shown in Figure 185.

Two sets of data are observed, corresponding to each of the pieces, with similar shades found in the orange-ochre region. Each dataset is narrow in terms of its angular distribution (hue). The Munsell color equivalents would be for Mano 1: 7.5YR 4/1 (dark gray) and for Mano 2: 7.5/R 5/2 (brown).

XRF Results

Due to the uniformity observed in the artifacts, 2 points were measured on each face of each hand, resulting in a total of 8 measurements per artifact. The data are presented by the intensities of the present elements, and not by elemental proportions or concentrations.

In Mano 1, Al, Si, K, Ca, Ti, Mn, Fe, Rb, and Sr were identified. A uniformity in its composition was observed, as all measured points generated similar results, indicating elemental homogeneity in the rock. The intensities of Ca, Si, and Fe stand out, indicating a significant presence of these elements.

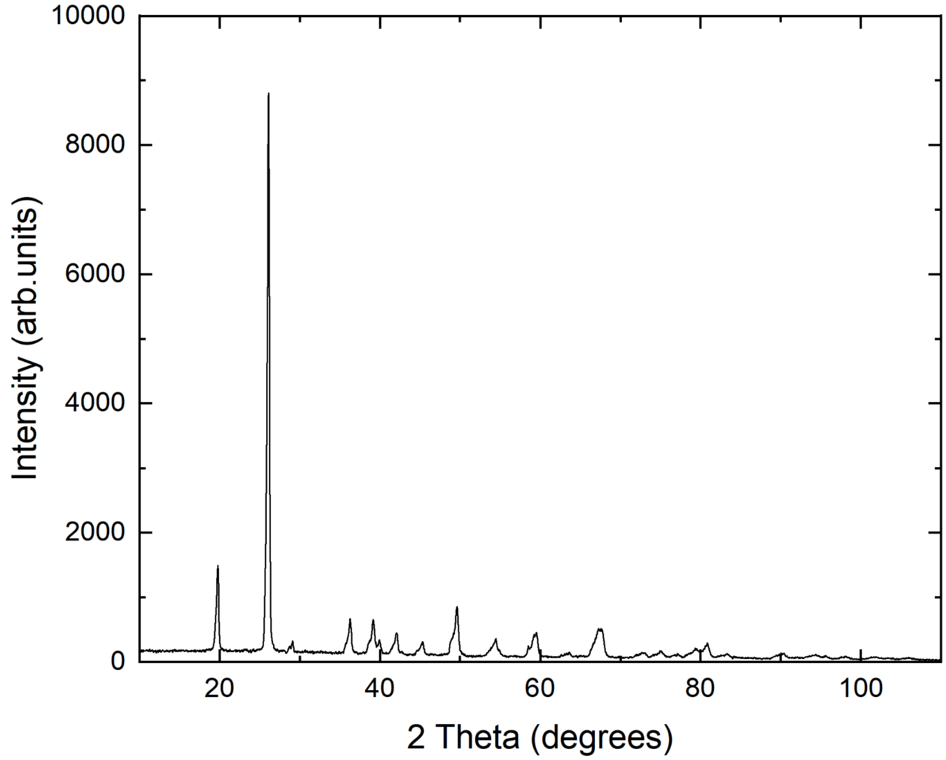

Figure 182. XRD spectrum of Mano 2.

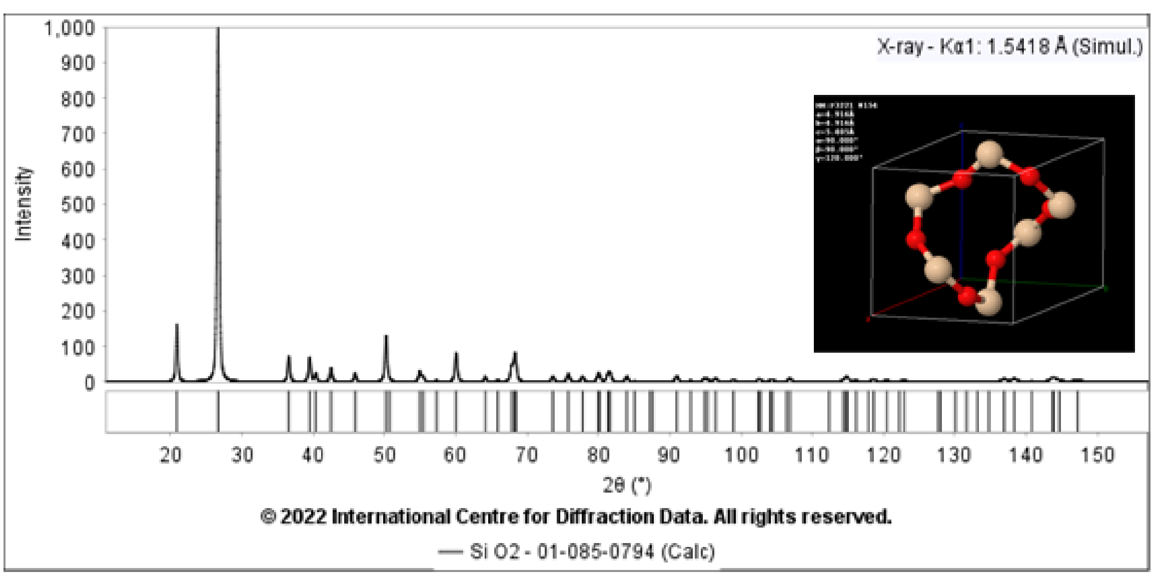

Figure 183. Typical XRD spectrum of quartz (SiO2)

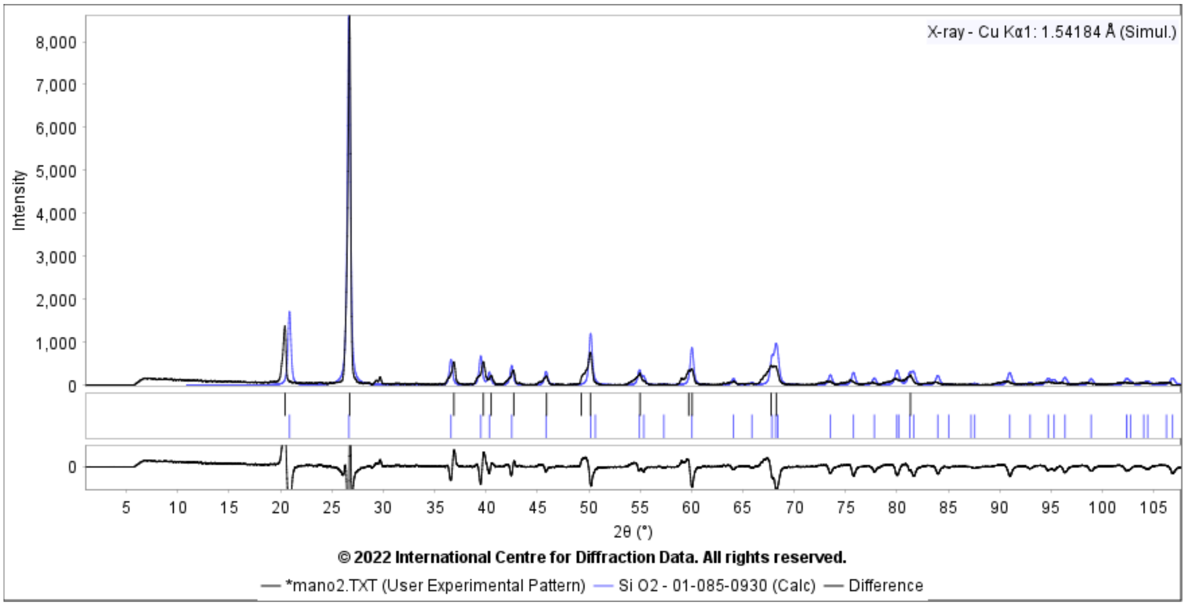

Figure 184. XRD spectrum of Mano 2 showing the experimental information (black) and the corresponding quartz (blue).

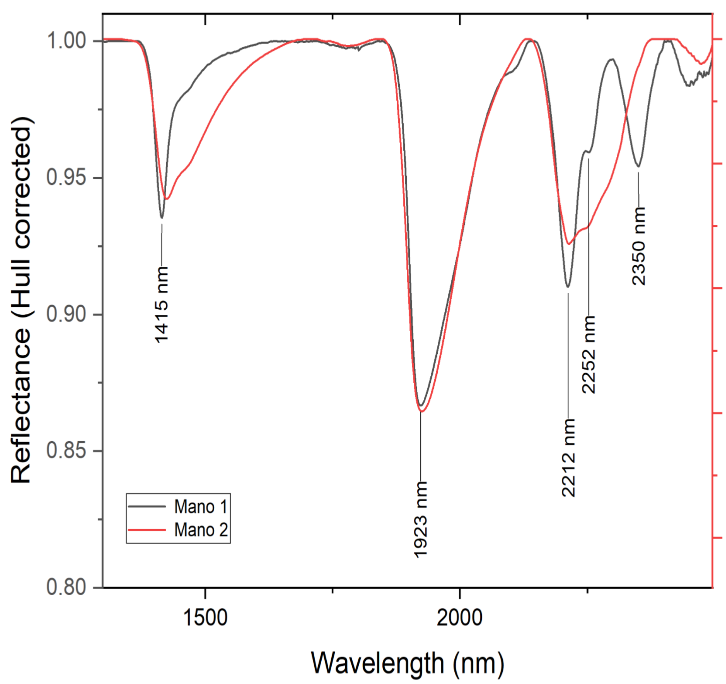

Figure 185. Reflectance spectrum, where the spectral characteristics of the two hands are compared

In Mano 2, Al, Si, K, Ca, Ti, Mn, Fe, Rb, and Sr were identified. Variation in their composition was observed, resulting in two types of spectra. In both, the intensities of Ca and Fe stand out and remain similar. The intensity of Si is higher in the spectra of some areas, and it is especially located on faces 1 and 3 of the artifact, while on faces 2 and 4 the intensity of Si decreases.

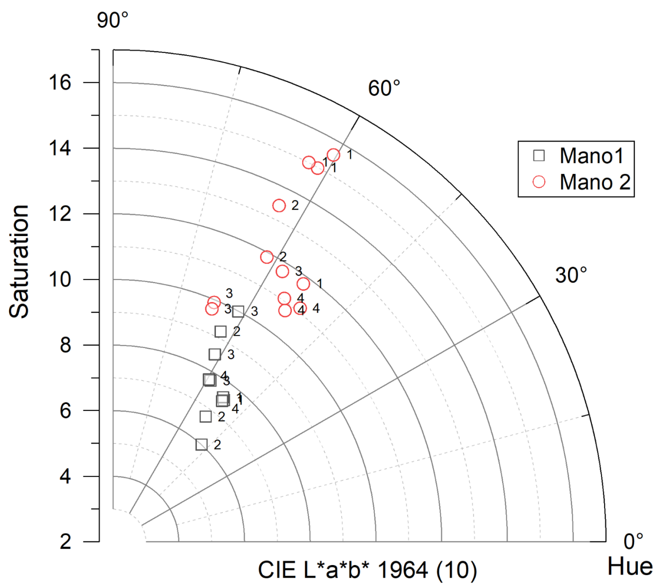

Figure 186. Values corresponding to the colorimetry of Mano 1 (black squares) and Mano 2 (red circles) expressed in the CIE Lab 1964 color space

The results indicate that Mano 1 has a uniform composition with high intensities of Ca, Si, and Fe on all its faces. Mano 2 has a variable composition, with high Si intensity on faces 1 and 3, and lower Si intensity on faces 2 and 4. This indicates two different compositions in the piece. The areas of faces 1 and 3 show greater wear from use. It is possible that it is a limestone rock with a flint nodule and that this area erosion due to use has exposed the flint on these faces, resulting in higher Si intensities.

Microscopy Results

The results of the microscopy analysis allow for the recording of surface erosion, small fractures, and the presence of white particles that could correspond to the diagenesis of calcium carbonate, caused by its burial context over natural sedimentation, as shown in Figure 192. In Figure 193 of Mano 1, the quartz arrangements present within the limestone rock corresponding to the geological nature of the region are observed. Finally, in Figure 194, a detail of the wear caused by the use of the metate mano is presented.

Mano 2 shows small white particles corresponding to the dissolution of natural carbonate and its deposition in the pores of the hand (Figure 195). This deposition inside the pores could be related to the use of the mano in a context similar to a stucco smoother. Likewise, small fractures corresponding to the geological and mineralogical characteristics of the base rock used in the manufacture of the hand were identified (Figure 196).

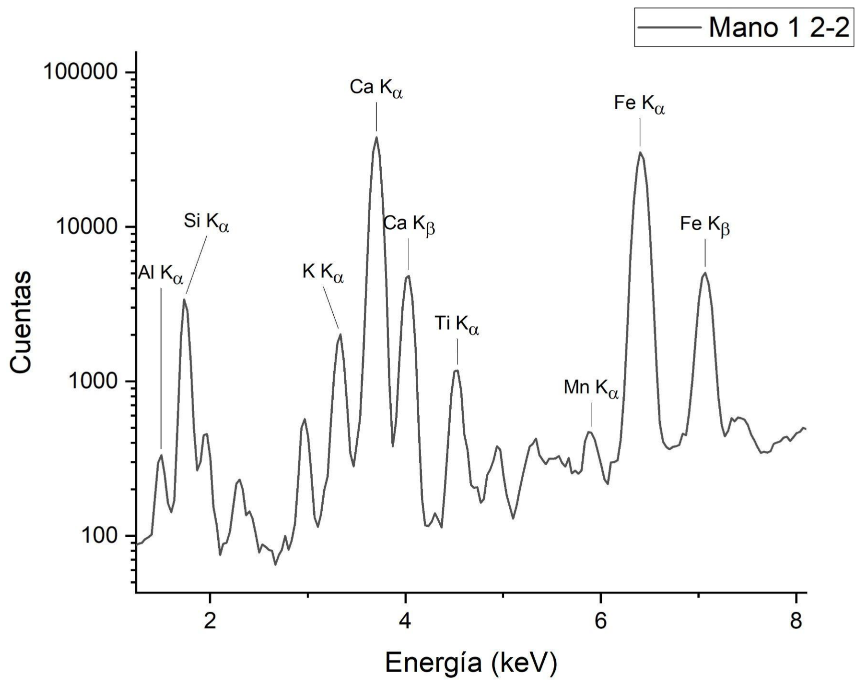

Figure 187. XRF spectrum of Mano 1

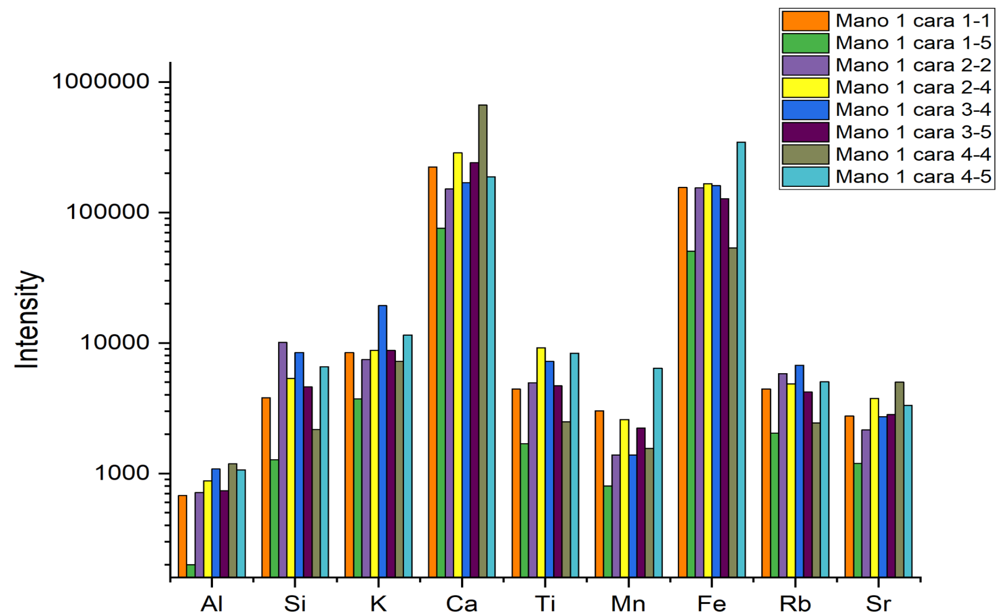

Figure 188. Histogram of representative elements for Mano 1

Table 26. Emission intensities of the K layer for measurements in Mano 1 by XRF.

Element	Al-K	Si-K	K-K	Ca-K	Ti-K	Mn-K	Fe-K	Rb-K	Sr-K
Mano 1 face 1-1	6.79E+02	3.80E+03	8.42E+03	2.23E+05	4.44E+03	3.02E+03	1.55E+05	4.45E+03	2.75E+03
Mano 1 face 1-5	2.00E+02	1.28E+03	3.74E+03	7.58E+04	1.69E+03	8.03E+02	5.04E+04	2.04E+03	1.20E+03
Mano 1 face 2-2	7.15E+02	1.01E+04	7.46E+03	1.51E+05	4.96E+03	1.39E+03	1.54E+05	5.82E+03	2.17E+03
Mano 1 face 2-4	8.78E+02	5.37E+03	8.80E+03	2.86E+05	9.19E+03	2.59E+03	1.66E+05	4.85E+03	3.77E+03
Mano 1 face 3-4	1.08E+03	8.44E+03	1.93E+04	1.69E+05	7.24E+03	1.39E+03	1.60E+05	6.74E+03	2.71E+03
Mano 1 face 3-5	7.38E+02	4.61E+03	8.77E+03	2.40E+05	4.69E+03	2.23E+03	1.28E+05	4.21E+03	2.82E+03
Mano 1 face 4-4	1.19E+03	2.17E+03	7.22E+03	6.65E+05	2.49E+03	1.55E+03	5.36E+04	2.44E+03	5.02E+03
Mano 1 face 4-5	1.07E+03	6.58E+03	1.15E+04	1.87E+05	8.37E+03	6.41E+03	3.45E+05	5.04E+03	3.32E+03

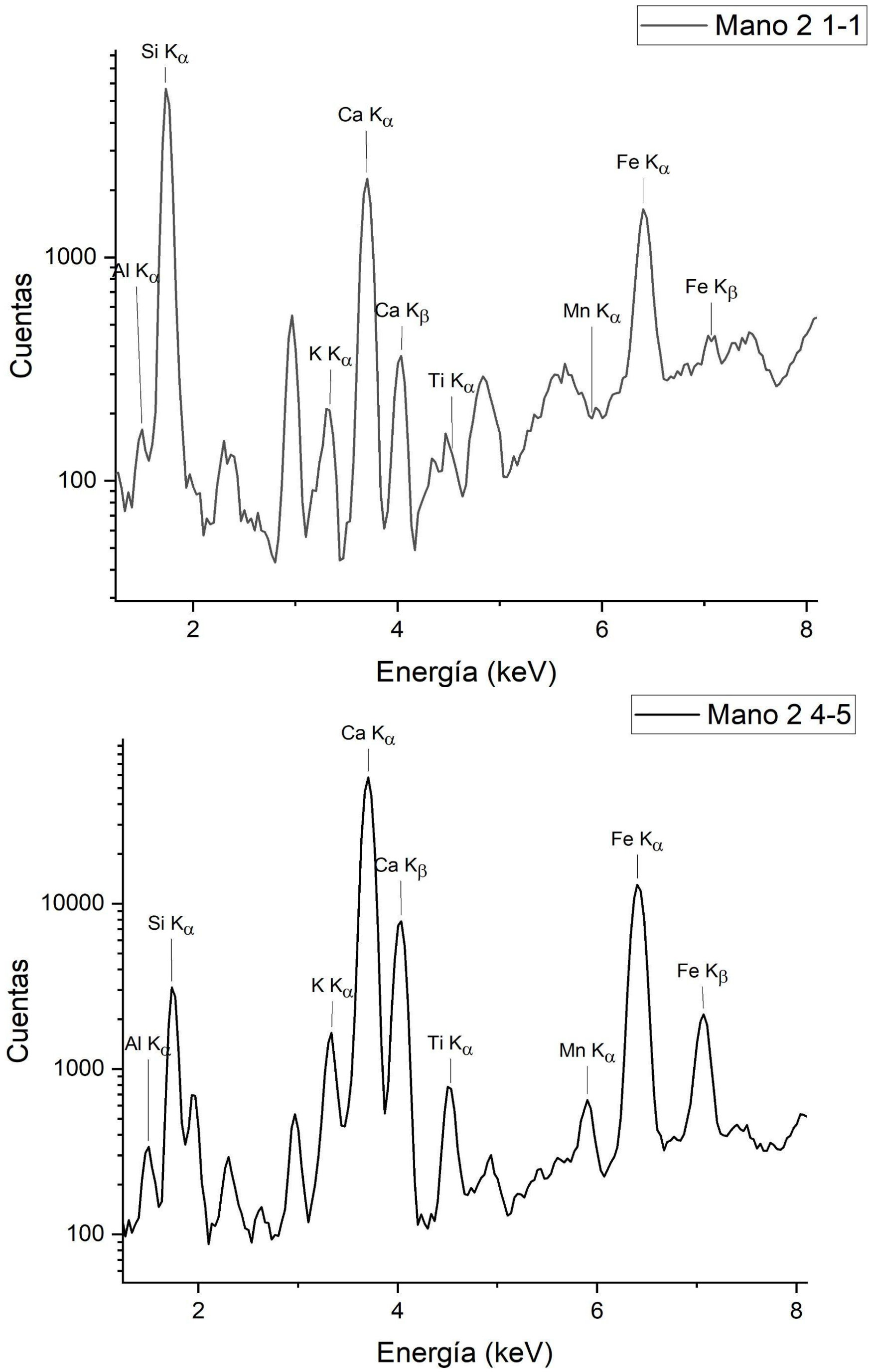

Figure 189. Representative XRF spectra of Mano 2.

Tabla 27. Emission intensities of the K layer for measurements in Mano 2 by XRF

Elemento	Al-K	Si-K	K-K	Ca-K	Ti-K	Mn-K	Fe-K	Rb-K	Sr-K
Mano 2 face 1-1	2.49E+02	1.72E+04	7.05E+02	9.13E+03	3.59E+02	2.76E+02	7.79E+03	5.61E+02	6.57E+02
Mano 2 face 1-2	6.82E+02	8.19E+03	5.48E+03	1.66E+05	3.12E+03	1.60E+03	7.12E+04	1.31E+03	2.64E+03
Mano 2 face 2-2	2.33E+02	1.83E+04	5.90E+02	5.01E+03	3.05E+02	2.78E+02	7.10E+03	8.12E+02	1.09E+03
Mano 2 face 2-4	9.72E+02	5.43E+02	4.38E+03	7.54E+05	6.70E+02	9.94E+02	1.17E+04	5.02E+02	5.68E+03
Mano 2 face 3-3	4.46E+02	1.77E+04	2.28E+03	5.50E+04	9.87E+02	9.35E+02	2.11E+04	9.43E+02	1.00E+03
Mano 2 face 3-4	4.61E+02	1.65E+04	1.37E+03	3.08E+04	7.01E+02	3.86E+02	1.37E+04	6.75E+02	1.17E+03
Mano 2 face 4-2	3.28E+02	1.61E+04	1.19E+03	1.71E+04	4.67E+02	5.35E+02	9.68E+03	7.01E+02	1.06E+03
Mano 2 face 4-5	7.10E+02	9.46E+03	6.15E+03	2.35E+05	3.24E+03	2.40E+03	6.56E+04	7.98E+02	2.25E+03

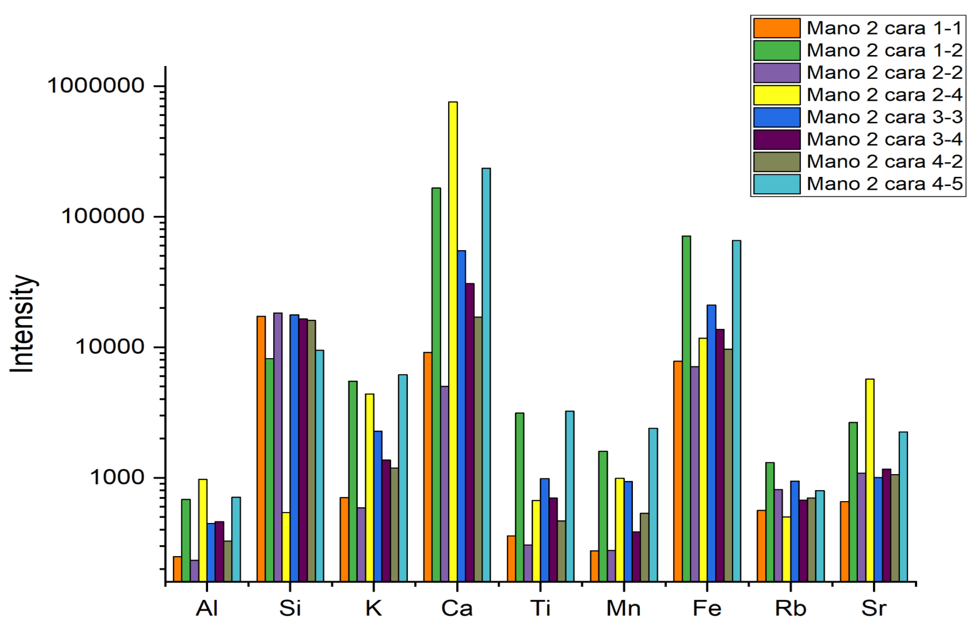

Figure 190. Histogram of representative elements for Mano 1

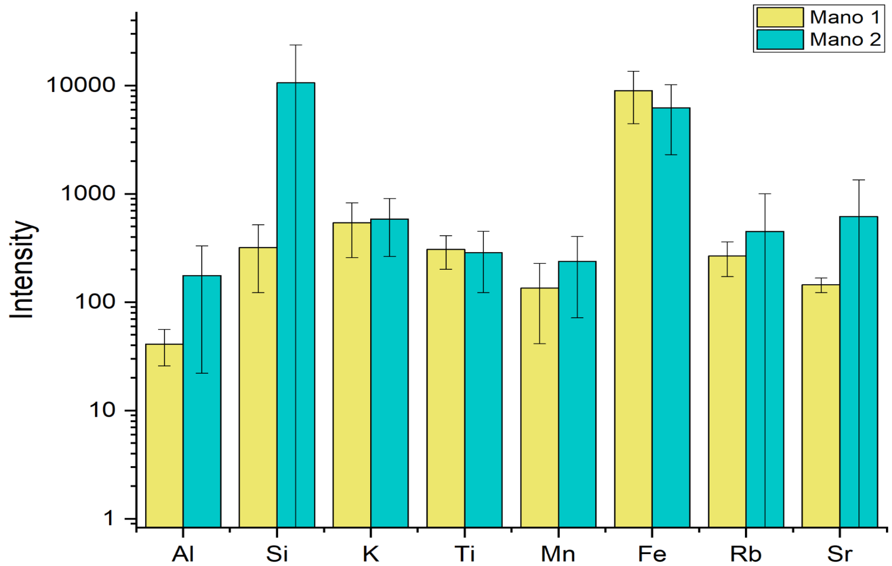

Figure 191. Average and standard deviation of the intensities per element by XRF for hands 1 and 2

Figure 192. Calcium carbonate particles in white present on Mano 1. Identification in the photographs: A020

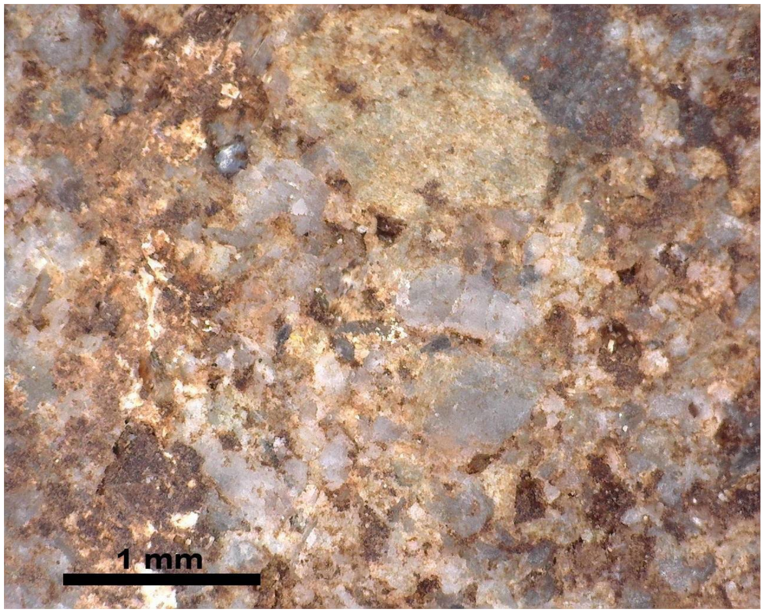

Figure 193. Region of Mano 1 where there are no foreign particles, quartz crystals are seen in the rock as inclusions along with a brown chroma rock in the region of lesser wear. Identification in the photographs: A021

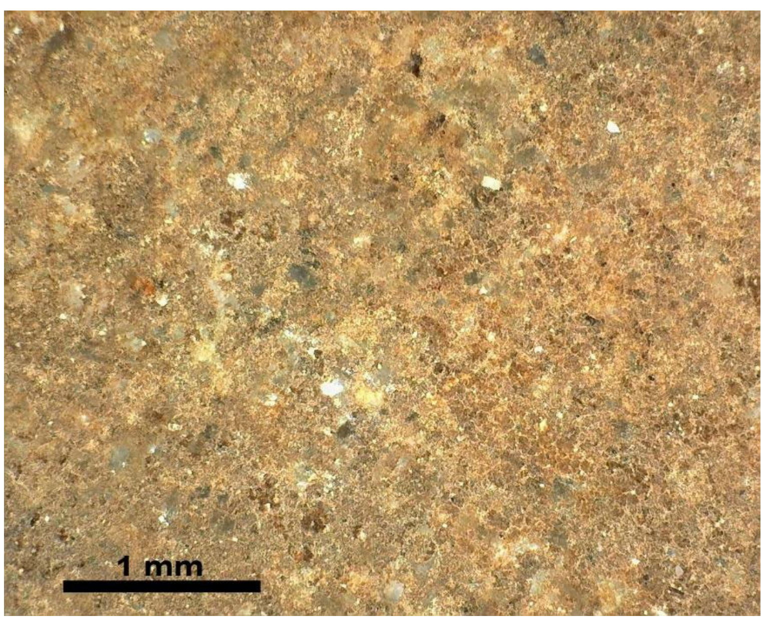

Figure 194. In the region of greatest wear on Mano 1, the size of the calcium carbonate particles is smaller, as are the quartz crystals. Identifier in the photographs: A027.

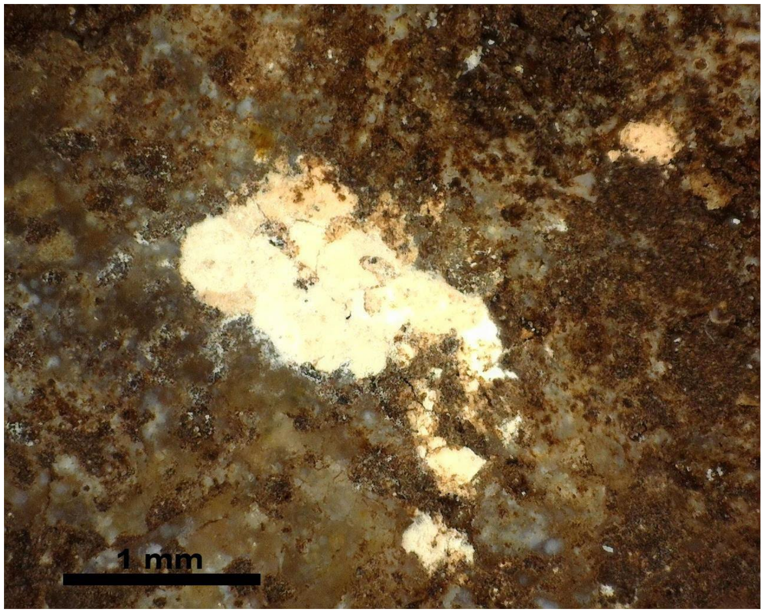

Figure 195. Calcium carbonate particles in white present on Mano 2. Identification in the photographs: A003

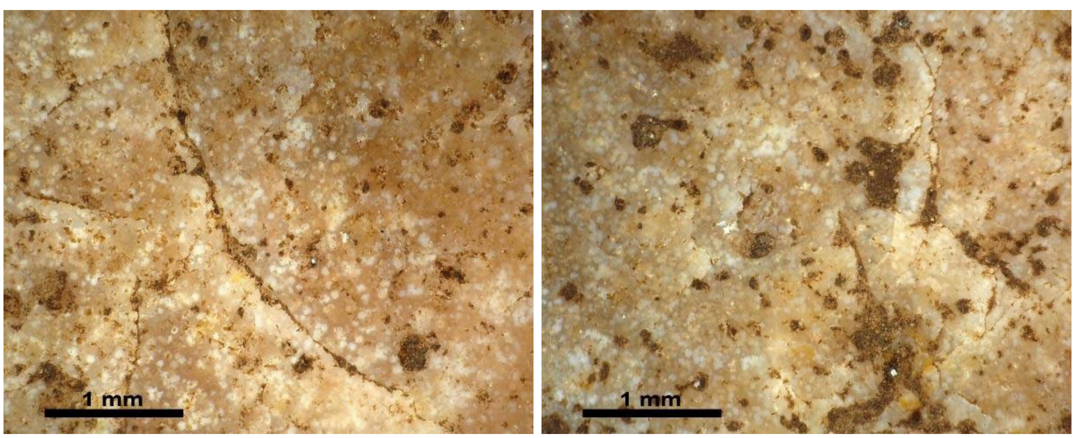

Figure 196. Fracture in Mano 2

Conclusion

The results of the characterization of the metate manos indicate that the base rock used for the manufacture of the manos was a silicified limestone that presents quartz and flint cores. Mano 1 presents a uniform mixture of calcite with quartz, the wear area was carved with the purpose of using the smoothing characteristics of quartz with limestone cortex on the exterior surface of the piece.

In the case of Mano 2, the base rock exhibits a variable composition with a higher presence of quartz (SiO_2) or possible flint nodules in the area of wear and on the exterior surface with limestone cortex.

The presence of calcium carbonate as white particles in the pores of the metate hands may be related to the activity carried out with the hands. Although they are associated with a metate, the hands could also have been used to grind lime stones and prepare or smooth stucco. However, the particles are scarce and it is not possible to define the functionality of the entire piece, given the karstic context in which the metate hands were buried. This could be defined based on the integration of contextual data with the characterization of the pieces.

Acknowledgments

This work was supported by the CONACYT Frontier Science project 2019, number CF-731762. Entitled "BREAKING POINT: Study of pyrotechnological contexts and their archeological, archaeomagnetic, and physical implications in the technological innovation of pre-Hispanic Maya society

Part 4: Summary and Analysis

Chapter 19. Isotopic Analysis of Burials of Operation 8, Sisal, San Felipe

Dr. Raymundo G. Martínez-Serrano,
Laboratorio Universitario de Geoquímica Isotópica, (LUGIS)

The isotopic analyzes of Sr were conducted using a THERMO SCIENTIFIC TRITON PLUS thermal ionization mass spectrometer at the University Laboratory of Isotope Geochemistry (LUGIS), Institute of Geophysics, UNAM. The TRITON has 9 adjustable Faraday collectors and 5 ion counters. All measurements were made statically.

The Sr samples were loaded as chlorides onto a double rhenium filament and measured as metal ions. In each run, 60 isotopic ratios for Sr were analyzed. The integrated software outputs outliers depending on the stability of the signal during data acquisition. The values (1sd = ±1σ abs) refer to the errors during measurement, in the last two digits; 1 SE(M) = 1σ abs /sqrt n. All Sr isotopic ratios were corrected for mass fractionation via normalization to 86Sr/88Sr = 0.1194. LUGIS values for the NBS 987 (Sr) standard: 87Sr/86Sr = 0.710257 ± 13 (±1σ abs, n = 114). The analytical blanks obtained during the sample analysis in this work resulted in: 0.60 ng Sr.

Acknowledgments

To the LUGIS staff who were involved in data collection: To Teodoro Hernández Treviño for the mechanical preparation of the samples. To Gabriela Solís Pichardo for conducting the isotopic analytical work in the ultrapure chemistry laboratory and data reduction. To Gerardo Arrieta García for the isotopic measurements. Thanks to LUGIS for the partial funding of the analyzes.

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Laboratorio Universitario de Geoquímica Isotópica
(LUGIS)

09/04/2025

Estas tres columnas se utilizaron para crear las gráficas.
Cuidado al modificarlas o moverlas.

	Muestra	Código (Lugis)	Tipo	87Sr/86Sr	1 sd*	1 SE(M)	n	gramos muestra	Concentración (D.I.) Sr (ppm)	87Sr/86Sr	1 sd	Notas
	Std SRM 987	SrT246	standard	0.710273	33	4	59					
1	Sisal-m Lix1	6847 AF ID	esmalte	0.708096	33	4	58	0.00313	135.36	0.708096	0.000033	
2	Sisal-m Lix2	6847 AF ID	esmalte	0.708091	30	4	58	0.00626	155.58	0.708091	0.000030	
3	**Sisal-m Res**	**6847 AF ID**	**esmalte**	**0.708101**	**29**	**4**	**58**	**0.07946**	**210.4**	**0.708101**	0.000029	
4	Sisal-h	6850 AF ID	hueso	0.708536	33	4	59	0.00952	403.9	0.708536	0.000033	
5	Sisal-cc	6845 AF ID	caracol	0.708707	26	3	57	0.07725	460.4	0.708707	0.000026	conchas de caracoles chicos
6	Sisal-cg	6846 AF ID	caracol	0.708700	25	3	58	0.06929	801.4	0.708700	0.000025	conchas de caracoles grandes

Análisis realizados en un Espectrómetro de masas TRITON PLUS
Valor del laboratorio del estándar NBS987: 0.710257 ± 13* n = 114

1 sd = 1 desviación estándar
*) En las dos últimas cifras.
1SE(M) = 1sd/raiz n
n = número de relaciones medidas por corrida
D.I. = dilución isotópica

Participación en los trabajos analíticos:

Ing. Teodoro. Hernández Treviño
M.C. Gabriela Solís Pichardo
M.C. Gerardo Arrieta García

Lix 1= lixiviado 1
Lix2 = lixiviado 2
Res = Residuo del esmalte

El individuo es migrante ya que las firmas isotópicas del hueso y
El esmalte del diente no coinciden entre ellas ni con las de las conchas.

Table 28. Results of Sr isotopic analysis, Operation 8, Sisal

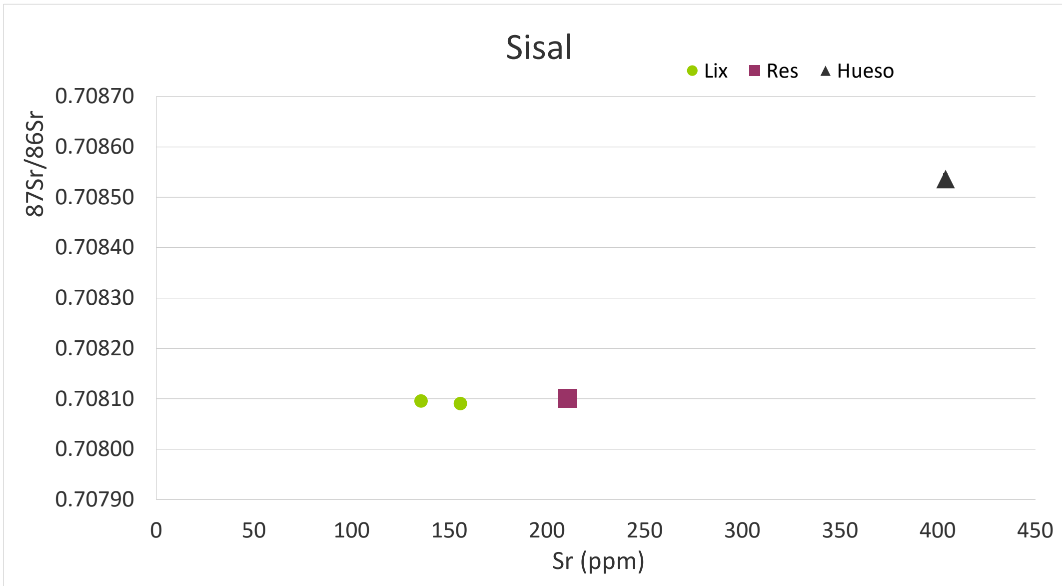

Figure 197. Mestra Sisal: leachates, enamel residue, and bone

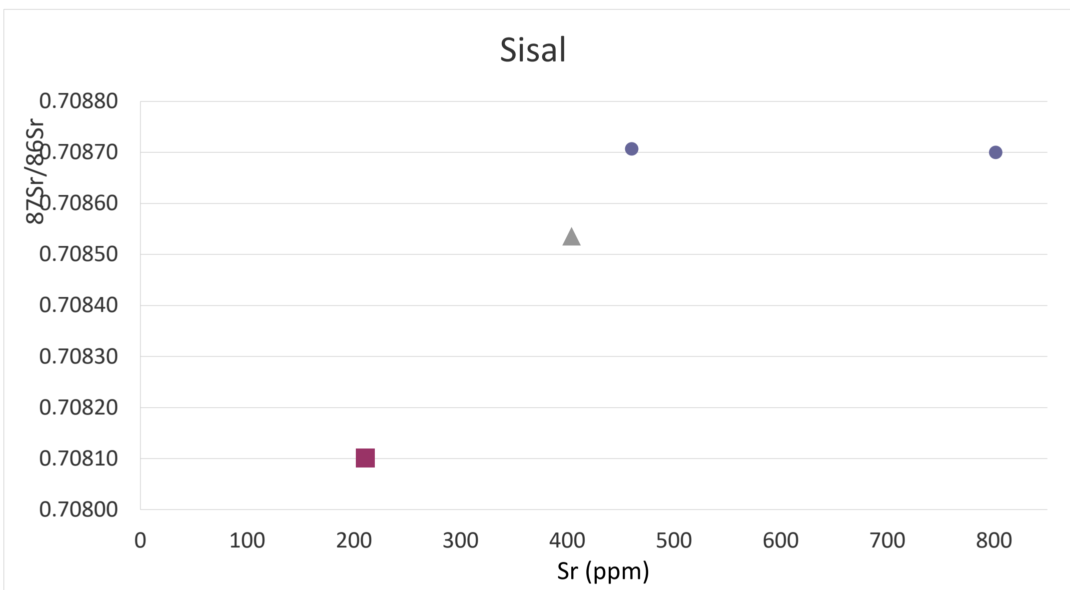

Figure 198. Sisal Sample: enamel residue (red square), bone (green triangle), and shells (blue circle)

Part 4: Summary and Analysis

Chapter 20. Interpretation of results of analysis of stable strontium isotope ratios (87Sr/86Sr) of Burial 1 and 2, Operation 8, Sisal, San Felipe

Allan Ortega (Centro INAH-QRoo)

The Laboratorio Universitario de Geoquímica Isotópica (LUGIS), of the Universidad Nacional Autónoma de México (UNAM), conducted an analysis on two samples from Burial 1, one of which is an adult lady accompanied by a fetus. This individual underwent an analysis of a first molar, which suggests the significance of the stable strontium isotope ratio—transmitted through the food chain to the tooth enamel—pertaining to the birthplace and early developmental years. A fragment of long bone from the same individual was studied, and due to the remodeling rate of bones, it would reflect the stable strontium isotope ratio incorporated into the body during the last 10 years of the individual's life.

Table 29 delineates the findings for tooth enamel and bone, alongside reference values of 87Sr/86Sr for the Prehispanic site of Sisal, Quintana Roo, utilizing two snails retrieved during the excavation. The dental enamel had an 87Sr/86Sr ratio of 0.708101 ‰, while the bone displayed a ratio of 0.708536 ‰. The local value, as suggested by the snail samples, is 0.7087.

The analysts succinctly identify the individual's origin, asserting that "The individual is a migrant as the isotopic signatures of the bone and tooth enamel are inconsistent with one another and with those of the shells."

Table 29. Results of the analyzes conducted on bone and tooth from Burial 1 at the Sisal site to obtain stable strontium isotope ratios (87Sr/86Sr)

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(LUGIS)

09/04/2025

	Muestra	Código (Lugis)	Tipo	87Sr/86Sr	1 sd*	1 SE(M)	n	gramos muestra	Concentración (D.I.) Sr (ppm)	87Sr/86Sr	1 sd
	Std SRM 987	SrT246	standard	0.7103	33	4	59				
1	Sisal-m Lix1	6847 AF ID	esmalte	0.7081	33	4	58	0.00313	135.36	0.708096	0.000033
2	Sisal-m Lix2	6847 AF ID	esmalte	0.7081	30	4	58	0.00626	155.58	0.708091	0.000030
3	**Sisal-m Res**	**6847 AF ID**	**esmalte**	**0.7081**	**29**	**4**	**58**	**0.07946**	**210.4**	**0.708101**	0.000029
4	Sisal-h	6850 AF ID	hueso	0.7085	33	4	59	0.00952	403.9	0.708536	0.000033
5	Sisal-cc	6845 AF ID	caracol	0.7087	26	3	57	0.07725	460.4	0.708707	0.000026
6	Sisal-cg	6846 AF ID	caracol	0.7087	25	3	58	0.06929	801.4	0.708700	0.000025

Análisis realizados en un Espectrómetro de masas TRITON PLUS
Valor del laboratorio del estándar NBS987: 0.710257 ± 13* n = 114

We concur with the interpretation offered by the LUGIS personnel. To substantiate this conclusion, we have analyzed the data released by Cucina and colleagues for the Noh-Bec site, which is geographically proximate to Sisal, Quintana Roo, and may exhibit the same 87Sr/86Sr ratio as Noh-Bec. In this context, Figure 199 illustrates the local values spanning from 0.07086 to 0.7088, as reported by Cucina et al. (2015), with the values of the snails residing within this spectrum. The 87Sr/86Sr ratios of both enamel and bone are below these values, confirming that this individual was neither born nor resided outside of Sisal during the last decade of their life.

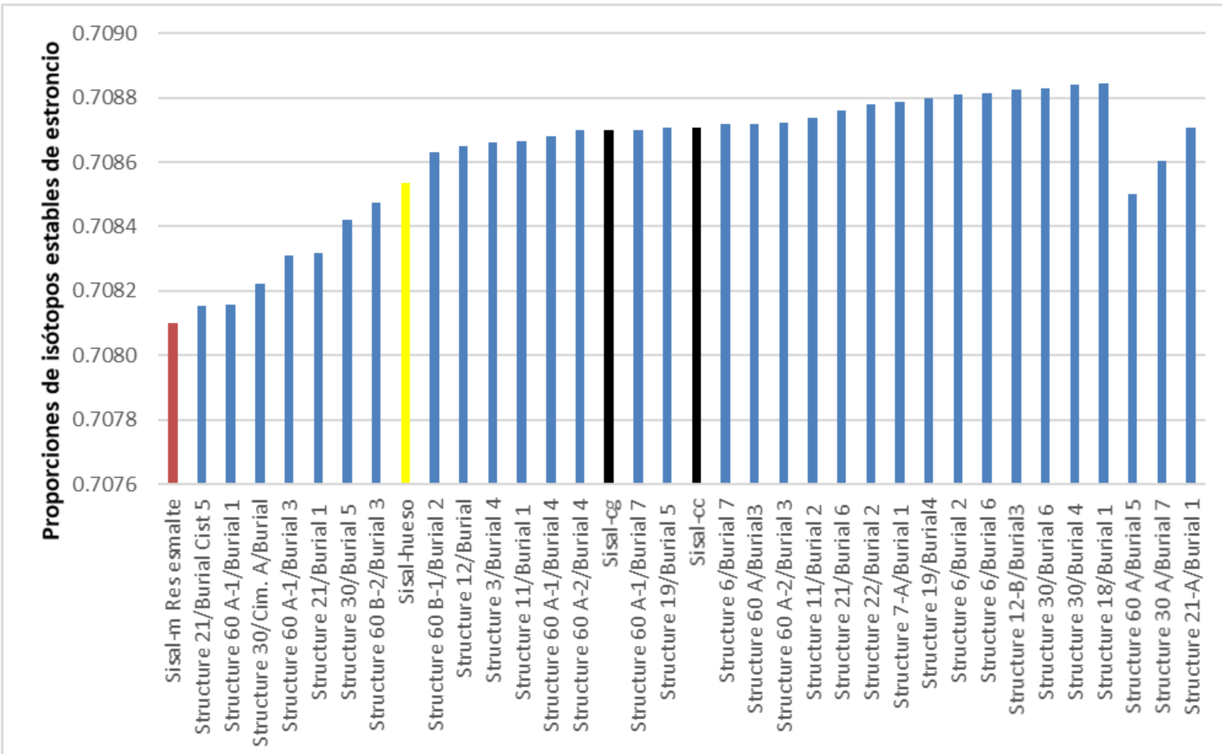

Figure 199. Distribution of 87Sr/86Sr ratios for Noh-Bec, Yucatán, and Sisal, Quintana Roo. Brown bar: enamel. Yellow: osseous tissue. Black: gastropods. Individuals with blue pigmentation from the archaeological site of Noh-Bec, Yucatán (Source: Cucina et al., 2015).

What is the birthplace of this individual and where did they reside throughout the final decade of their life? To examine this, it is essential to compare the values with reference standards, such as those provided by Price et al. (2008). The value of 0.7081, derived from enamel, pertains to the La Venta region in Tabasco and Escárcega, Campeche. The value of 0.7085, derived from the bone, is indicated in the area of Nohmul, Belize. Is it plausible for these two locations to be their isotopic source? Additional study is in progress, and updates will be disseminated in forthcoming papers.

Part 4: Summary and Analysis

Chapter 21. Report of Datation of Burials of Operation 8, Sisal, San Felipe

Dra. María Rodríguez Ceja, Laboratorio LEMA, UNAM

USUARIO: DR. ALBERTO FLORES COLÍN **NÚM. REPORTE: 169**
CONTACTO: albertoflorescolin@gmail.com **FECHA DE REPORTE: 13/12/2024**
ELABORÓ: DRA. MARÍA RODRÍGUEZ CEJA **FECHA DE RECEPCIÓN DE MUESTRA: 22/11/2024**
OPERADOR DEL SISTEMA EMA: FÍS. ARCADIO HUERTA HERNÁNDEZ
ENCARGADO DEL SEPARADOR ISOTÓPICO: DR. EFRAÍN CHÁVEZ LOMELÍ
REVISÓ Y APROBÓ: DRA. CORINA SOLÍS ROSALES

Corina Solís R

I INTRODUCCIÓN

Se recibieron dos muestras de hueso, para fechar con ^{14}C por espectrometría de masas con aceleradores (AMS) (Tabla 1).

Tabla 1. Identificación de muestras

Clave Laboratorio	Clave Usuario	Material	Descripción	Sitio
LEMA 2365	Entierro 1	Hueso	Hueso fémur de no nato. Proyecto CRAS 2018	Sisal, Ejido de San Felipe Oriente, Quintana Roo.
LEMA 2366	Entierro 2	Hueso	Op 8. Muestra de fémur.	Sisal, Ejido de San Felipe Oriente, Quintana Roo.

II METODOLOGÍA

2.1 Preparación de muestras

Las muestras se limpiaron con agua ultrapura para eliminar sales y otros contaminantes adheridos. Una vez secas se pulverizaron. Luego se sometieron a un procedimiento químico con HCl 0.5 M a temperatura ambiente, para disolver la fase mineral y eliminar los carbonatos. Posteriormente se realizó una limpieza con NaOH 0.1 M a temperatura ambiente para eliminar contaminación orgánica y ácidos húmicos. Finalmente se realizó la gelatinización, mediante un tratamiento ácido con HCl 0.001 M en alta temperatura. El colágeno disuelto se filtró para conservar las fibras mayores a 30 KD, obteniendo así el *colágeno ultrafiltrado.*

2.2 Grafitización

Las muestras fueron procesadas en un Equipo de Grafitización Automatizado *AGEIII* de *Ion Plus*, para transformar su contenido de carbono en CO_2 y luego éste en grafito.

2.3 Análisis por Espectrometría de Masas con Aceleradores

Se realizó el análisis de ^{14}C, ^{13}C y ^{12}C del grafito obtenido mediante AMS. Se utilizó un equipo Tandetrón de *High Voltage Engineering Europa* (HVEE), con un acelerador de 1 MV de energía. A partir de los valores obtenidos, se calculó la *Edad Radiocarbono o Convencional* (^{14}C), dada en años antes del presente (a.P.), es decir, antes de 1950. La *Edad Radiocarbono* fue corregida por fraccionamiento por $\delta^{13}C$ a partir del cociente de $^{13}C/^{12}C$ en la muestra. $\delta^{13}C$ es un valor medido en grafito y podría haber sufrido un fraccionamiento adicional.

2.4 Calibración

La *Edad Radiocarbono* fue corregida por las variaciones del ^{14}C en la atmósfera, con el programa OxCal v4.2.4 (https://c14.arch.ox.ac.uk/oxcal/OxCal.html; Bronk Ramsey, 2013), utilizando la curva de calibración *IntCal20* (Reimer et al, 2020). Se obtuvo la *Edad calibrada antes del presente,* dada en *años cal a.P.,* y la *Edad calendario*, dada en años calibrados antes de Cristo (*cal a.C.*) o después de Cristo (*cal d.C.*). Se calcularon los intervalos más probables, con los niveles de confianza del 68% (1σ) y del 95% (2σ).

III RESULTADOS

En la Tabla 2 se presentan los resultados de las muestras fechadas. Adicionalmente se analizaron estándares de edades conocidas proporcionados por el Organismo Internacional de Energía Atómica (OIEA), para verificar su reproducibilidad en nuestro laboratorio (Tabla 3).

Tabla 2. Resultados *

Clave LEMA	Fracción fechada	Edad ^{14}C Años (a.P. ± 1σ)	Edad calibrada (años) Nivel de confianza	
			1σ (68%)	2σ (95%)
LEMA 2365.1.1	Colágeno ultrafiltrado	1056 ± 35	1047 – 924 cal a.P.	1058 – 916 cal a.P.
			903 cal d.C.- 1026 cal d.C.	892 cal d.C. – 1035 cal d.C.
LEMA 2366.1.1	Colágeno ultrafiltrado	1144 ± 35	1173 – 973 cal a.P.	1177 – 958 cal a.P.
			778 cal d.C.- 977 cal d.C.	773 cal d.C. – 992 cal d.C.

***La representatividad de la muestra no es responsabilidad del Laboratorio.**
***Los resultados obtenidos amparan únicamente la muestra ensayada.**
*** Este informe de resultados sólo puede ser reproducido en su totalidad.**
*** El laboratorio no se hace responsable de la información proporcionada por el cliente que pueda afectar la validez de los resultados.**

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Tabla 3. Estándares de referencia del OIEA

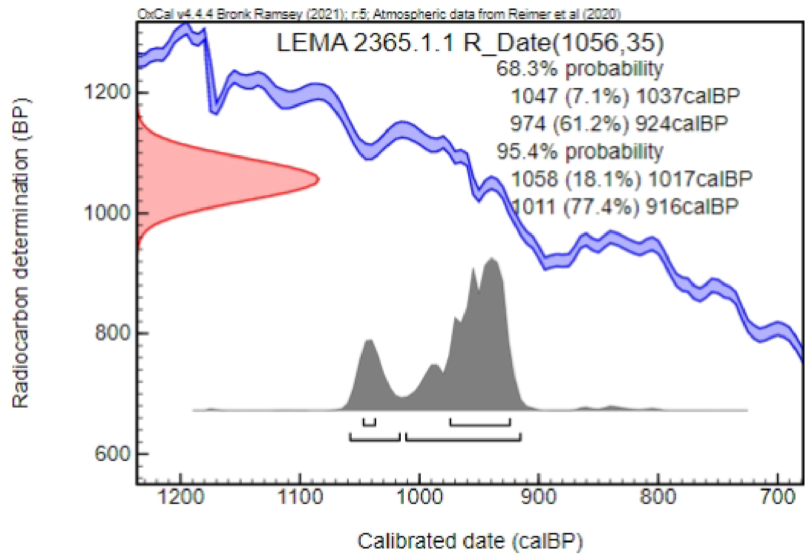
Muestra	Material	Edad certificada (años a.P. ± 1σ)	Edad Medida (años a.P. ± 1σ)
C3	Celulosa	-2071 ± 30	-2104 ± 34
C5	Madera	11788 ± 40	11737 ± 40
C7	Ácido oxálico	5642 ± 30	5641 ± 40

CALIBRACIÓN

1. LEMA 2365.1.1
   Edad: 1056 ± 35 A.P.

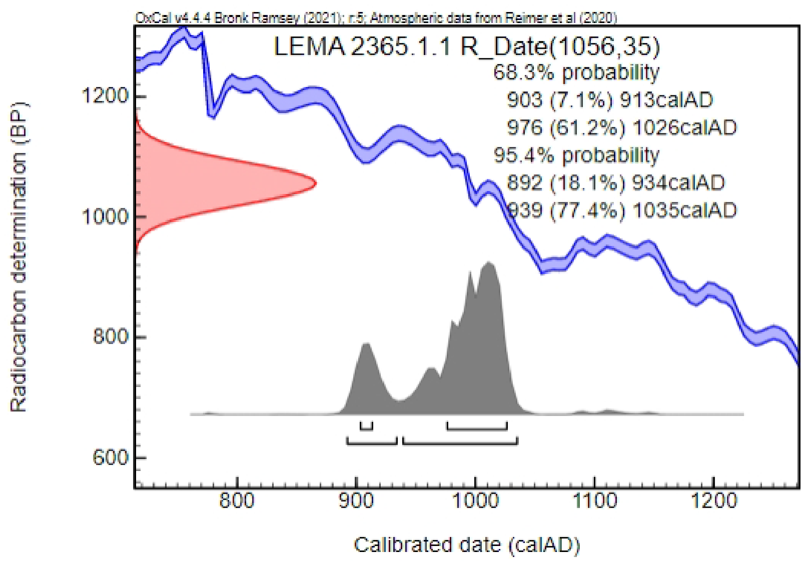
CALIBRACIÓN cal AP

Name		Unmodelled (BP)				Controls		
		from_68.3	to_68.3	from_95.4	to_95.4	Select	Page	Edit
R_Date LEMA 2365.1.1		1047	924	1058	916	2		



CALIBRACIÓN a.C.- d.C.

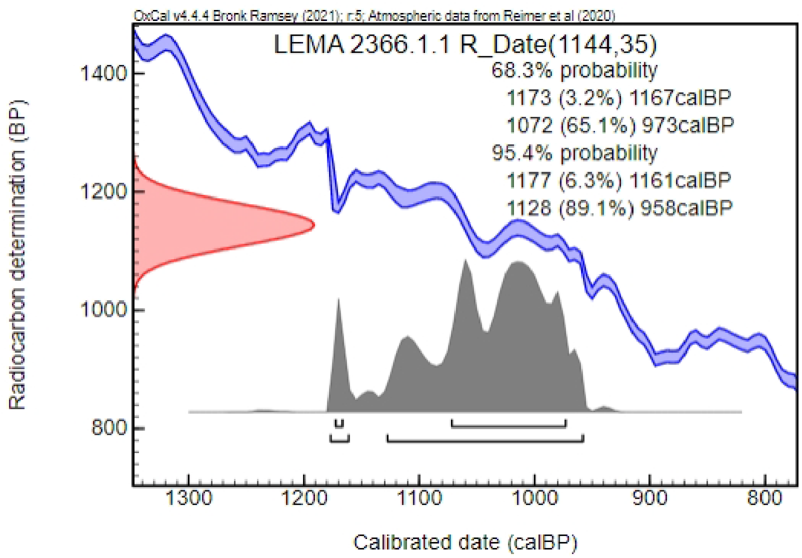
Name		Unmodelled (BC/AD)				Controls		
		from_68.3	to_68.3	from_95.4	to_95.4	Select	Page	Edit
R_Date LEMA 2365.1.1		903	1026	892	1035	☑ 2	☐	



2. LEMA 2366.1.1
   Edad: 1144 ± 35 A.P.

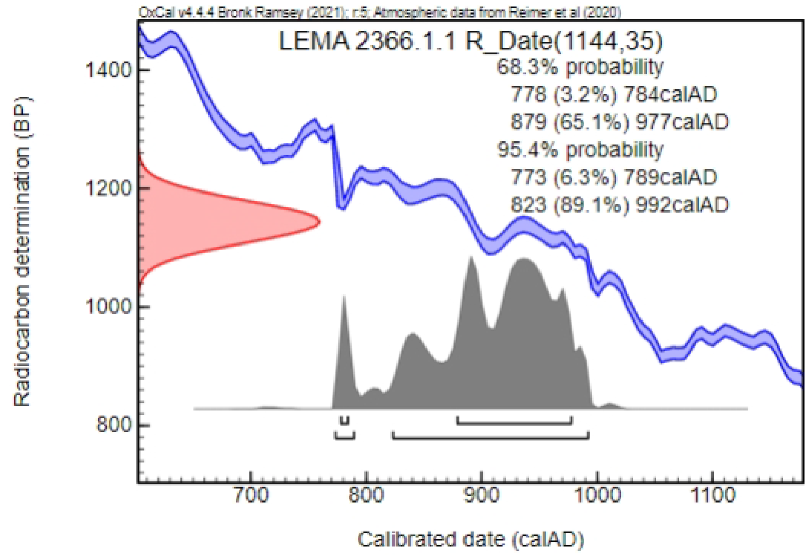
CALIBRACIÓN cal AP

Name		Unmodelled (BP)				Controls		
		from_68.3	to_68.3	from_95.4	to_95.4	Select	Page	Edit
R_Date LEMA 2366.1.1		1173	973	1177	958	☑ 2	☐	



CALIBRACIÓN a.C.- d.C.

Name		Unmodelled (BC/AD)				Controls		
		from_68.3	to_68.3	from_95.4	to_95.4	Select	Page	Edit
R_Date LEMA 2366.1.1		778	977	773	992	☑ 2	☐	



IV ANEXO: FOTOGRAFÍAS

LEMA 2365

LEMA 2366

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Part 4: Summary and Analysis

Chapter 22. Final Thoughts

Alberto G. Flores Colin and Justine M. Shaw

The excavations carried out at sites that had already been previously mapped but not excavated, in the ejidos of Sacalaca and San Felipe, have been quite productive and have helped us understand and complement the occupational sequence of the region, a task that the project has been undertaking over various seasons and that demonstrates the complexity of settlement in the Cochuah region, gradually changing the perception that it is an area with isolated sites as seen in many archaeological maps.

Similarly, the excavations carried out at the San Andrés Norte Milpa and Sisal sites have helped to better understand one of the lines of research conducted by the project in recent years: the foundations of perishable structures as markers of a late phase of the Terminal Classic. These extensive excavations, complemented by a series of laboratory analyzes, such as spot test soil analysis and stone type characterization, have helped us understand the dynamics and possible functions of these constructions.

The data obtained from the four extensive excavations carried out this season, combined with the results of the soil analysis, suggest that these constructions had a domestic type of activity; none of them show signs of being a structure specialized in the production of any product, nor that they were warehouses or apiaries, as we had proposed as a possibility at the beginning of the research. Similarly, the characterization of the metate manos provides insight into the type of material and domestic technology used in these perishable-type structures.

Additionally, the radiocarbon analyses conducted on the remains found in Operation 8 of Sisal have corroborated the chronology we had suggested for this type of construction: a late phase of the Terminal Classic. As we had been observing in other contexts of the study area, this type of construction, built with reused stones from earlier phases and placed without arrangement and over earlier constructions or spaces, seems to be a temporal and diagnostic marker of this late phase of the Terminal Classic.

Similarly, the results of the stable isotope analysis on the remains found in Operation 8 of Sisal have shown that it was a migrant, a person who had been born in the southern area of the peninsula and who had arrived in the area a few years before they were buried. This also corroborates what had been proposed for this late phase of the Terminal Classic, when there seems to have been an abandonment or population decline of the settlements and a subsequent reoccupation by non-local inhabitants who built the foundations of perishable structures.

In conclusion, both the excavations and the analyses have been extremely beneficial in better understanding the region's occupational history, as well as the domestic activities of the residents who reoccupied a large portion of the previous sites, which were then abandoned and deteriorating. Future work in the area will verify and corroborate whether this phenomenon extends to other settlements or if it is a more localized process, which will be essential for understanding the demographic and cultural changes that the Cochuah region underwent.

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