# The Stones of Calakmul: Lithics and Other Technologies Among the Maya at Calakmul, Campeche, During the Late and Terminal Classic and Their Cultural Implications

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## Abstract:

This chapter discusses the stone artifact assemblage excavated from Calakmul, Campeche, Mexico between 1984 and 1994 under the direction of William J. Folan, Centro de Investigaciones Históricas y Sociales of the Universidad Autonoma de Campeche. After setting the analysis of stone tools in the context of the Central Maya lowlands, methods of studying stone implements are related from various sources including previous Maya lithic studies, the French Upper Paleolithic, and Southeastern United States. Then we explore the assemblage in a three-step investigation:

1. We characterized the assemblage in very general terms to bracket the weight-sizes and shapes of what was found.

2. We break the assemblage down into types and subtypes. Types are usually standard stone tool technology forms whose function is understood through direct observation in ethnographic societies, or forms on which only limited understanding is available from historical and ethnographic records and so has to be inferred. The approach taken herein is to analyze the size modes of the forms to insure each represents a homogenous population. If it is not, it is divided into subtypes based on the modes, usually of weights or occasionally other aspects of sizes.

3. We cluster the types/subtypes based on their associations in "rooms". Most rooms are literal rooms with walls and some doors, but rooms may also be some other confined spaces such as porticos, zones, and segments of staircases. The room clusters are then assigned inferred functions based on the members of these tool kit clusters with the best understood functions. For example, if barkbeaters used in making bark cloth are found with obsidian prismatic blades, it is assumed that those blades were also used in the bark cloth making process, perhaps for trimming edges, and that rooms containing these combinations of tools included those functions. Some rooms appear to be single use, especially small rooms, other larger rooms appear to be multiuse.

**Keywords:** Central Maya lowlands | lithic studies | Calakmul | stone artifacts

## Chapter:

*****Note: Full text of chapter below**

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Portada: Máscara de jade reconstruida de la Tumba 1 de la Estructura VII de Calakmul, Campeche (Información #9) superpuesto en un cuchillo de obsidiana hecho por Joel D. Gunn, PhD. durante la escuela de campo Don Crabtree Lithics 1972 patrocinada por NSF: Glas Butes Oregón obsidiana basal con muesca, atado con cuero crudo, mango de abedul negro.

Cover: Reconstructed Jade Mask from Tomb 1 de la Estructura VII de Calakmul, Campeche (Información #9) superimposed on obsidian knife made by Joel D. Gunn, Ph.D. during the 1972 Don Crabtree Lithics Field school NSF Sponsored: Glass Buttes Oregon Obsidian basal notched point, raw hide binding, black birch handle.


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# THE STONES OF CALAKMUL: LITHICS AND OTHER TECHNOLOGIES AMONG THE MAYA AT CALAKMUL, CAMPECHE, DURING THE LATE AND TERMINAL CLASSIC AND THEIR CULTURAL IMPLICATIONS

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## Introduction

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To provide a broader functional context for rooms, lithics are also analyzed in conjunction with non-lithic artifacts such as figurines (ritual) and ceramic types (food preparation, serving, carrying, storage, ceremony, mortuary). Inferences are also suggested as to the flow of artifacts through and between the structures to identify workshop rooms where tools were made and functional areas where they were used. All of this was done keeping in mind Michael E. Smith's (2019:489–490) suggestion to downplay the long held fascination of archaeologists with status, but rather giving attention to quality of life issues such as income, for which room size serves as a proxy, and capabilities, which are represented by the number and frequencies of artifact types/subtypes in rooms and the internal and external social networks they represent. This point of view is particularly apt in a Terminal Classic context in which Classic Period ideas about status and architecture appear to have been scrambled by the need to encastlate urban populations in defensible quarters (Marken and Arnauld 2018). It appears that the former high-status pyramids at Calakmul provided obvious military advantages regardless of status issues. An interesting question to be asked of the lithic data is, given the assumed status-driven design of the palaces and temples in the Early Late Classic, how do quality of life values overlay with the Early Late Classic status-based room template? Was it a more egalitarian society? Was there any hierarchy?

## Lithics in the Maya Lowlands

The 1984 and 1994 excavations at Calakmul added to a growing literature in Maya lowlands use of stone as a primary means of making tools: 15,000 stone fragments and tools serve as a class, lithics. Most (N=9,205) came from pyramid Structure II, one of the largest human made structures in Mesoamerica, and palace Structure III (N=3,034) on the same plaza in the city's key acropolis (see ***Table 2*** and ***Table 3***) (Folan et al. 1995). Smaller assemblages were gathered from Structure I and Structure VII. This collection is one of the largest lithics assemblages in the Maya lowlands, certainly when the volume of excavation is considered. It is also one of the few systematically collected assemblages, being separated stratigraphically by and within rooms. With the exception of a workshop in two adjoining rooms on the lowest zone of pyramid Structure II, the lithics are thinly and more or less evenly distributed through the rooms of the palaces and pyramids. Most rooms have between 1 and 100 artifacts. Some of the large palace rooms have between 100 and 1000 artifacts. This includes the large structures on the summit of pyramid Structure II and rooms on the zones of the north façade of Structure II.

The first significant study of lithics in the Maya lowlands was by A. V. Kidder published in a 1947 report on Uaxactún (Rovner and Lewenstein 1997:6). Kidder applied his experience with stone tools from the southwestern United States to the study of Maya lowland lithics. His work was an exceptional effort during a time when lowland lithics were generally ignored and typically not even collected during excavations. Those that were collected were not systematically curated to serve for later analysis. Although a laudable effort, Kidder's work is now considered to be dated because of his methods of assigning function to tools, especially as regards utilitarian or ritual purpose, without benefit of the studies of lithic production and use wear that have been systematically investigated in the last 50 years.

Beginning with Rovner's (1975) studies of lithics at Dzibilchaltun and Rio Bec in the early 1970s, more attention was paid to the cultural information garnered from the study of lithics. As a result of decades of studies on the lithics of the Maya lowlands, important information has emerged on their distribution and use, the functions to which they were applied, and the movement of materials between subregions. A substantial corpus of data and writing exists (Rovner and Lewenstein 1997:1–10). Rovner reporting on work that was undertaken for his dissertation completed in 1975, undertook a relatively widespread study of lithic methods and types by combining artifacts excavated from Dzibilchaltun (northwest Yucatan Peninsula) and the Becán project (east central Yucatan Peninsula) (Rovner 1974, 1981, 1975; Rovner and Lewenstein 1997). A wide variety of tools were studied and some stratigraphic evidence of changes in uses of lithics through time was observed.

Evidence identifies Pleistocene and Early Holocene residents of the peninsula as Paleoindians and Early Archaic. In a survey of 230 sites and survey locations in Belize MacNeish et al. (1980:59-64) found five preceramic periods before 2,000 BC. Before 7,500 BC was a Paleoindian complex. Before 4,200 BC they appear to have been terrestrial hunter-gatherers. After 4,200 BC they turned to reliance on aquatic habitats represented by large coastal middens. In other words, they were responding to sea level stabilization by 6,200 BP (see Day et al. 2012). After 3,300 BC attention turned in addition to interior river valleys. Archaeological remains are sparse or absent in the Laberinto and Ramonal bajos of Campeche before 4,500 BP, perhaps because precipitation was intense enough during the Middle Holocene to scour upland and bury lowland surfaces (Gunn et al. 2002, 2009). After approximately 3,000 BP populations from the Laguna de Terminos and Chetumal Bay areas spread across the southern lowlands Sub-Sierra Madre Depression (see Gunn 2019 for additional discussion) or Lake District. They appear to have been sophisticated frontiers people, perhaps traders, bearers of Xe, Mamon and other ceramics varieties (Adams 2005:130ff).

As Rovner pointed out (Rovner 1981:168; Domínguez Carrasco et al. 1998), it has become clear that lithics were used extensively at all levels of society and in all parts of the Yucatan Peninsula.

> "…chert industries do vary clearly, substantially and significantly in space and through time in respects of form, function, complexity and economic importance. Furthermore,

any assumption that chert industries served only local functions for the lower classes is also not correct. Chert was a major item of exchange, widely distributed for a number of reasons, often serving elite, sumptuary and ceremonial purposes." (Rovner 1981)

Furthermore, taken as whole, the distribution and use of imported obsidian is not as widespread as one might have been led to believe by early studies in the Guatemalan Petén. In cities north of the Petén obsidian generally occurs in low frequencies. Typical of this pattern was Dzibilchaltun in which 600 test pits yielded only 52 pieces of obsidian (Rovner 1981). By contrast excavations at Tikal revealed millions of obsidian pieces (Moholy-Nagy 1997).

The Yucatan Peninsula has various sources of chert both within and without the region. Rovner (1981) identified three zones of chert sources (**Figure 1**). Zone A is along the north coast. Since no lithic resources exist in this geologically young subregion, Rovner believed that the lithics there originated further south in older rocks formed in marine sediments. A nearby source is the Puuc Hills. Mayapan in west central Yucatan Peninsula seems to have the assemblage with the most consistent variety of lithics suggesting that the exploited sources may be in the nearby Puuc Hills.

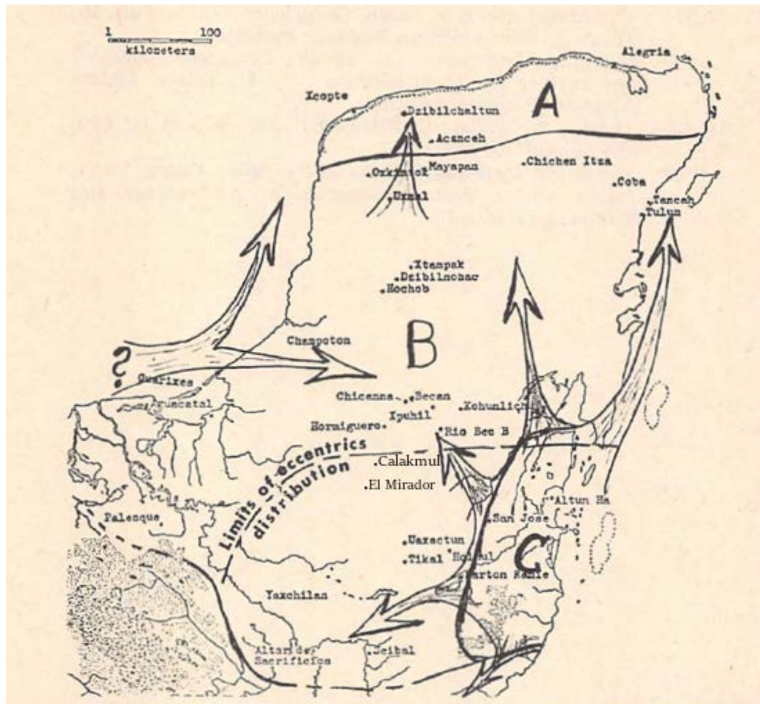


**Figure 1 Lithic distributions in the Yucatan Peninsula. (adapted from Rover 1981)**

A search of chert deposits of the Conhuas-to-Villahermosa road, which passes along the central and east side of the Calakmul Basin, suggests a wide variety of lithic materials including jasper and fine brown chert is available proximate to Calakmul and within the Calakmul regional state (Morales López et al. 2017). If this proves to be the case, much of the potential to analyze trade relations from lithic types will be obscured, at least in the immediate area of the Calakmul regional state. Rovner reports that the Puuc Hills also have a wide variety of chert, although it tends to be of lesser quality than the fine brown cherts of Belize (Hester and Shafer 1984).

Zone B is a broad area south of the Puuc Hills and west of Belize, which includes Calakmul. According to Rovner's (1981) analysis the local sources may be of moderately high quality. Implements were made primarily into biface celts and retouched flakes. Rovner believed that some of the material could have been imported by sea borne trade from the west (see Rovner and Lewenstein 1997:44-45 for discussion of trade indices from obsidian). Recent reports of a fine brown chert source in/near El Tigre/Itzamkanac further extends this possibility (Meza Rodríguez 2008).

Zone C is confined to Belize. The chert sources there have been extensively studied by the Colha Project (Hester and Shafer 1984). They consisted of fine-grained, honey-brown to coffee-brown cherts gathered in large nodules from near-surface exposures. Granites and slates also occur in Zone C because of the Maya Mountains. Caracol may have been an exporter of granites (A. Chase, personal communication, 2015).

Rovner (1981) proposed various systems of exchange drawing on implement morphology and material types. Relative to the Calakmul assemblage, comparison of the lithic sequences at Dzibilchaltun to the north and Becan-Chicanná to the east will help set a cultural context. Eccentrics, for example, were found to be limited to the area south of Rio Bec (Becan-Chicanná). Calakmul falls on this boundary, and true to this pattern, only four eccentrics were found in the assemblage of over 15,000 lithics.

Rovner's examination of the Dzibilchaltun assemblage showed that during the Preclassic little in the way of exchange occurred, even with the hills to the immediate south. Chert artifacts were generally simple, unretouched flakes. A few pieces of obsidian appear. During an otherwise impoverished Early Classic, the importation of obsidian increases and importation of Zone C (on the southeast in Belize) cherts begins. The well-developed Classic Period witnessed the extensive importation of both zone B and C cherts. Dzibilchaltun seems to have been drawn first into long distance trade to obtain high quality Zone C chert rather than developing nearby resources. Later it turned to nearby resources. This process is reminiscent of the Classic Period pattern of settlement in the northern peninsula by overlaying earlier populations with new elites (military monastics such as the Itza, or water wise men) from the south as described by Piña Chan (1976) from his studies of historical records.

At Becan the lithic sequence is much more complex than at Dzibilchaltun. During the Preclassic, and from the earliest settlement, a rich array of implements (celts, retouched flakes, beaks, gravers, notches, denticulates, etc.) were made from local cherts. Some obsidian was present. Sophisticated points, however, do not appear until the Early Classic. Rovner believed that all weapons of chert (points, daggers, etc.) begin with the Early Classic. Initially most points are of obsidian of Mexican highland origin, although some points appear from Zone C fine brown chert. During the Early Classic, as at Dzibilchaltun, Becan was drawn into long distance trade in lithics before developing relationships with nearby suppliers. This suggests, as at Dzibilchaltun, the imposition of an external elite. Obsidian reaches peaks of importation during the Early Classic Period but declines during the Late Classic (Hutson et al. 2010). Interestingly, importation of obsidian resumes in the Terminal Classic.

Since the local cherts at Becan are of low quality (Andrieu 2013), it is safe to say that the fine brown cherts there were imported, and that they probably came from Belize or El Tigre. If fine brown chert exists in the vicinity of Calakmul, this fact raises the question of whether Becan traded with Belize or Calakmul for fine brown chert, and whether Calakmul traded with Belize for fine brown chert. Some of the brown chert at Calakmul such as in the bipoints and snapped points is of such high quality it seems likely that they did.

During the Middle Classic, Chicanná was established 2 km to the west of Becan. Though built according to a similar architectural concept to that of Becan and incorporating similar ceramics, Chicaná's lithic assemblage reveals a distinct lithic pedigree. In a parallel departure, the chert assemblage at Chicanná contains an anomalously high percentage of blades made on the local chert and tools made from these blades. This appears to be an attempt to apply an alien technology, Zone C chert blade production, to an inappropriate material: not-so-fine local chert.

The Late Classic Period assemblages at Becan and Chicanná reveal a pattern of isolation. Both obsidian and zone C fine brown chert declined in frequency. The local chert was used in the manufacture of points for the first time. They were made in large numbers. Bifacial celts, which had varied greatly in size and means of manufacture during the Preclassic, became standardized on a middle range of size and manufacturing technique. None of the bits are polished as before.

With the collapse of the elite capable of enforcing standardization, even on lower class tools, the gates of trade once again opened. During the Terminal and Postclassic, materials traded include old categories such as obsidian and fine brown chert but are also expanded to include new materials such as basalt. Basalt is also found at Calakmul.

Most interestingly, although apparently in the same economic and social sphere, Becan and Chicanná exploited two distinctive spheres of external influence. Because of obsidian sourcing through neutron activation, it is known most reliably that Becan gathered most of its obsidian from a Gulf coast network originating from central Mexican sources. Chicanná found its sources of obsidian from a Caribbean network originating with the Ixtepeque Volcano in Highland Guatemala. This bifurcation of sources for cities 2 km apart includes other surprising divisions of interest. Additional work by Braswell (Braswell et al. 2004) indicates that the importation of obsidian from Guatemala is a Terminal Classic phenomenon. It is unclear how this pattern links to the obsidian recovered from Chicanná, but it suggests that Chicanná may have been temporally later than Becan, perhaps a moved city. This could also explain the peculiar proximity of the two sites.

The Becan point inventory includes several narrow, shouldered points made of local or other Zone B cherts. It shares this point morphology with Xpuhil to the southeast, but not with Chicanná to the southwest. Other examples of the point are known from the Puuc Hills and Dzibilchaltun. Parallel associations of ceramics have also been noted between these two regions (Domínguez Carrasco 2008). Few points, however, appear at Becan from Zone C fine brown chert.

Chicanná, by way of contrast, received greater amounts of Zone C fine brown chert. This suggests that they were maintaining connections to the Belizian culture possibly of their Middle Classic roots (see above), as well as their east coast trading partners.

As with obsidian, a Terminal Classic date for Chicanná would explain its relationship to Belize, i.e., as Rovner points out, Becan being earlier would have been limited in its trade reach; Chicanná with a Terminal Classic date would have been opened to trade with Belize for fine brown cherts. This issue of resolving these two hypotheses deserves further consideration. If the two cities were contemporary, that Becan would associate itself with networks to the west, across the bow of Chicanná as it were, while Chicanná turned to the east, and both only 2 km apart, seems spatially inappropriate. However, the historical records support such cross-purpose alliances as a possibility. Schele and Friedel (1990) report that an alliance between Piedras Negras and Naranjo, across the bow of Tikal it would seem, initiated a period of domination by Piedras Negras of marital alliances. Similarly, Calakmul allied with Naranjo to cause trouble for Tikal (Martin and Grube 2008; Schele and Freidel 1990). These were probably peculiar conditions made possible by the hegemonic mode of building alliances. If contemporary, the disparity between orientations of Becan and Chicanná could have been as grand as the intrigue of alliances or as innocent as maintaining lineage associations between centers. The answers to these questions, no doubt, lie in the written texts rather than lithics. However, a mosaic of alliances could make any such seemingly incongruous spatial pattern understandable.

Whatever the resolution of the Becan-Chicanná question, that such an important nexus as the separation between eastern and western trading networks could lie at the Becan-Chicanná divide is intensely interesting for a study of Calakmul lithics. At the tip of the inquiry iceberg is the question of how Calakmul, an obvious cross-peninsular trade route candidate because of the Candelaria River system (Volta et al. 2019; Volta and Gunn 2012), relates to Becan and the western sphere. Another is the relationship between fine brown cherts found at both Chicanná and Calakmul.

Of particular interest to this research is the idea that artifacts can be found in combinations that suggest a more limited perspective on function than simply examining tool morphology in isolation. This later perspective is regarded as the flawed strategy in Kidder's Uaxactún study. Other efforts have been made to note associates of tools. In Rovner's studies of Dzibilchaltun he noted an association of two tool types that he interpreted to be a mason's tool kit (Rovner 1981; Rovner and Lewenstein 1997:8, 55, 58).

Also important is an understanding of lithics in the context of trade. The Calakmul lithic assemblage is largely of apparently locally available, medium-grade brown chert. However, it also contains a rich variety of jaspers, chalcedonies, and other materials that may have come from local or distant sources, and granites, serpentines, etc., that certainly came from distant sources. Also, chalcedony was available in Belize (Hester and Shafer 1984).

Most of the Calakmul assemblage comes from two buildings and therefor probably represents a very small sample of what was transported to the acropolis and the city. Unlike Andrew's (1983) study of salt, we cannot look at modern populations and estimate the annual quantity of lithics used by a city of 50,000, but it must have been substantial, and it must lie unexcavated in the vast uninvestigated precincts of the city. Studies of the post-1994 Calakmul assemblage (Andrieu 2013) sheds light on this question. A more detailed study of obsidian usage in the Chunchucmil area by Hutson et al. (2010) is also of assistance in this regard.

The question of trade in obsidian has been a topic of research since the 1970s because of its obvious external source (Rovner and Lewenstein 1997:44-45). In more recent years a great deal of research has focused on the movement of trade goods, especially obsidian, through and across the lowlands (Lohse 2010; Golitko et al. 2012; Inomata et al. 2015; Demarest 2007; Volta and Gunn 2012; Domínguez et al. 2012; Volta and Gunn 2016; McKillop 2005; Hutson et al. 2010). There are occasional hints of considerable movement of goods. Perhaps the most convincing is the salt trade argument posed by Andrews (1983). Through a series of comparisons with modern consumption, ethnohistorical sources, and historical shipping records Andrews compiles sufficient information to calculate the salt necessary to keep the city of Tikal functioning based on an estimated population of 45,000. His calculations pose a necessary import of over 14 tons a year. Although some salt could have come from the Belize coast and the saltpans of Chiapas, most of this would almost certainly have come from the north coast of the Yucatan Peninsula where salt pans are capable of yielding such quantities on a sustained basis. Salt would have had to come in a constant and reliable flow for the population of the city to continue. After contact the northern salt beds were exploited for salt used in silver mining at a much more intensive rate than the ancient Maya would ever have required. Cities such as Calakmul and its dependencies, however, would have required substantial quantities of salt, all pointing to a volumous salt trade. The importation of salt would have overlapped with fish as fish appear to be essential for interior peninsular nutrition as well (Gunn et al. 2019; Tiesler et al. 2017; Scherer et al. 2007).

Rovner's findings on the movement of lithics suggests a substantial trade in lithics over surprising distances, i.e., from Belize to Dzibilchaltun. Something of the volume can be perceived in Hutson et al.'s (2010) study of Chunchucmil. Most cities have scarce evidence of obsidian although the obsidian found at Tikal is plentiful. The movement of Zone C chert, however, seems to point to a general movement of desirable chert classes. In perishables, Pohl's (1996) work on potential trade items also seems to hint at movement of goods in quantities. Without direct evidence of transportation means, we can only suppose that the evidence will emerge from the now-hidden waterways that must exist if movement of goods was accomplished on a grand scale in ancient times. A very convincing network analysis of east coast obsidian movement by Golitko et al. (2012) shows evidence of shifting networks in the obsidian trade from east coast ports with the frequency of El Chayal declining with distance from the east coast. Also, in the Postclassic El Chayal was replaced by Ixtepeque obsidian.

## Analytical Strategy: The Fabric of a Culture in Subtypes and Rooms

Calakmul like any community was composed of many households woven together in a self-organized fabric that enabled adaptation to local conditions and external resources. In the end we examine the remains of this fabric as 71 lithic, figurine and ceramic subtypes and varieties arranged in 183 rooms that reflect the organizations of households and workshops of late Late Classic (750-800 CE) and Terminal Classic (800-900 CE). However, these households were overlain on the previous architectural patterns of the Early and early Late Classic (450-750 CE) royal household of the Kaan Dynasty. It was they who built and remodeled the structures about and within which the later inhabitants organized themselves under new pressures from social chaos and extended droughts. Before we arrive at this final view of the social fabric, we will take numerous other looks at Calakmul's social fabric from differing perspectives to provide assurance that the patterns we are supposing are statistically important and understood at their deepest levels. These studies amount to looking at the fabric through narrow windows such as the weaving together of households and foreign trade networks by examining the room distributions of exotic materials such as jade and obsidian.

The analytical strategy for the lithics collection was to divide the artifacts into reasonably homogenous morphologies: scrapers, adzes, flakes, etc. The resulting tool types were further subdivided into subtypes based on weight modes. Then, the subtypes were used to study combinations of tools in rooms to identify tool kits and to determine the diversity of tools in the rooms. Rooms are the unit of study in this investigation. About 183 "rooms" as will be elaborated later, form the basis of associated technologies that in turn provide information on tool kits and the statuses of their users. The artifact contents and dimensions of rooms themselves become part of the study of quality of life understandings of the inhabitants. To implement this strategy a database was built containing observations on 10,074 lithics as described in Appendix 1. (Databases are supplied with this report as spreadsheets: datasets generated from the databases are in the text or appendices.) Observations included provenience and various aspects of material and technology of fabrication. Datasets were extracted using SPSS crosstabulation to aggregate artifacts into rooms by subtypes and/or attributes. Factor analysis was utilized in several capacities to microscopically find and understand tool kits, determine tool diversity, and identify the of external networks of room's inhabitants. In selected analyses the underpinnings were enhanced by calculating statistical significance probabilities on select tables.

Ideally a functionally identifiable form would appear in each tool kit that would mark the accompanying tools as part of their functions. Some of the tool types identified at Calakmul are of ambiguous function, and probably many were of multifunctional character, especially axes, celts, and large bifaces. However, there are some tools that are clearly identifiable as for certain functions and can be used to signal the function, or part of the function, of their accompanying tools in a tool kit. An especially good example in this regard are barkbeaters. As noted above, one can imagine a few auxiliary uses for barkbeaters, such as paper weights, which would not leave a use wear impression, or hammer stones, which would leave visible wear. However, the morphology of barkbeaters dictates that by-and-large they are of little value apart from the intended purpose of making bark paper or cloth, both now and in the past. A more ambiguous tool type is obsidian blades sometimes found with barkbeaters. It is not hard to imagine that if found in the same room, the blade might have been used in conjunction with the barkbeater to trim bark paper and cloth. Tool kit identification was accomplished as much as possible on this basis of inclusion of clearly identifiable functioning tools in mathematically determined tool kits.

Calakmul offers a great range of lithic tools. The typology used for this study utilized over thirty subtypes, many of them with large numbers of specimens (see Appendix 1 and Database 1-1). By way of comparison, a typical prehistoric site might contain from one type, flakes, to at the most a half dozen readily identifiable tools (flakes, points, scrapers, drills, hammer stones). The types of Calakmul reflect the fabric of an extremely complex civilization left for our regard.

# PART I: ARTIFACT DESCRIPTIONS AND DISCUSSIONS

## Lithics by Structures and Rooms

Pyramid Structure II, one of the largest human-made structures in the western hemisphere, is complex in its layout. On the summit of the pyramid are Pyramid A and Structures B through H (**Figure 2**). On the zones or steps of the pyramid are 67 rooms that were mostly added in the Terminal Classic. Though with one exception, a lithic workshop, artifacts generally did not occur in great numbers but in considerable variety. As such it is an excellent laboratory for studying the distributions of artifacts as discussed in the analytical strategy above. In this map zones, the steps of the pyramid, are numbered from the top down, levels (nivel) 1-9: zone 1 = rooms . The Principal Staircase (Escalera Principal or EP) is evident down the center of the map.

## Lithics from Calakmul Excavations of 1984-1994

Over 15,000 stone artifacts were catalogued from the Calakmul excavations in the decade between 1984 and 1994 (***Table 1***). Over 4,500 of them were from one room (Room 60-61) at the base of the principle staircase on pyramid Structure II. The remainder were found more or less evenly distributed between Structure II and Structure III with a few additional artifacts from the minor excavations in Structure I and Structure VII. Effectively, the number of rooms that can be identified with lithics are 93: Str I 5, Str II 70, Str III 12, and Str VII 6 (***Table 2***). The number of rooms appearing in any given analysis vary with the design of the study.

**Table 1. Distribution of Artifacts in Structures and Stratigraphic Contexts.**

| Operation | | Unproven-ienced (0) | Rubble (1) | Floor (2) | Stratified Pit (5) | Total |
|---|---|---|---|---|---|---|
| **No Room Prov.** | 0 | 8 | | | | 8 |
| **Structure I** | 1 | 172 | | 1 | | 173 |
| **Structure II** | 2 | 190 | 3096 | 1223 | 92 | 4601 |
| **Structure III** | 3 | 95 | 1300 | 1648 | | 3043 |
| **Structure VII** | 7 | 251 | 10 | 24 | | 285 |
| **Total** | | 716 | 4406 | 2896 | 92 | 8110 |

The types of artifacts vary widely both within standard categories and in the broad number of categories. (see Database 1 Lithics.xlsx). They include artifacts that archaeologist would recognize as the standard faire of non-metallurgical cultures: points, scrapers, adzes, axes (ground and unground) and many more. Also present are manos (grinding maize and clay in metates), spindle whorls (preparing cotton and other fibers), and barkbeaters (manufacturing bark paper and bark cloth). A few exotic items were discovered such as small metates with three or four legs ground from diorite and other imported materials.

During the excavations the artifacts were bagged according to stratigraphic locations within rooms (see below for discussion of data collection design). Five types of vertical provenience or context were recognized (see ***Table 2***), no room provenience, i.e., between buildings not in a room. (0), in the rubble (1), within 10 cm of the floor, i.e., on the floor (2), and in stratified pits (5). An effort was made to discriminate the artifacts immediately on floor from those in the rubble above. Some provenience was lost because of a flood resulting from hurricane Gilberto in September 1988 during which central Campeche City suffered extensive inundation including the CIHS headquarters. This applies to 8. 8 percent (n=716) of the rooms 60-61 (workshop) assemblage.

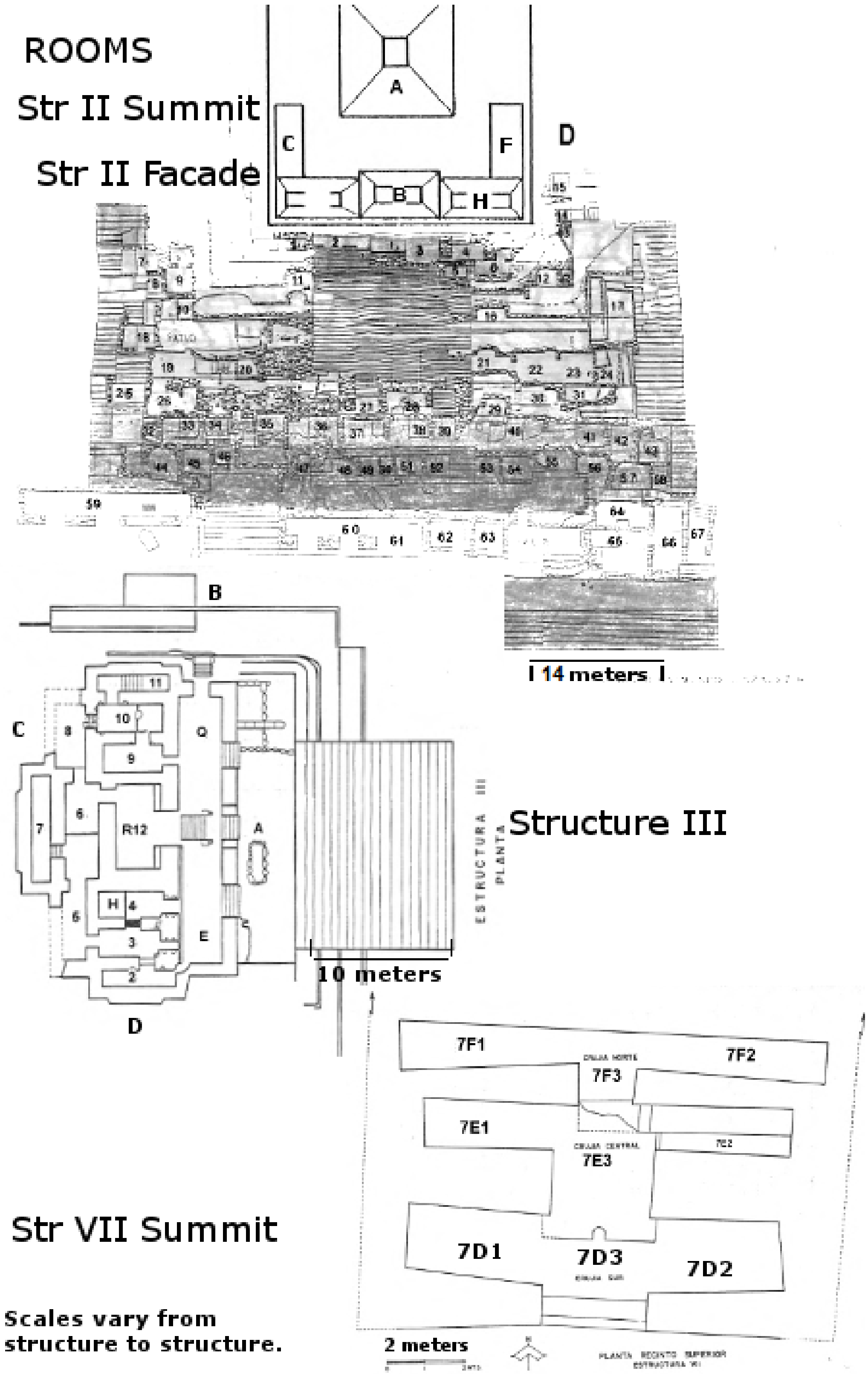


**Figure 2. Room Arrangements of Structures II (2), III (3), VII (7). Note: the structures are at different scales as indicated.**

As mentioned above, an effort was made to separate the on- and above-floor components on the assemblage. During the analysis of the material after the excavation, giving due consideration to field observations during the field work, especially on the façade of pyramid Structure II, this scheme was modified. During the excavation of the Structure II façade it was observed by field supervisors that there was no particular buildup of rubble at the bottom of the structure. *Rather the rubble seems to have remained in large part where it fell on the broad zones of the pyramid.

Note: "*" In the text indicates a searchable conclusion. "**" indicates the observation was used in the final conclusions

The rubble exhibited three distinctive layers (***Table 2***). The first layer near the floor was fine grained and contained apparently *in situ* artifact distributions. It may have originated as the mortar for the walls of rooms. Clear evidence of workshop arrangements of tools was found, apparently as they were left during the exit of the premises. From a lithic standpoint, room 60-61 at the bottom on the principle staircase contained about 4,500 secondary and tertiary flakes, rather neatly piled together. Around this were the typical accouterments of lithic reduction including hammer stones of various descriptions, and bone and antler pressure flakers.

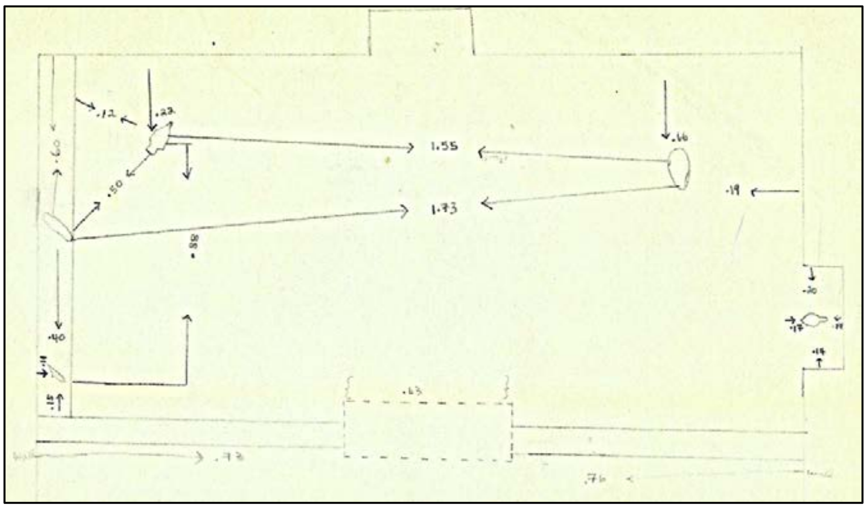


**Figure 3. Sketch Map of Floor Level Artifacts from Structure II-G. Including a niche on the right. Notice that the tip of the point is directed outward from the niche. (Florey Folan 1994)**

Above the floor was a second layer of medium course rubble that appeared to have fallen from the immediate construction material of the rooms. This also contained some artifacts including points, barkbeaters, and spindle whorls. Above the second layer (*escombro*) was another level of much coarser material (*relleno*). This material appeared to have piled on the early, immediate-collapse rubble, in effect protecting the escombro from further disruption by later collapses and disturbance by vegetation. This latter pattern suggested to us that the artifacts found in the escombro probably also bore relationship to activities in the rooms. They would have hung on the walls and rafters of rooms and perhaps fallen through the roof as the roofing decayed. Excavation supervisors reported instances of artifacts being found in niches (nicho, **Figure 3**) in the wall. These niches would also have contributed to the collection of room-related functional artifacts. Thus most of the material in both the floor and the escombro probably relates to the activities in the room or in the immediate area of the room, also fair game for our analysis of the association of artifacts in patterns using rooms as loci of one activity or another.

This perspective changed our view of a room from a two dimensional pattern of horizontal artifacts to a three dimensional, collapsed cube. A room in this perspective is a locus of activity targeted at some primary, but no doubt not exclusive, specialization. Before collapse, artifacts might be found on the floor, in wall niches, hanging from the ceiling in jars or nets, and on the roof that could also have served as a workspace, or on the nearby staircase. Most of the spindle whorls were found on the staircases. Given the immanently three-dimensional character of a pyramid more than 50 m high, this fuzzy-set approach to artifact associations has much more utility than the limited scope of a two dimensional workspace, typically the fodder of archaeological analysis.

**Table 2 Frequencies of Lithics by Operations (structures) and Suboperations (rooms/substructures). See Table 3 for lithic room frequencies on Structure II (2) north façade zones.**

| | | | | | Context | | Total |
|---|---|---|---|---|---|---|---|
| | | | ? S/N | Rubble Escombro | On Floor Sobre Piso | In Pit Pit | |
| Operation | | (Structure) | 0 | 1 | 2 | 5 | |
| **0** | **Suboperation** | (Room*.) | 1 | | | | 1 |
| | | SP | 4 | | | | 4 |
| | | T | 3 | | | | 3 |
| | **Total** | | 8 | | | | 8 |
| **1** | **Suboperation** | A | 88 | | 1 | | 89 |
| | | B | 4 | | | | 4 |
| | | C | 31 | | | | 31 |
| | | D | 6 | | | | 6 |
| | | E | 1 | | | | 1 |
| | | SP | 42 | | | | 42 |
| | **Total** | | 172 | | 1 | | 173 |
| **2** | **Suboperation** | | 62 | 1314 | 646 | | 2022 |
| | | A | 26 | 468 | 474 | 92 | 1060 |
| | | AB | 11 | | | | 11 |
| | | B | 48 | 326 | 8 | | 382 |
| | | BH | | 21 | | | 21 |
| | | D | 12 | 76 | 1 | | 89 |
| | | EP | 13 | 697 | 94 | | 804 |
| | | F | 4 | 106 | | | 110 |
| | | H | 3 | 88 | | | 91 |
| | | PE | 2 | | | | 2 |
| | | SP | 9 | | | | 9 |
| | **Total** | | 190 | 3096 | 1223 | 92 | 4601 |
| **3** | **Suboperation** | | 2 | 434 | | | 436 |
| | | A | 19 | 25 | 889 | | 933 |
| | | B | 14 | 83 | 141 | | 238 |
| | | C | | 27 | | | 27 |
| | | D | 3 | 26 | 101 | | 130 |
| | | E | 4 | 413 | | | 417 |
| | | G | | 52 | | | 52 |
| | | H | 8 | 1 | 117 | | 126 |
| | | I | 17 | 11 | 2 | | 30 |
| | | J | 3 | 28 | | | 31 |
| | | K | | 11 | | | 11 |
| | | L | 14 | 19 | | | 33 |
| | | M | | | 50 | | 50 |
| | | N | 7 | 5 | | | 12 |
| | | O | | 34 | | | 34 |
| | | P | | 88 | | | 88 |
| | | Q | 4 | | 241 | | 245 |
| | | R | | 43 | 107 | | 150 |
| | **Total** | | 95 | 1300 | 1648 | | 3043 |
| **7** | **Suboperation** | | 2 | | | | 2 |
| | | A | | 1 | | | 1 |
| | | B | | 1 | 1 | | 2 |
| | | D | 2 | 1 | | | 3 |
| | | E | 2 | 2 | 4 | | 8 |
| | | F | 239 | 5 | 18 | | 262 |
| | | H | 2 | | 1 | | 3 |
| | | SP | 4 | | | | 4 |
| | **Total** | | 251 | 10 | 24 | | 285 |

*SP = without provenience (*sin procedencia*)

## Table 3 Frequencies of Lithics by SUBLOTE (Room) * LOTE (Zone).

| | Zone (lot) | | | | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n/a | N1 | N2 | N3 | N4 | N5 | N6 | N7 | N8 | N9 | NA | NICHO | PE | SP | TR.2 | TR.GL | |
| Room (sublot) | 2545 | | 39 | 37 | | | 80 | 67 | 173 | 17 | 3 | 17 | 93 | | 9 | 2 | 3082 |
| A | 1 | | | | | | | | | | | | | | | | 1 |
| A3 | 1 | | | | | | | | | | | | | | | | 1 |
| ALTAR | | | | | | | | | | 6 | | | | | | | 6 |
| B | 1 | | | | | | | | | | | | | | | | 1 |
| C01 | | 5 | | | | | | | | | | | | | | | 5 |
| C02 | | 4 | | | | | | | | | | | | | | | 4 |
| C04 | | 2 | | | | | | | | | | | | | | | 2 |
| C08 | | | 53 | | | | | | | | | | | | | | 53 |
| C09 | | | 27 | | | | | | | | | | | | | | 27 |
| C11 | | | 2 | | | | | | | | | | | | | | 2 |
| C12 | | | 77 | | | | | | | | | | | | | | 77 |
| C13 | | | 2 | | | | | | | | | | | | | | 2 |
| C14 | | | 1 | | | | | | | | | | | | | | 1 |
| C15 | | | 4 | | | | | | | | | | | | | | 4 |
| C16 | | | 2 | | | | | | | | | | | | | | 2 |
| C17 | | | | 1 | | | | | | | | | | | | | 1 |
| C18 | | | | 11 | | | | | | | | | | | | | 11 |
| C19 | | | | | 1 | | | | | | | | | | | | 1 |
| C21 | | | | | 9 | | | | | | | | | | | | 9 |
| C23 | | | | | 7 | | | | | | | | | | | | 7 |
| C25 | | | | | | 16 | | | | | | | | | | | 16 |
| C26 | | | | | | 5 | | | | | | | | | | | 5 |
| C27 | | | | | | 4 | | | | | | | | | | | 4 |
| C28 | | | | | | 13 | | | | | | | | | | | 13 |
| C30 | | | | | | 15 | | | | | | | | | | | 15 |
| C31 | | | | | | 47 | | | | | | | | | | | 47 |
| C34 | | | | | | | 32 | | | | | | | | | | 32 |
| C37 | | | | | | | 23 | | | | | | | | | | 23 |
| C38 | | | | | | | 8 | | | | | | | | | | 8 |
| C39 | | | | | | | 16 | | | | | | | | | | 16 |
| C40 | | | | | | | 9 | | | | | | | | | | 9 |
| C43 | | | | | | | 8 | | | | | | | | | | 8 |
| C44 | | | | | | | | 51 | | | | | | | | | 51 |
| C45 | | | | | | | | 5 | | | | | | | | | 5 |
| C50 | | | | | | | | 9 | | | | | | | | | 9 |
| C51 | | | | | | | | 15 | | | | | | | | | 15 |
| C52 | | | | | | | | 7 | | | | | | | | | 7 |
| C53 | | | | | | | | 15 | | | | | | | | | 15 |
| C56 | | | | | | | | 3 | | | | | | | | | 3 |
| C57 | | | | | | | | 36 | | | | | | | | | 36 |
| C58 | | | | | | | | 52 | | | | | | | | | 52 |
| C59 | | | | | | | | | 53 | | | | | | | | 53 |
| C60 | | | | | | | | | 120 | | | | | | | | 120 |
| C61 | | | | | | | | | 48 | | | | | | | | 48 |
| C63 | | | | | | | | | 1 | | | | | | | | 1 |
| C64 | | | | | | | | | 22 | | | | | | | | 22 |
| C66 | | | | | | | | | 1 | | | | | | | | 1 |
| C67 | | | | | | | | | 28 | | | | | | | | 28 |
| CL | 1 | | | | | | | | | | | | | | | | 1 |
| EP | 434 | | 2 | | 35 | 21 | 8 | 20 | | 77 | | | | 42 | | | 639 |
| Est11 | | | | | | | | | | 1 | | | | | | | 1 |
| LW | | | | | 2 | | | | | | | | | | | | 2 |
| Total | 2983 | 11 | 209 | 49 | 54 | 121 | 184 | 280 | 446 | 101 | 3 | 17 | 93 | 42 | 9 | 2 | 4604 |

In the artifact analyses below, some of the artifact types are described and analyzed to demonstrate their internal variability. The variants are then used as part of an inter-typical analysis of distributions in the holographic environment of one of the largest Precolumbian buildings in the western hemisphere.

The spatial distribution of 1516 artifacts on pyramid Structure II is recorded (***Table 3***) as to their room (Suboperation) and quadrant (Sublot). The zones (N=nivel) will be used to analyze the elevation of artifacts on the pyramid. Since many of the artifacts on the summit of pyramid Structure II are clearly of the upper class, this raises questions as to the class structure on the zones of Structure II. The rooms of palace Structure III are treated as zone 0 putting them on a par with the palace structures temple A and Structures II-B, II-D, II-F, II-H on the pyramid Structure II summit.

The "EP" designation near the bottom of ***Table 3*** is the principal staircase (*escalera principal*). Many of the artifacts (n=2,059, 31 percent) for which zone provenience was obtained were on the principal staircase (n=639).

## Timing of the Calakmul Lithic Assemblage

Much about the Calakmul rooms suggests that they were left as they had been at a rather abrupt moment in time. For example, points are found in niches in the walls. There are not several hundred years of debitage in the rooms; flakes were found sparsely scattered through the rooms with the exception of room 60-61 at the base of the main staircase on Structure II, which contained about 4,500 flakes. It was obviously a lithic manufacturing room, but 4,500 flakes could be a day's work at the rate flakes are produced during flint knapping. Braswell (2013; 2004) reports that the platform grinding technique used on the obsidian at Calakmul post-dates A.D. 800. There are some artifacts that were recovered from under floors, probably dating from an earlier era before the floor fill was obtained, and some in the debris over the floors. However, most of the artifacts in this analysis were from floors. Overall, the positions and density of the artifacts suggests the accumulation of a few days or weeks before the city was abandoned. More discussion of timing follows in Part III when we analyze associated ceramics.

## Tool Kits and Tool Proxies

Searching for patterns of lithic use in a highly complex environment such as that of the palaces and pyramids of Calakmul is a task that begs assistance from every possible source of inspiration. A comparison of the distribution of lithics within Calakmul itself adds some light to the question of the social value of lithics. Jade, for example is found almost exclusively in tombs of noble personages. Obsidian, on the other hand is found in both tombs or rooms. Other materials and tools forms appear outside the tombs suggesting lesser status than jade. However, some jade flakes were found in the pyramid Structure VII summit temple (Gallegos Gomora et al. 2005).

Some observations have been made during previous archaeological excavations on the locations of lithics. At Dzibilchaltún, Folan (1969) considered the distribution of metates, spindle whorls and celts. Metates were found in a room, and an entryway into the reception area that was inferred to indicate domestic activities. This was supported by auxiliary information such as adjacent middens and infant burials in certain rooms. A small metate was presumably used for grinding spices.

An interesting suggestion from Dzibilchaltún is obtained from the juxtaposition of a spindle whorl and a celt. Burial crypts were generally found in rooms with debris (Folan 1969:458). In crypt M1263 a spindle whorl was found in the center of the burial (Ibid:447). This contrasts with a celt found lying outside crypt M1271 (Ibid:448). This suggests a contrasting feeling for the two implements. The celt outside the crypt signals an object of lesser social value; this is not surprising as celts were common, probably functioning as general-purpose tools much as machetes do now. The spindle inside a crypt indicates that, in at least one case, the spindle whorl and presumably its associated task, was in some sense elevated in social value, enough so that the woman buried within wanted it to signal her status. That women are found juxtaposed with males on stelae at Calakmul (Marcus 1987) lends credence to elevated female roles and the tools of female activities in the northern Yucatan Peninsula.

These simple polar contrasts in the social positioning of tools can be part of a multidimensional perspective inferred from what was simply lying about in various archaeological contexts. However, among the complex tasks of daily life, relationships between tools and the society that uses them are seldom so simple as the polar opposites of high and low social status. Some may reflect the quality of life aspect of a household as suggested by Smith (2019). Because of the differing functions of the patterns of rooms between the Classic and the Terminal Classic, we also need to keep in the change of function between the two periods, especially in the case of pyramid Structure II, which appears to have changed from a place of ritual to a place of fortification, exchange, and/or occupation.

In some abstract social sense, political elites own the palaces and religious elites own the pyramids. At the level of daily activities, however, the social elites mix with non-elites in the form of services rendered to elite persons by non-elite servants, economic partners, and acquaintances (e.g., Chase and Chase 2011). Thus while the elites own the palaces and pyramids, the distribution of things within their confines are more likely to result from the activities of their associated social strata. It comprises the intersection of the two social sets. Both, for example interact at some level with the persons who supply various raw materials, such as chert and basalt, for various tools. In a sense, all of those that benefit from tools interact with tool types as they are conceptualized and used in their designated tasks, worn and refreshed, re-conceptualized, and in the end discarded.

It is our hope to step over the threshold of this multidimensional interactive world by examining, in a sense, the whole of the Calakmul lithic domain as a single system of functions. We emphasize the threshold because there are obviously much more that can be done with the lithic domain, and the holistic perspective will only come when all of the classes of artifacts are examined together later in this document. Lithics, however, are in themselves a complex footing for much of the daily activities of the city. Analyzing lithics at Calakmul is like analyzing the flow of metal in a modern city. Certainly everything cannot be understood thereby, but an important portion of it can. Each artifact class stands as a proxy to some degree for other artifact classes: where there are flakes, there are antler hammers. Where there are antlers, there must be hunters, points of a certain type(s).

An interesting question is what is the difference between the Classic and Terminal Classic distributions in this perspective? Is the Classic arrangement managed by a kingly presence and the Terminal Classic managed cooperatively by an egalitarian society as is implied by the comparison to the northern polities in the latter period? But does the decapitation of the Terminal Classic society change anything for the makers and users of lithic implements? Maybe not if the range of functions is still the same or similar. Obviously, if the zones were used as residences in the Terminal Classic, and in the Classic period residences were more commodious and outside the sacred precinct, then room size suggest a reduction in the quality of life.

## Step 1: General Characterization of the Assemblage

### Artifacts by Locations

Tools in the tables and figures that follow are located by a system of structures, operations, sometimes rooms, within structures, and lot/artifact numbers within operations. The structure excavation designations are in Roman numerals, I, II, III, and VII. Because Roman numerals are not uniformly manageable in analytical programs, the structures will sometimes be referred to by their Arabic equivalents: 1, 2, 3, and 7. Suboperations/rooms are marked by capital letters: A, B, …. In the cases in which artifacts are from the rooms on the zones of pyramid Structure II, the entire zone is assigned an N number, N1, N2, …N9, as well as C and a room number (see ***Table 3*** and ***Figure 2***). Artifacts are designated by a combination of their structure, operation, suboperation, lot and artifact numbers. Artifact IA7B10B (or 1A7B10B), a stemmed point, from Structure I, Room A, Lot 7, artifact B10B.

### Artifacts by Weights: Everything Has It.

In an effort to obtain a holistic perspective on the Calakmul lithic assemblage, a measurement was sought that would place all artifacts in a similar perspective. Weight was chosen for this purpose because it generally has some relevance to the morphology and function of artifacts. (see Database 1 Lithics.xlsx) It is also a reliably replicated measure. Because of the variability of artifact types, no one measurement such as weight encompasses the details of the various types. For these dimensions of the artifacts, we turned to additional metric observations appropriate to specific shapes. It matters to a lesser degree if the weight of an artifact is distributed in a long, thin, stone, a point, or a somewhat spherical stone, a hammer. Weight, however, provides a constant quantitative backdrop for all artifacts. Consider for example the largest and smallest hand tools in the lithics data base. The smallest is an obsidian blade (0.1 g) and the largest is a diorite mano fragment (7,000.0 g). The sheer size of the two implements constrains the services to which they can be applied. It is unlikely that a 7,000.0 g diorite fragment would be used for trimming the edge of a codex. It would be impossible to grind corn with a 0.1 g obsidian blade 0.69 mm thick. A theory of weight-to-function relationships would be useful although we are not aware of previous work on the concept. A series of thresholds such as appear in ***Table 4*** might be useful for framing lithic studies.

**Table 4 Approximate Weight Utility Thresholds for Stone Implements.**

| Weight (g) | Utility |
|---|---|
| .1-10.0 | cutting, adornment |
| 10.0-100.0 | cutting, piercing, scraping |
| 100.0-1,000.0 | chopping, hammering, grinding |
| 1,000-10,000.0 | grinding, building |

The sequential examination of weight and then other dimensions that measure shape follows a two-stage path. In the first size dimension modalities of weight reveal the properties of tools that pivot on size. In the second stage, implements that are of similar weight but different shapes are investigated. In this assemblage there are numerous shapes among the points that are largely indistinguishable by weight alone.

***Figure 4*** shows that weights in the collection range from obsidian blades as small as 0.1 grams to an 8,800 g metate fragment. Only special metates were collected. Great numbers of large metates were recorded in the field but are not in the data set. This single fragment served as a reminder, a place holder for metates. Some metates on the summit of pyramid Structure II were turned upside down, apparently to preserve them for anticipated future use.

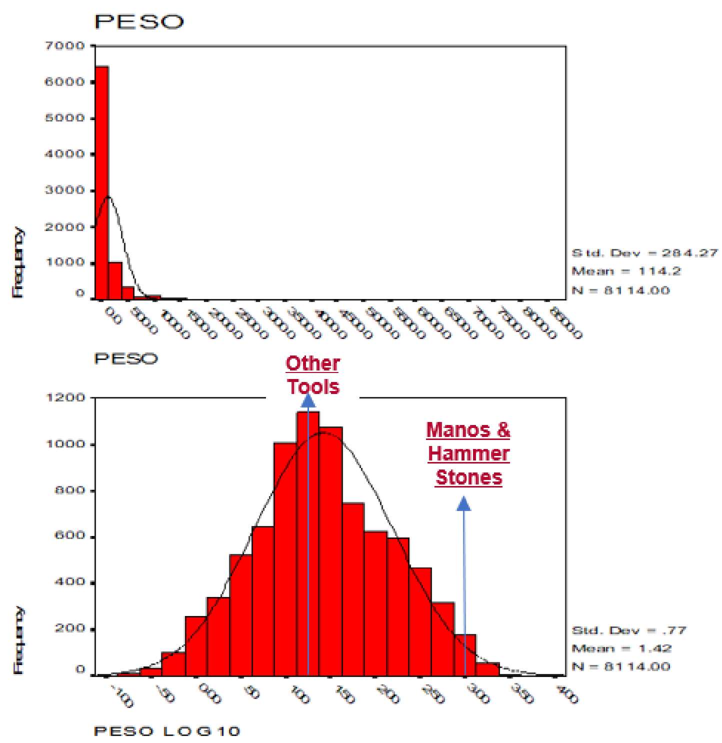


**Figure 4. Weight (Peso, upper panel) and Log10 Weight (lower panel). Bar charts of the Calakmul lithics assemblage (without the Room 60-61 debris pile).**

The tendency in the weight population is for small things to be more numerous than large things by several orders of magnitude. Examining the bar charts of specimen weights (***Figure 4***, top panel), especially the log transformed weights (see ***Figure 4***, bottom panel), indicates that the greater part of the assemblage weights less than about 300 g ($\log_{10}$ 2.48).

The $log_{10}$ transformation shows that the distribution is skewed slightly to the left (0.075). Anomalies relative to the normal curve indicate a slightly bimodal distribution with a large mode around peso $log_{10}$ 1.25 (17.8 g) and the other from peso $log_{10}$ 2.25 to 3.00 (177.8 g to 1000 g). The real magnitude of the second mode is evident in ***Figure 5***. It consists of 168 artifacts, most of them manos and hammerstones. The remainder of the artifacts occur as single specimens per category up to 2200 g.

In terms of the Weight Utility Model, about 2% of the tool assemblage (+field observed metates) falls in the range of chopping, hammering and grinding and the other 98% in the cutting, piercing and scraping range.

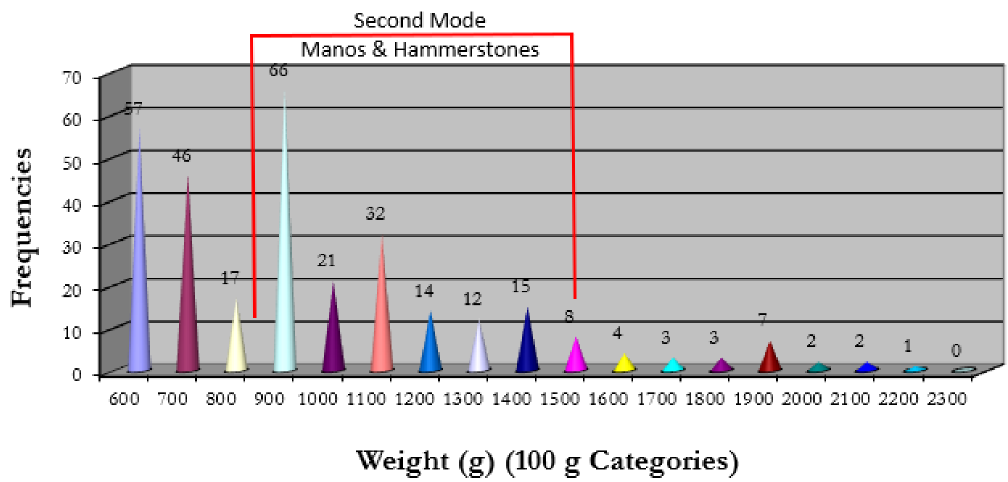


**Figure 5. Frequencies of Tools by 100 g categories between 600 g and 2300 g. A second mode is generated between 900 g and 1500 g with N = 66+21+32+14+12+15+8=168 artifacts.**

## Tools by Materials: External Networks (TRADES)

The materials from which lithics were made were predominately tan to brown cherts (83.8% Pedernal, high clay content, low transparency; ***Table 5***, database 1). -The assemblage is completely dominated by chert. It appears in every room in all four structures. This is not surprising as it is easily obtainable from El Laberinto Bajo. Obsidian, basalt, chalcedony, and jasper comprise nearly equal (1.8-2.5 percent) minority proportions of the collection. Flint (silex, low clay content, high transparency) is rare at only 0.2 percent of the assemblage. Quartzite is over twice as frequent (N=313) as the other minority material types.

**Table 5. Frequencies of Lithics by Material Types Excluding Room II-60.**

| Material | Frequency | Percent |
|---|---|---|
| Obsidiana | 450 | 7.6 |
| Basalto | 147 | 2.5 |
| Chert (Pedernal) | 4953 | 83.8 |
| Flint (Sílex) | 13 | 0.2 |
| Calcedonia | 107 | 1.8 |
| Coral | 1 | 0.0 |
| Limestone (Caliza) | 147 | 2.5 |
| Quartzite (Cuarcita) | 313 | 5.3 |
| Jasper | 86 | 1.5 |
| Total | 5912 | 100.0 |
| Externally acquired materials | 1263 | |
| External network relations | 21.4 | % |

The most important aspect of the material types relative to quality of life measures is that materials imported from foreign lands indicate potentially elevated capabilities for prosperity by accessing external networks (Smith 2019). 21.4% of the lithics are in rooms that may represent households with external network relations. As we shall see in the section on inter-structural lithic distributions for Structure II and Structure III, all of the material types except basalt and quartzite are associated with pyramid Structure II (see factors 1 and 2). About equal proportions of obsidian pieces appear in both structures but in palace Structure III they are systematically associated with room tool kits. In the section on inter-structural flows, we find using crosstabulations that this relationship between Structure III and obsidian holds up with a high chi-square significance

When we look at obsidian in more detail (see ***Table 19***), only pyramid Structure VII (7) exhibits a greater number of obsidian artifacts than expected ($p<0.001$) as compared to all other artifacts in the structures. Pyramid Structure I has fewer. Both Structure II and Structure III have approximately what would be expected. *This points to the inhabitants of Structure VII as benefiting the most from external trade networks as regards obsidian. There were also a few jade flakes in the pyramid Structure VII summit palace bringing into focus a striking set of external networks and indication of household wealth. This raises the question as to whether it was a well to do household or a workshop for such a household? If a workshop owned by a well to do household, then both would imply the same high quality of life status.

**Table 6. Room Areas in Structures. (see Figure 2 for maps)**

| Room | Area | Room | Area | Room | Area | Room | Area |
|---|---|---|---|---|---|---|---|
| r11C | 1.0 | r2C30 | 3.2 | r2C67 | 3.2 | r3P | 4.9 |
| r13C | 1.0 | r2C31 | 3.6 | r2C8 | 1.2 | r3Q | 4.2 |
| r1A | 9.0 | r2C34 | 1.8 | r2D | 5.4 | r3R | 4.2 |
| r1C | 9.0 | r2C37 | 3.2 | r2F | 4.2 | r7F | 4.9 |
| r1E | 9.0 | r2C38 | 1.6 | r2H | 4.8 | | |
| r2A | 6.6 | r2C39 | 1.4 | r3A | 15.4 | | |
| r2A | 6.3 | r2C40 | 1.4 | r3B | 12.2 | | |
| r2A | 6.3 | r2C43 | 2.2 | r3C | 9.4 | | |
| r2B | 4.5 | r2C43 | 2.2 | r3D | 9.8 | | |
| r2H | 9.3 | r2C44 | 2.4 | r3E | 8.4 | | |
| r2C11 | 2.0 | r2C50 | 0.8 | r3G | 4.9 | | |
| r2C12 | 1.6 | r2C53 | 1.8 | r3H | 4.9 | | |
| r2C13 | 1.0 | r2C54 | 2.6 | r3I | 4.9 | | |
| r2C18 | 2.6 | r2C57 | 3.0 | r3J | 3.1 | | |
| r2C21 | 3.2 | r2C58 | 1.2 | r3K | 7.7 | | |
| r2C23 | 2.8 | r2C59 | 14.0 | r3L | 4.9 | | |
| r2C25 | 2.6 | r2C60 | 7.8 | r3M | 4.9 | | |
| r2C26 | 4.2 | r2C61 | 3.2 | r3N | 4.9 | | |
| r2C28 | 3.2 | r2C64 | 4.4 | r3O | 4.9 | | |

Relative to conclusions concerning quality of life, the location of high quality, externally acquired lithic materials raises something of a conundrum for Smith's (2019) equivalencing of wealth with room size. The room sizes on pyramid Structure VII (7) with their wealth of variety are relatively small (4.9 $m^2$) compared to those in palace Structure IIH (9.3 $m^2$), pyramid Structure IIA (6.3 $m^2$), pyramid Structure IA (9.0 $m^2$), or palace Structure IIIC (9.4 $m^2$). A resolution of this contradiction might be that, in the case where high quality, exotic materials are in smaller rooms, that would indicate that the rooms are part of a community rather than a household. A community, in terms of rooms, would be an aggregate of rooms serving the ends of the community by providing space for specialists to serve the community.

See also the detailed analysis of obsidian sources below for information on external networks (***Table 21***). ***Table 7*** shows relationships between the area of rooms, representing incomes, and the material types representing external networks (see Appendix 2). The data set is presence or absence of the material types by rooms drawn from Database 1-1 with an estimate of room area added.

Factor 3. In a certain set of rooms, the largest room size relationship (=0.65) suggests that in larger rooms, higher income, basalt (=0.28) is more frequent. Flint (Silex = -0.65) and chalcedony (= -0.34) becomes frequent in smaller rooms (less income).

Factor 2. In another set of rooms, the larger the room (Area = 0.50), the greater the chance of jasper (= 0.30) and chalcedony (= 0.32). Conversely, the chance of limestone (Caliza = -0.72), quartzite (Cuarcit = -0.45) and basalt (= -0.29) is more prevalent in smaller rooms.

Factor 4. In a third set of rooms (= 0.38), obsidian (= 0.42) becomes more frequent in larger rooms, and jasper (= -0.49) and basalt (= -0.48) is more frequent in smaller rooms.

**Table 7. Networks links and Exotic Lithic Materials**

| Source Distance Rank | | Component 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| | AREA | 0.17 | 0.50 | Most Important 0.65 | Least 0.38 | 0.13 | 0.21 | 0.19 |
| 1 | CALIZA | 0.31 | -0.72 | -0.02 | 0.32 | 0.43 | 0.08 | -0.22 |
| 2 | CALCED | 0.60 | 0.32 | -0.34 | 0.04 | 0.45 | -0.36 | 0.28 |
| 2 | CUARCIT | 0.64 | -0.45 | 0.22 | 0.16 | -0.18 | 0.18 | 0.27 |
| 2 | JASPER | 0.59 | 0.30 | 0.20 | -0.49 | 0.24 | 0.26 | -0.35 |
| 3 | BASALTO | 0.59 | -0.29 | 0.28 | -0.48 | -0.22 | -0.24 | 0.17 |
| 3 | SILEX | 0.50 | 0.17 | -0.65 | 0.03 | -0.20 | 0.44 | 0.11 |
| 4 | OBSIDIA | 0.64 | 0.23 | 0.00 | 0.42 | -0.36 | -0.30 | -0.38 |
| | % of Variance | 28 | 17 | 14 | 11 | 9 | 8 | 7 |

**Table *8*** shows the factor scores for the factors that account for room area and their related material types. For example, Factor 3, loading 0.65, has Basalt as its key material. Basalt is present in all rooms except one, r3B. Scores shown are at or above 1 standard deviation either negative or positive. The P or As (Presence or Absence) are a check to see if the materials are present in the indicated rooms. Where the P or As are regularly absent (green), that represents the value below which the scores are not effectively picking up the materials in the expected combination. As would be expected, the number of missed combinations increases with the lesser loadings in Factor 4. Rare misattributions mean the combination of exotic lithics in the room is close to the expected overall combination for the factor even if one of the key elements is missing.

Plotting the distributions of factors scores 3 (left) and 2 (right) in ***Figure 6*** shows the locations for rooms with scores greater than +/- 1 standard deviation. Factor 3 marks the most likely locations for the combination of flint and chalcedony as on/in Structure II and Structure III (red squares). Basalt (blue squares), on the other hand, appears among the workshops of pyramid Structure II lower zones and the back rooms of palace Structure III. *This suggests that rather than being a status indicator, basalt objects were dedicated to some sort of function(s) that required imported and carefully designed and executed tools. The basalt manos, for example, were probably used to grind dried maize.

In Factor 2 scores on the right, chalcedony and jasper (red) in this set appear in a range of situations though not in the elevated palace and pyramid on the Structure II summit. Limestone and quartzite are confined to the right side of pyramid Structure II zones.

Factor 4 scores (***Figure 7***) show that obsidian is not especially related to any structure or cluster of rooms. Obsidian appears on almost all of the factors except the ones that are related to room size. *This suggests that in spite of the sparsity of obsidian, there was widespread interest in its use. Perhaps the community as a whole participated in the purchase and use of obsidian. On the other hand, the combination of jasper and basalt (blue) is mostly on the lower zones of pyramid Structure II. The basalt distributions in factors 3 and 4 are similar implying that is it active in more than one tool kit by the quality of life assumptions of this analysis. *It continues to imply that the crafts persons on the lower zones were linked to distant networks. Perhaps through their own agency or intermediaries of other classes in the community.

## Linearization of Material and Technology Distinctions

The preceding variable-by-variable examination of the Calakmul lithics data lays the groundwork for a multivariable study of the lithic gathering and utilization system. Since the crosstabulations do not require any linear statistics on variables, the ordering of their values was not a matter of concern. However, factor analysis will be necessary to understand the whole system as a system, a fabric of dozens of materials, technological, spatial, temporal, and trade relationships. Factor analysis assumes that the underlying structure of the variables is linear grading from one conceptual state to another. (This constraint can be escaped somewhat by using presence or absence data as we do in some of our factor analyses.) Insights from spatial trends suggested the following recoding of the material, color, and termination variables into linear states. The remainder of the variables are either inherently linear, i.e., measurements, or originally coded as linear states such as reduction sequence which reflects the beginning to the end of the flake production process (primary, secondary, tertiary), or degree of firing (discolored, potlidded, fractured). Use ware (polished, chipped, step fractured), and platform preparation (none, core, biface, ground biface) also reflects underlying trends.

The material variable was recoded to reflect two separate properties of the stone (**Table *9***). The first, MatDur, is designed to reflect the durability and hardness of the material; 1 is soft and 8 is very hard. The second, MatExo, represents the presumed distance of acquisition, exotic origin, expense, and symbology of the material; 1 (one) is from a nearby source and 8 is from a distant source.

**Table 8. Room Factor Scores for Area/Exotic Materials. Chert has been removed because it is local and ubiquitous. Shown are room designations, factor scores greater and less than 1 standard deviation, and the presence or absence of the related materials listed.**

| Factor 3 | | | Factor 2 | | | Factor 4 | | |
|---|---|---|---|---|---|---|---|---|
| Area Loading<br>Room scores greater than 1s | | 0.65 | | | 0.50 | | | 0.38 |
| Related Materials | | Basalt | | | Calced Jasper | | | Obsidian Limesto |
| Room | Score | P or A | Room | Score | P or A | Room | Score | P or A |
| r2C59 | 2.23 | P | r2C59 | 2.13 | PP | r3A | 2.41 | PP |
| r3A | 2.06 | P | r7F | 1.90 | PP | r3E | 2.03 | PA |
| r3B | 2.04 | A | r3B | 1.88 | AP | r2C44 | 1.92 | PP |
| r3D | 1.73 | P | r3E | 1.84 | PA | r3D | 1.65 | PP |
| r3C | 1.68 | P | r2EP59 | 1.66 | PP | r2EP36 | 1.62 | PP |
| r2A | 1.53 | P | r3Q | 1.48 | PP | r2EP40 | 1.53 | PP |
| r1A | 1.37 | P | r3C | 1.47 | AP | r2C43 | 1.52 | PP |
| r2H | 1.28 | P | r1E | 1.40 | AA | r3B | 1.15 | PA |
| r2H | 1.08 | P | r1C | 1.40 | AA | r3L | 1.14 | AP |
| r2C21 | 1.04 | P | r2EO57 | 1.27 | PA | r3G | 1.14 | AP |
| r2C61 | 1.01 | P | r3K | 1.25 | AA | r2D | 1.13 | PP |
| r2D | 1.00 | P | r2C60 | 1.13 | PP | r2C64 | 1.08 | AP |
| r2A | 0.97 | P | r2C11 | 0.99 | AA | r2C31 | 1.00 | PP |
| Room scores less than 1s | | | | | | | | |
| Related Materials | | Flint Calced | | | Limesto Quartz Basalt | | | Jasper Basalt |
| r2EP36 | -1.00 | AP | r2EP38 | -0.98 | PPP | r2H | -1.05 | PP |
| r2C43 | -1.03 | AA | r2C13 | -1.01 | APP | r2C28 | -1.07 | AP |
| r3R | -1.06 | PP | r2EP40 | -1.02 | PPP | r2C18 | -1.14 | AP |
| r3E | -1.21 | PP | r2C67 | -1.04 | PPA | r2EP34 | -1.18 | AP |
| r2EO57 | -1.36 | AP | r2C12 | -1.19 | PPP | r2EO42 | -1.18 | AP |
| r2EP37 | -1.51 | PA | r3P | -1.29 | PPP | r2EP51 | -1.42 | PP |
| r3Q | -1.52 | PP | r2EP43 | -1.34 | PPP | r2C12 | -1.43 | PP |
| r2C44 | -1.63 | PA | r2EO39 | -1.39 | PPA | r2EP59 | -1.50 | PP |
| r2EP51 | -1.75 | PP | r2C57 | -1.50 | PPP | r3C | -1.56 | PP |
| r2- | -1.76 | PP | r2C54 | -1.55 | PPP | r2C34 | -1.77 | PP |
| r2EP59 | -2.13 | PP | r2C53 | -1.63 | PPP | r2C21 | -1.93 | PP |
| r2EP38 | -2.13 | PP | r2C39 | -1.68 | PPP | r2EP41 | -2.31 | PP |
| r3M | -2.20 | PP | r2C8 | -1.70 | PPP | r2EP33 | -2.59 | PP |

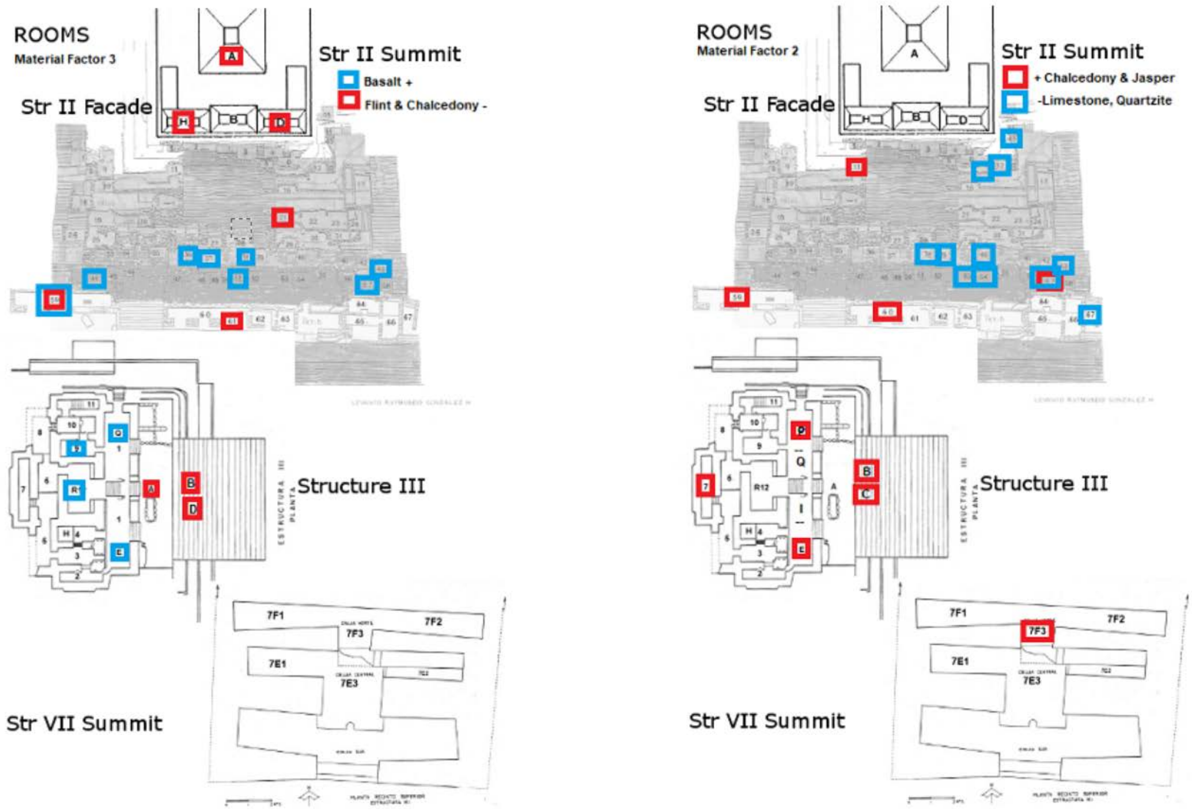


**Figure 6. Plots of Material Type Combinations for Factors 3 (left) and 2 (right). <>1.0 std.**

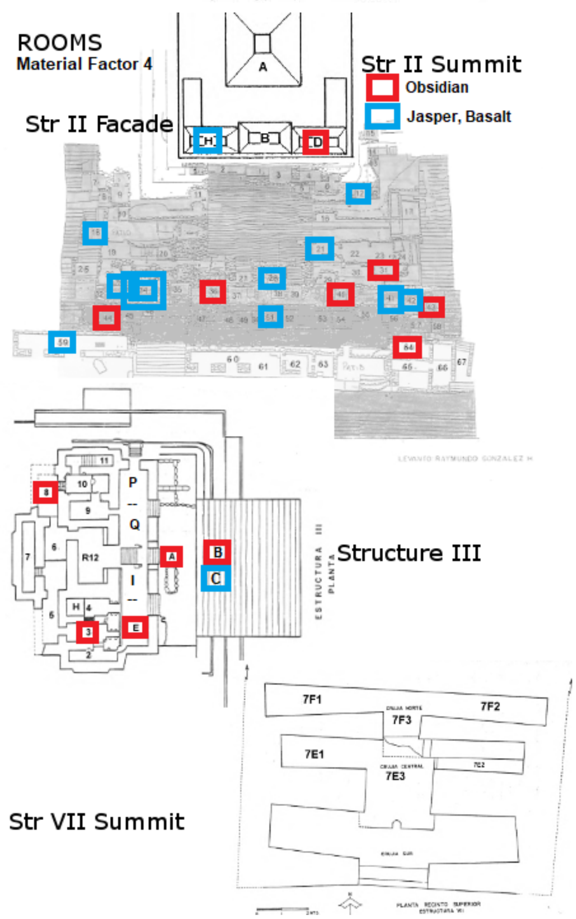


**Figure 7. Factor 4 Material Distribution (left). <>1.0 std.**

**Table 9. Linear Transformations of Material Types and Exotic Materials.**

| Material Durability | Material Exotic |
|---|---|
| MatDur | MatExo |
| 1 Obsidian | 1 Chert |
| 2 Chalcedony | 2 Quartzite |
| 3 Flint | 3 Chalcedony |
| 4 Chert | 4 Flint |
| 5 Jasper | 5 Jasper |
| 6 Quartzite | 6 Serpentine |
| 7 Basalt | 7 Basalt |
| 8 Serpentine | 8 Obsidian |
| 9. Jade | |

Color was recoded to reflect a trend from brown (1) and gray, common, local, materials, to exotic and potentially symbolic colors (9) (**Table *10***). This recoding also in essence transforms the variable to reflect a gray/blue-to-red chroma shift (see Munsell color chart).

**Table 10. Linear Transformations of Material Colors.**

| | | | |
|---|---|---|---|
| 1. Brown | 6. Purple | 2. Gray | 7. Yellow |
| 3. Black | 8. Red | 4. Green | 9. Rose |
| 5. Blue | | | |

The terminations were recoded on a normal to sheared trend (**Table *11***). The normal and step fractured terminations indicated unmodified flake length. Retouched terminations indicate intentional modification flakes' terminal ends. Plane snaps are also probably intentional modifications of length. Top and bottom overhang conditions of snaps are assumed to represent snaps caused by shear stresses during utilization. Thus the trend is from manufacture (1) to use (4).

**Table 11. Linear Transformations of Flake Terminations.**

| |
|---|
| 1. Normal or Step fracture |
| 2. Retouched |
| 3. Plane Snap |
| 4. Top or Bottom overhang |

## Summary: Quantitative material and fabrication character of Calakmul lithics

The above recoded variables were included in factor analyses (***Table 12***, see Database 1) along with naturally linear measurements such as weight and width to provide a view of the overall technology and material characteristics of the assemblage. In brief summary, the five factors that account for 50 percent of the variance in material and other technological measurements yield the following insights.

1. **Factor 1**, as is typical of factor analyses, accounts for the size of objects. Weight appears on the factor along with durability of material indicating that specimens made of more durable materials are larger; consider for example basalt manos (hard) and obsidian blades (soft). In the domain of flaking, the reverse (non-negative) relationship of reduction sequence indicates that flakes later in the sequence are smaller. Those are the dominant if unexciting characteristics of the total assemblage.

**Table 12. Factoring Materials and Rooms. Yellow is important (positive) relationships and Blue is important (negative) relationships.**

| COMPONENT | LOADINGS | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **OPERation** | **0.18** | **-0.73** | **0.18** | **0.06** | **0.05** | **0.01** | **0.07** |
| **CONText** | **0.07** | **-0.24** | **0.37** | **-0.03** | **0.61** | **0.29** | **0.36** |
| **ELEVation** | **-0.04** | **0.39** | **-0.28** | **0.45** | **0.39** | **0.03** | **0.20** |
| **PESO** | **-0.70** | **0.12** | **-0.01** | **0.17** | **0.16** | **0.01** | **0.06** |
| **PLATW** | **-0.32** | **0.41** | **0.48** | **-0.04** | **-0.19** | **-0.03** | **-0.06** |
| **CONSistency** | **-0.11** | **0.22** | **0.74** | **0.00** | **0.05** | **-0.06** | **0.09** |
| **PLATFshape** | **0.36** | **0.18** | **0.21** | **-0.47** | **0.20** | **-0.09** | **0.15** |
| **REDUC** | **0.74** | **0.07** | **-0.04** | **0.12** | **0.04** | **0.08** | **0.01** |
| **FUEfire** | **0.01** | **0.12** | **-0.10** | **-0.06** | **-0.55** | **0.37** | **0.73** |
| **CORTex** | **0.35** | **0.57** | **-0.01** | **0.32** | **0.11** | **-0.07** | **0.07** |
| **MATDUR** | **-0.68** | **-0.06** | **0.06** | **-0.03** | **0.01** | **0.00** | **0.03** |
| **MATEXO** | **-0.36** | **0.00** | **-0.39** | **-0.25** | **0.28** | **0.41** | **-0.01** |
| **COLOR3** | **0.14** | **0.13** | **0.23** | **0.12** | **-0.12** | **0.76** | **-0.47** |
| **TERM2** | **0.07** | **0.40** | **-0.18** | **-0.65** | **0.14** | **0.00** | **-0.08** |
| Variance | 15 | 11 | 9 | 8 | 7 | 1.0 | 1.0 |

3. Like factor 1, **Factor 3** is a general characteristic of the assemblage not associated with either structure II or III. It indicates that flakes with large platform widths have greater consistency of material of color. This is, again, a mundane characteristic of large chunks of chert to be uniform in their interior color structure. Smaller pieces, however, are likely to encounter impurities and inhomogeneities.

2. **Factor 2** *distinguishes the pyramid Structure II and palace Structure III assemblages (OPER). The palace Structure III assemblage is characterized by small platform widths, little visible evidence of use, and generally intentional modification or no modification of terminal ends of flakes. This probably indicates lighter uses such as cutting food or fabric. *By contrast, the pyramid Structure II assemblage evidences large platforms, more visible evidence of use, and shear stresses in unintentional modification of flakes terminations. *This suggests a facility in which hard primary materials are being modified such as wood resulting in unintentional breakage of flakes.

4. **Factor 4** reflects differences of lithic distributions by elevation and presumably capabilities and classes on the palaces and zones of the pyramid. Prepared platforms tend to appear in the upper reaches of the pyramid Structure II and in the palace Structure III. This probably indicates great care being excised to remove flakes for, and perhaps in the presence of, elite sacred and secular personages. Less care, as might be expected, is exercised for early reduction sequence tasks in the lower reaches of the pyramid where the knapping shops and mass utilization tasks are being performed. There is also more of a tendency for sheared flake terminations down pyramid. This is where the rough work is going on to introduce and refine materials for the community. *As the flow of substances and lithics continues up pyramid and toward palace Structure III, there is less unintentional modification of flake terminations, as less rigorous and more delicate use is made of them.

I ***Factor 6** confirms a relationship between exotic materials and exotic colors. Were factions in the community more concerned with the color of their tools than their material characteristics such as hardness? This implies a prosperous community with external links to luxury goods. **Factor 7** affirms the relationship between burning and reddening of stone.

*The first four factors, two with structural referents and two without, define the major characteristics of the system. Based strictly on lithic reduction characteristics, a thought akin to down the line trading of materials, mentioned in the introduction, lithics flow from the base of pyramid Structure II toward the pyramid summit and palace Structure III. Lithics are being severely stressed as they encounter raw materials to be processed in the shops on the lower zones of pyramid Structure II. Up pyramid and in the Structure III palace they suffer less damage as they are used for more delicate tasks related to finished, softer materials. The analysis places the tendencies detected unsystematically in the cross tabulations in a relative context of their importance in the overall picture of the flow of lithics and the inferred parallel flow of raw materials through the key precinct of the city. The analysis appears to confirm previously hypothesized sacred and secular relationships that placed the control of lithics, and perhaps much else, in the hands of the sacred faction while the statecraft and the arts were the domain of the secular authorities. It appears to suggest that there were class distinctions in the Terminal Classic. However, the classes and the production activities were crowded into the space formerly occupied by a vast, royal, Kaan household.

## Step 2: Lithic Tool Types and Subtypes

Lithic tool types are the recognized means of dividing assemblages into manageable subsets. Some, such as the barkbeaters, have clear functional intent. Others less so but sometimes, as we shall see, the functional ambiguities can be cleared up by examining the associations of ambiguous and unambiguous tool functions.

### Barkbeaters (Artifact Type 22)

Barkbeaters are found in most Mesoamerican sites. Examples are Edzná (Matheny et al. 1983) and Becan (Rovner and Lewenstein 1997). Barkbeaters are composed of biscuit-sized pieces of dense limestone. A groove is ground around the edge for hafting and the two faces are incised with a pattern of lines (***Figure 8*** upper left). Parallel lines are scored on both surfaces usually 2-5 mm apart. The lines are further apart on one side than the other. Barkbeaters have been observed in use ethnographically in highland Mexico (Rovner and Lewenstein 1997:55-56). In Precolumbian times they were probably used for preparing ficus bark for making codices.


**Figure 8. Barkbeater (upper left), mano fragment (upper and lower right) and Hammerstone (lower left).**

The frequency of barkbeaters at Calakmul, as at most sites, is not great. Ten specimens were found, one each in Structure I and Structure III and eight on Structure II. The distribution of barkbeaters on Structure II shows most of them to be on the lower zones (***Table 13***). Only one barkbeater was found on the summit of Structure II in temple II A, which may be significant; i.e., codices may have been written on top, but not much ficus bark was turned into bark paper there. Only Zone 6 has more than one specimen and the two above and below have one each. Of the barkbeaters on Structure II, all were in rooms on the zones except two: one is of unknown provenience and the other is on the principal staircase (EP).

**Table 13. Barkbeaters by ROOM * Type Crosstabulation Count and Artifact Map (#=room, Bold=item present).**

| Struc. | Room | Site Freq | Zones (rooms) | MAP--Barkbeaters | | | | | | | | | | | | | | | | Str II Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | 1SP-- | 1 | | | | | | | | | | | | | | | | | | |
| II | 2A-- | 1 | Unknown | | | | | | | | | | | | | | | | | |
| | 2--C04 | 1 | 1 (1-7) | 1 | 7 | | | 2 | | | | 3 | 5 | **4** | 6 | | | | | 1 |
| | 2-N4C21 | 1 | 2 (8-16) | 8 | 9 | 10 | | 11 | | | | | | | 16 | 12 | 13 | 14 | 15 | 0 |
| | 2N5C31 | 1 | 3 (17-18) | 18 | | | | | | | | | | | | | | | 17 | 0 |
| | 2--C34 | 1 | 4. (19-24) | | 19 | | 20 | | | | | | | | **21** | 22 | 23 | 24 | | 1 |
| | 2-N06C39 | 1 | 5. (25-31) | 25 | 26 | | | | | 27 | 28 | | | | 29 | 30 | **31** | | | 1 |
| | 2N7C44 | 1 | 6. (32-43) | | 32 | 33 | **34** | 35 | 36 | 37 | 38 | **39** | 40 | | | | 41 | 42 | 43 | 2 |
| | 2-N8EP* | 1 | 7. (44-58) | **44** | 45 | 46 | | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 1 |
| | | | 8.(59-67) | 59 | | | | | | 60 | 61 | 62 | 63 | + | | 64 | 65 | 66 | 67 | 1 |
| III | 3P-- | 1 | | | | | | | | | | | | | | | | | | |
| Total | | 10 | | | | | | | | | | | | | | | | | | 7 |

*EP = principal staircase (*escalera principal*)

The distribution of barkbeaters on the zone map (see ***Table 13***) shows specimens across the bottom of the zones and up the pyramid on the right. The numbers are room numbers. Bold room numbers mark the occurrence of barkbeater(s). The right side of the pyramid is the location of the spotted fine brown snapped points.

The mean weight of barkbeaters (***Figure 9***, mean=422.6 g) fall well above the assemblage mean (114 g). We have no information on whether the durable limestone from which the barkbeaters were made is local. However, the western part of the peninsula is generally thought to be poor in durable limestone. It seems likely that the barkbeaters were made of imported material from the eastern part of the peninsula or even imported as finished products. This would be an interesting and potentially fruitful study with regard to trade relations.

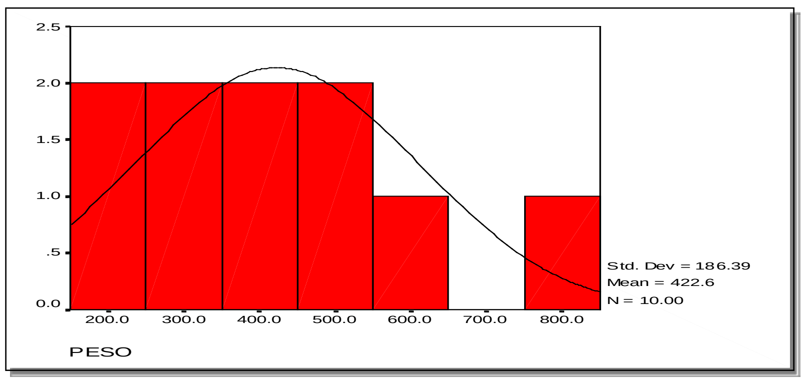


**Figure 9. Weight of Barkbeaters. The specimens below 300 g are broken.**

## Manos (Type 6)

All of the manos found at Calakmul were of the cylindrical, oval or faceted types as defined by Rovner and Lewenstein (1997:58). None were of the "flanged" or "dog bone" type thought to be associated with the Decadent or Protohistoric periods. In Rovner's collection, all of the flanged manos were from Dzibilchaltun, but none were from Rio Bec. This reflects the abandonment of the interior for coastal regions during the later periods and Calakmul's lack of flanged manos underscores the ubiquity of the interior abandonment. Many of the manos have damaged ends suggesting use as "mauls" (Rovner and Lewenstein 1997:58) during some period of their life histories.

Manos at Calakmul range from the huge 8,800 g limestone specimen that is an extreme outlier from the collection, to small, spectacular specimens of highly polished, exotic materials such as basalt. These small specimens seem to match the small, legged metates in compact and well-polished style, and material, more likely pallets for grinding cosmetics or spices than coarse materials such as corn. From the entire excavations, whole manos (n=132) and mano fragments (n=220) total 352. Some manos were reported by the excavator to have been found on Structure VII, but for unknown reason they were not returned to the laboratory. In retrospect, this could have been important information because it signals domestic use of the summit of Structure VII temple, and subtypes of manos might have been a source of better definition of the nature of that use. There were metates as well (Gallegos Gomora et al. 2005).

The weights of the whole and broken manos range from 20 to 7,000 g (***Figure 10***). With the exception of one extreme outlier, most of the population lies between 20 and 3,000 g. A bimodal distribution is suggested by the distribution, but with broken pieces in the sample it is impossible to determine if the bimodality is due to a real diversity of forms or breaks. A figure equivalent to thickness can be generated by dividing the weight by the length, which we will call "relative thickness." A histogram (***Figure 11***) of relative thickness shows about 10 modes, the most convincing of which is a cluster below 20 (subtype 6.2 = very small).

The manos above relative thickness of 20 could be divided but this would create a large number of subtypes with small sample sizes. We decided to divide the sample into very small (subtype 6.2), small (subtype 6.3) relative thicknesses of 21-47, medium (subtype 6.4) relative thicknesses of 48-95, and large (subtype 6.5) with a relative thickness of 96-150. As can be seen in ***Table 14***, the observed count matches the expectations of a random distribution so closely a significant chi-square is not generated. In other words, all of the subtypes were used in equal proportions in and on both Structure II (2) and Structure III (3).

The materials from which the manos are made (***Table 15***) vary significantly from subtype to subtype. A greater proportion of the medium sized manos are made of quartzite and a greater than expected number of small ones are made of basalt. Apart from these foci, however, the size of the manos seems to be unselective relative to material.

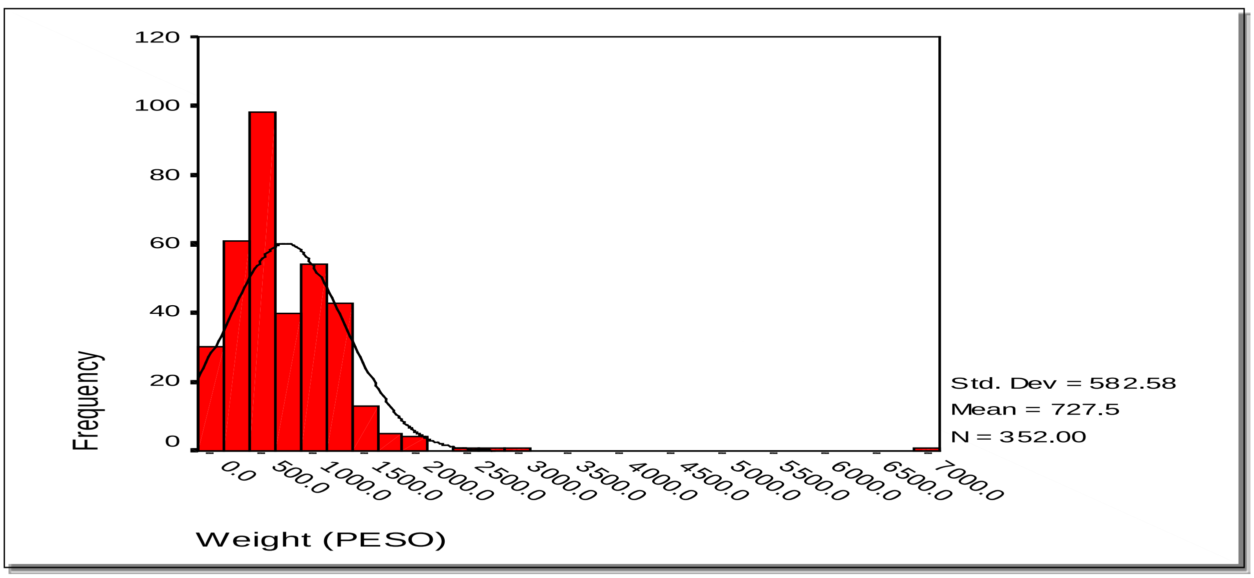


**Figure 10. Weights of all Whole and Broken Manos.**

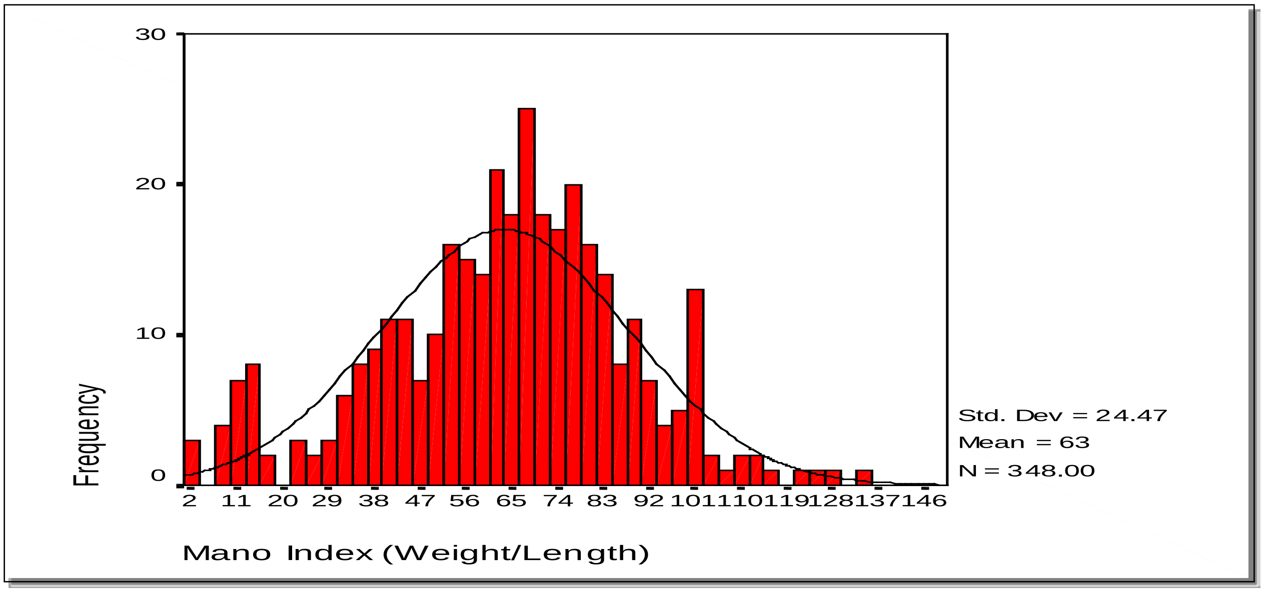


**Figure 11. Mano Relative Weight (Weight/Mano Length).**

**Table 14. Mano Subtypes for Structures II and III.**

| **Subtypes** | | | **Structure 2** | **3** | **Total** |
|---|---|---|---|---|---|
| **Very Small** | 6.2 | Observed Count | 20 | 4 | 24 |
| | | Expected Count | 19.3 | 4.7 | |
| **Small** | 6.3 | Observed Count | 48 | 9 | 57 |
| | | Expected Count | 45.8 | 11.2 | |
| **Medium** | 6.4 | Observed Count | 182 | 52 | 234 |
| | | Expected Count | 188.1 | 45.9 | |
| **Large** | 6.5 | Observed Count | 29 | 3 | 32 |
| | | Expected Count | 25.7 | 6.3 | |
| | Total | Observed Count | 279 | 68 | 347 |

Chi-Square Tests

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 3.8 | 3 | 0.284 |
| Likelihood Ratio | 4.2 | 3 | 0.241 |
| N of Valid Cases | 347 | | |

1 cell (12.5%) have expected count less than 5. The minimum expected count is 4.70.

**Table 15. Mano Subtypes by Material.**

| | | | Mano Subtypes | | | | Total |
|---|---|---|---|---|---|---|---|
| | | | **V. Small** | **Small** | **Medium** | **Large** | |
| | | | **6.2** | **6.3** | **6.4** | **6.5** | |
| **Material Type** | Siliceous Limestone | Count | 7 | 8 | 48 | 7 | 70 |
| | | Expected Count | 4.8 | 11.5 | 47.2 | 6.5 | |
| | Limestone | Count | 0 | 1 | 5 | 2 | 8 |
| | | Expected Count | 0.6 | 1.3 | 5.4 | 0.7 | |
| | Quartzite | Count | 10 | 19 | **159** | 23 | 211 |
| | | Expected Count | 14.6 | 34.7 | 142.3 | 19.5 | |
| | Basalt | Count | 6 | **28** | 20 | 0 | 54 |
| | | Expected Count | 3.7 | 8.9 | 36.4 | 5.0 | |
| | Other | Count | 1 | 1 | 2 | 0 | 4 |
| | | Expected Count | 0.3 | 0.7 | 2.7 | 0.4 | |
| **Total** | | Count | 24 | 57 | 234 | 32 | 347 |

Chi-Square Tests

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 73.7 | 12 | <.001 |
| Likelihood Ratio | 65.7 | 12 | <.001 |
| N of Valid Cases | 347 | | |

10 cells (50.0%) have expected count less than 5. The minimum expected count is .28.

The map of small manos (***Table 16***) shows that nine of 15 are located on the principal staircase of pyramid Structure II.

**Table 16. Room Distribution of Small Manos Artifact Map (Bold).**

| N | Room | Zones (rooms) | MAP—Small Manos (Numbers = Rooms) | | | |
|---|---|---|---|---|---|---|
| 1 | 2--- | Palaces | | | | Legend: |
| 2 | 2A-- | IIA | 1 2 3 4 5 | 6 7 **X** | | **12**=Room # |
| 7 | 2--EP | IIB | A B C D E | F G H I | | W/ 1 Artifact |
| 1 | 2-N2C12 | Zones | 1 7 2 | 3 5 4 | 6 | **X**= somewhere |
| | | 1 (1-7) | | | | |
| 1 | 2-N4EP | 2 (8-16) | 8 9 10 11 | **X X X X X** | 16 **12** 13 14 15 | 15 = room number |
| 1 | 2-N5C31 | 3 (17-18) | 18 | **X X** | 17 | |
| 1 | 2-N6- | 4. (19-24) | 19 20 | **X** | 21 22 23 24 | |
| 1 | 2-N8C59 | 5. (25-31) | 25 26 | 27 28 | 29 30 **31** | |
| 1 | 3A1- | 6. (32-43) | 32 33 34 35 | 36 37 38 39 40 **X** | 41 42 43 | |
| 1 | 3A5- | 7. (44-58) | 44 45 46 47 | 48 49 50 51 52 53 | 54 55 56 57 58 | |
| 1 | 3P-- | 8.(59-67) | **59** | 60 61 62 63 | 64 65 66 67 | |
| | | IIIA&B | **1** 2 3 4 **5** 6 7 8 B 1 2 3 4 5 6 7 | | | |
| | | IIIC-R | C D E F G H I J K L M N O **P** Q R | | | |
| | | VII | A B 1 2 3 4 | | | |

**X** = somewhere in the zone. Palace Structure III rooms are published as 1, 2, 3, rather than A, B, C, … in Folan et al. (1995).

## Metates (Type 7)

Metates occurred in large numbers all through the excavations (***Figure 12***). Because of the limited ability to transport and store the huge metates, only the small legged specimens were returned to the laboratory (***Table 17***). The small legged variety of metate is reported by Rovner and Lewenstein (1997:59) to appear in the Terminal and early Postclassic deposits at Rio Bec; none were found at Dzibilchaltún.

**Figure 12. Metates laid out for photograph of record.**

Of the 36 whole and 98 fragmentary metate specimens at Calakmul, most were made of basalt (n=109), and most of these of the dark gray (n=83) variety. All were located on pyramid Structure II (n=117) and in palace Structure III (n=17).

An impressionistic survey of the large limestone “trough” metates yield some interesting information. Perhaps the most illuminating is that some were stored upside down on Structure II. That they were on these highly elevated premises at all suggests that they were brought there during a period of civically well-organized activity. That they were stored carefully could imply any number of things. For example, why would they have been stored upside down at all? It would seem a precaution unnecessary in the dry season. Does it mean that Calakmul was abandoned in the wet season? Or were they roofed areas?

**Table 17. Small Metate Material Types and Material Color.**

| Material Color | Chert | Quartzite | Limestone | Material Type<br>Basalt | Jasper | Other | Total |
|---|---|---|---|---|---|---|---|
| **Lt Gray** | 3 | 2 | 1 | 5 | | | 11 |
| **Med Gray** | 1 | | | 7 | | 1 | 9 |
| **Dk Gray** | 2 | 2 | 1 | 83 | | 2 | 90 |
| **Lt Brown** | 1 | 2 | | | | 2 | 5 |
| **Med Brown** | 2 | | | 1 | | | 3 |
| **Dk Brown** | | | | 1 | | | 1 |
| **Dk Yellow** | 1 | | | | 1 | | 2 |
| **Black** | | | | 2 | | | 2 |
| **Lt Black** | | | | 7 | | 1 | 8 |
| **Lt Green** | | | | 1 | | | 1 |
| **Dk Green** | | | | 2 | | | 2 |
| **Total** | 10 | 6 | 2 | 109 | 1 | 6 | 134 |

Metates were also found in large numbers on the exterior verandas of palace Structure III and on the summit of Structure VII temple. This seems to paint a picture of the exterior spaces of the palaces as scenes of intense domestic production areas.

## Hammer Stones (Type 21)

Hammer Stones (Type 21) number 352 with the largest proportion of them being found in pyramid Structure II (2) (***Table 18***, n=254). This number is far above what would be expected if hammerstones were randomly distributed among structures. Palace Structure III (3) has many fewer than would be expected, and pyramid Structure I (1) possess about as many as would be expected.

**Table 18. Hammerstones and Other artifacts by Structures**.

| Structure | | Hammer stones and Other artifacts: Other | Hammer Stone | Total |
|---|---|---|---|---|
| 0 | Count | 8 | 0 | 8 |
| | Expected Count | 7.7 | 0.3 | |
| 1 | Count | 168 | 7 | 175 |
| | Expected Count | 167.4 | 7.6 | |
| 2 | Count | 4350 | **254** | 4604 |
| | Expected Count | 4404.3 | 199.7 | |
| 3 | Count | 2952 | 91 | 3043 |
| | Expected Count | 2911.0 | 132.0 | |
| 7 | Count | 286 | 0 | 286 |
| | Expected Count | 273.6 | 12.4 | |
| Total | | 7764 | 352 | 8116 |

| Chi-Square Tests | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 42.1 | 4 | <.001 |
| Likelihood Ratio | 55.3 | 4 | <.001 |
| N of Valid Cases | 8116 | | |

1 cells (10.0%) have expected count less than 5. The minimum expected count is .35.

The weights of hammerstones have two distinctive modes (***Figure 13***). Small hammerstones (subtype 21.1, small, n=322) have a mode at about 150-200 g and range in size form 24-850 g. Large hammerstones (subtype 21.2, large, n=30) have a mode of about 1050 g and range from 851-1350g. There are five very large outliers ranging up to 2220 g.

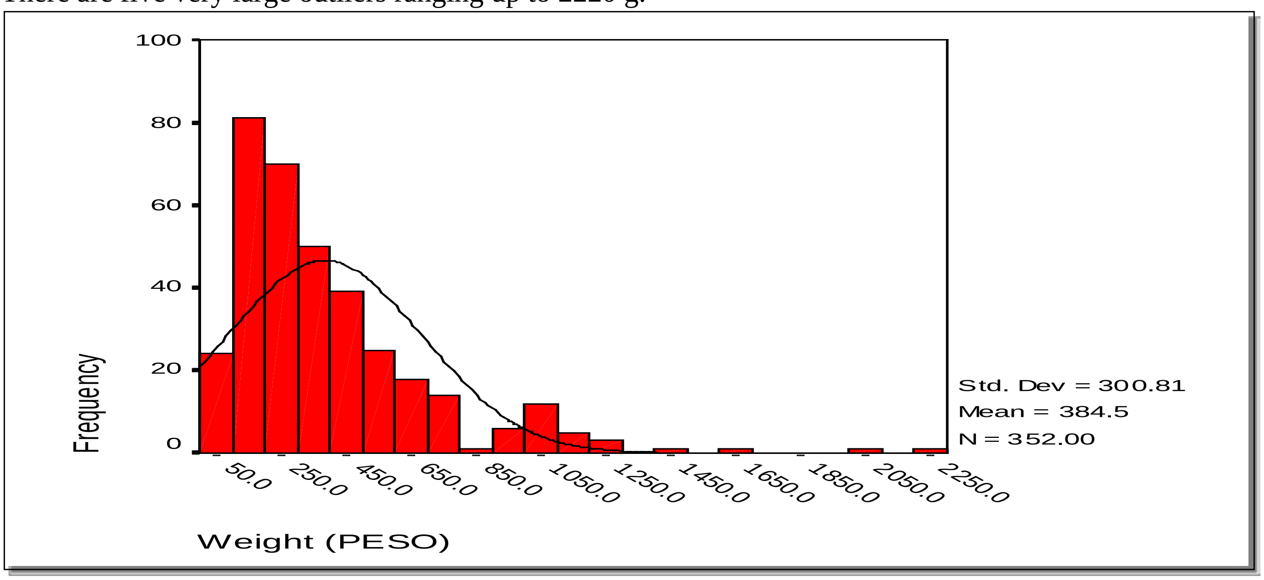


**Figure 13. Weights of Hammer Stones.**

## Obsidian (Type 30.XX)

Obsidian is found in most Mesoamerican sites. However, the millions of obsidian finds at Tikal skews the general perception of the frequency of obsidian. North of Tikal most cities such as Calakmul and Becan exhibit little obsidian. In Dzibilchaltún Rovner found 444 pieces of obsidian and in the Rio

Bec area sites 235 (Rovner and Lewenstein 1997:39). The precise correspondence of the sizes of the Calakmul collection (N=450) and the Dzibilchaltun collections raises the question of similar frequencies between the two sites. At Dzibilchaltun and Rio Bec Rovner observed that prismatic blades were made from obsidian of Guatemalan sources while points were made from Mexican sources.

At Calakmul the obsidian seems to have been used for elite ritual activities (Braswell et al. 2004), although many rooms contain single specimens and occasional caches of obsidian are found in palace Structure III. Braswell et al. (2004; Braswell 2013) has studied obsidian from many cities in Mesoamerica, including Calakmul. His measurements were incorporated into the lithics data base for this study. The assemblage consisted of 450 pieces of obsidian including prismatic blades (n=375), cores, and flakes ***Table 19***.

**Table 19. Distribution of obsidian Artifacts by Structures.**

| | | Structure | | | | Total | Percent |
|---|---|---|---|---|---|---|---|
| **Types of Artifacts** | **Type #s** | **1** | **2** | **3** | **7** | | |
| **Flake** | 30.05 | | 18 | 9 | | 27 | 6.0 |
| **Point** | 30.06 | 1 | 5 | 2 | | 8 | 1.8 |
| **Macroblade** | 30.08 | | 2 | | | 2 | 0.4 |
| **Small Percussion Blade** | 30.10 | | 1 | 1 | | 2 | 0.4 |
| **Prismatic Blade** | 30.12 | 1 | 201 | 140 | 33 | 375 | 83.3 |
| **Prismatic Blade Point** | 30.13 | | | | 1 | 1 | 0.2 |
| **Polyhedral Core** | 30.14 | | 11 | 9 | | 20 | 4.4 |
| **Chunk** | 30.17 | | 9 | 2 | | 11 | 2.4 |
| **Polyhedral Core Exhausted** | 30.18 | | 1 | 1 | | 2 | 0.4 |
| **Sculptural Eye** | 30.22 | | 1 | | | 1 | 0.2 |
| **Earspool** | 30.23 | | 1 | | | 1 | 0.2 |
| **Total** | | 2 | 250 | 164 | 34 | 450 | 100 |

Prismatic blades constitute 83.3 percent of the obsidian artifact assemblage. Flakes (6 percent) and polyhedral (or prismatic) cores (20 percent) are the only other numerically significant types of obsidian artifacts. Eight obsidian points were found along with other important singular finds such as an earspool and a sculptural eye. Interestingly, the same number of ear spools (n=1) were recovered at Dzibilchaltun. None were found in the Rio Bec sites. One obsidian eccentric was found at Dzibilchaltun, equivalent in number to the four eccentrics from Calakmul, but significantly they were made from brown chert. Apparently Calakmul's knappers were doggedly intent on sticking with their brown chert theme even though they must have had a lot of control over the flow of obsidian at locations like Cancuen (Demarest et al. 2014) during the Calakmul Golden Age.

At Dzibilchaltun and Rio Bec, Rovner was unable to detect patterns of distribution in obsidian prismatic blades (Rovner and Lewenstein 1997:41). Rather they seemed to be distributed randomly across the sites.

At Calakmul, obsidian prismatic blades were the most numerous type in the collection. They are largely concentrated in Structure II and Structure III (***Table 20***). However, using the total non-obsidian blade tool type population to generate expected numbers, the frequency of obsidian blades is about what would be expected, 201 and 140 respectively. Pyramid Structure I (1) has only one obsidian blade, fewer than would be expected. A small number of artifacts were recovered from Structure VII temple, but the number of obsidian blades was unusually elevated, more than twice as many as would be expected. As we shall see, Structure VII (7) blades were not only more frequent than expected, but from surprising material sources in Mexico.

**Table 20. Obsidian Prismatic Blades * Other Artifacts in Structures.**

| | | Artifact Types: Non-Obsid. Blade | Artifact Types: Obsid. Blade | Total |
|---|---|---|---|---|
| **Structure** | | 0 | 1 | |
| **0** | Observed Count | 8 | 0 | 8 |
| | Expected Count | 7.6 | 0.4 | |
| **1** | Observed Count | 174 | 1 | 175 |
| | Expected Count | 166.9 | 8.1 | |
| **2** | Observed Count | 4403 | 201 | 4604 |
| | Expected Count | 4391.3 | 212.7 | |
| **3** | Observed Count | 2903 | 140 | 3043 |
| | Expected Count | 2902.4 | 140.6 | |
| **7** | Observed Count | 253 | **33** | 286 |
| | Expected Count | 272.8 | 13.2 | |
| **Total** | Observed Count | 7741 | 375 | 8116 |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| **Pearson Chi-Square** | 38.6 | 4 | <0.001 |
| **Likelihood Ratio** | 34.0 | 4 | <0.001 |

1 cells (10.0%) have expected count less than 5. The minimum expected count is .37.

The weights of obsidian prismatic blades (n=350) are slightly skewed to the left (skewness = 1.94) (***Figure 14***). This, however, is probably a product of damage in use since the blades are highly breakable on the length axis (Rovner and Lewenstein 1997:46). The dimensions of prismatic blades that remain most constant in use are the more robust and generally unmodified width and thickness. The widths are nearly normally distributed (skewness .36) (***Figure 15***). This suggests that the knappers were intending a single mode of production. No other modes suggesting multiple subtypes are present. We will treat the obsidian blades as a single tool type in subsequent analyses.

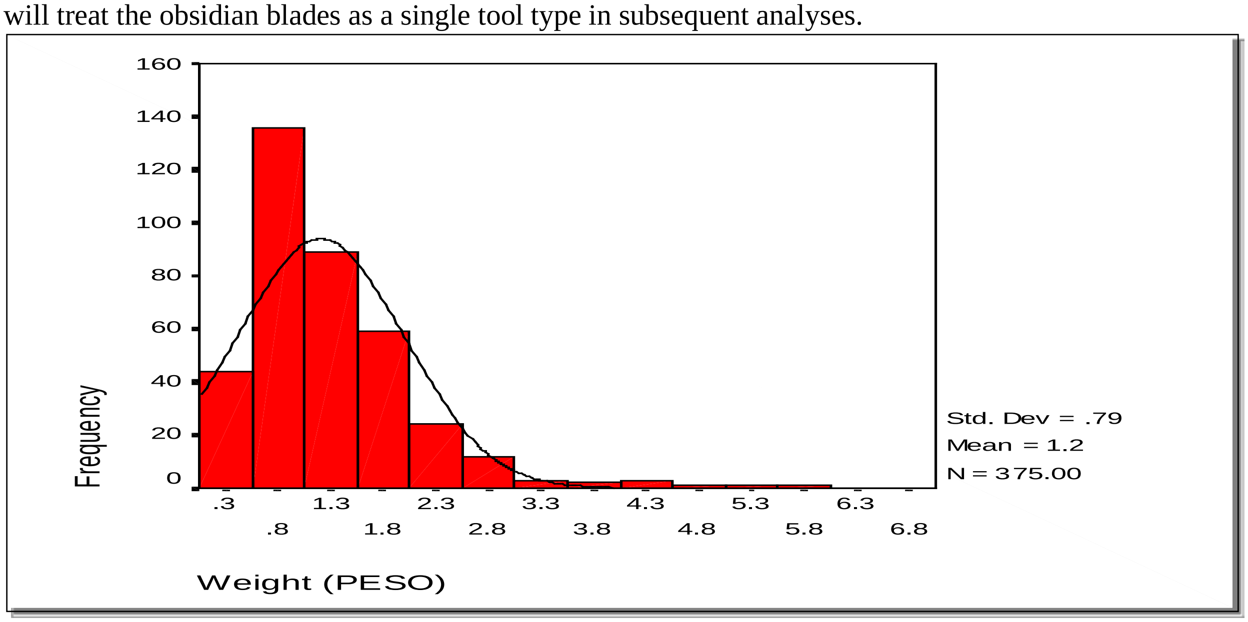


**Figure 14. Weights of Obsidian Prismatic Blades.**

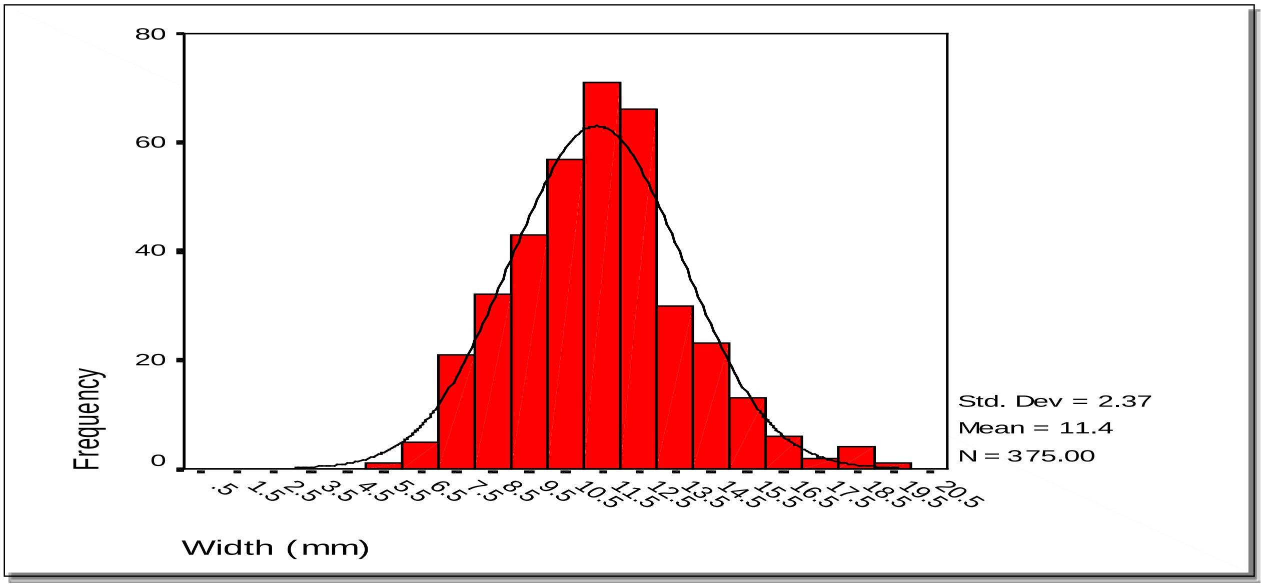


**Figure 15. Widths of Obsidian Prismatic Blades.**

**Table 21. Obsidian Source Areas by Structure. (red = greater than expected, blue = less than expected)**

| Structure | | CHY | IXT | SMJ | PAC | UCA | ZAR | Total |
|---|---|---|---|---|---|---|---|---|
| | | Obsidian Sources | | | | | | |
| | Source Area Code* | CHY | IXT | SMJ | PAC | UCA | ZAR | |
| | Significance | Most Freq | | Preclassic | High Value | | | |
| | Region | Gua | Gua | Gua | Mx | Mx | Mx | |
| 1 | Observed Count | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| | Expected Count | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 2 | Observed Count | 177 | 9 | 6 | 7 | 1 | 1 | 201 |
| | Expected Count | 173.7 | 8.0 | 3.8 | 9.6 | 5.4 | 0.5 | |
| 3 | Observed Count | 114 | 5 | 1 | 11 | 9 | 0 | 140 |
| | Expected Count | 121.0 | 5.6 | 2.6 | 6.7 | 3.7 | 0.4 | |
| 7 | Observed Count | 32 | 1 | 0 | 0 | 0 | 0 | 33 |
| | Expected Count | 28.5 | 1.3 | 0.6 | 1.6 | 0.9 | 0.1 | |
| | Total | 324 | 15 | 7 | 18 | 10 | 1 | 375 |

*The sources identified are (see Rovner and Lewenstein 1997:48ff for sources):

1. CHY=el Chayal, Guatemala (lumped Kaminaljuyu sources in Rovner and Lewenstein 1997:47) (Classic periods)
2. IXT=Ixtepeque, Guatemala, brown transparent (Post Classic)
3. SMJ=San Martin Jilotepeque, (Rio Pixcaya) in Guatemala (Preclassic source, Olmec control)
4. UCA=Ucareo, in Michoacán, Mexico
5. ZAR=Zaragoza, Puebla, Mexico
6. PAC=Pachuca, Mexico, green (small amounts in Classic Period, possibly through Kaminaljuyu, Post Classic, highly valued)
7. UNK= Unknown source

In addition to a relatively large and homogenous population, the obsidian blades possess other properties that are highly efficient indicators of interaction within the royal precincts of Calakmul. The obsidian was sourced by Braswell using expert judgement supplemented by neutron activation (***Table 21***). Using these avenues of identification, he attributed the obsidian to one or another of the sources in the highlands of Guatemala and Mexico. In an antecedent study using neutron activation Rovner (Rovner 1975; Rovner and Lewenstein 1997) was able to add much to their insights concerning trade relations between different periods at Becan-Chicanná and Dzibilchaltun. Another attribute that Braswell reports is that the platforms were ground, an approach to blade removal that was adopted during and after the Terminal Classic.

Dreiss and Brown (1989:71) found that about 70 percent of the obsidian imported to the lowlands during the Classic Period originated in the El Chayal quarries. Interestingly, this relationship to the Guatemalan highlands is also found in Chunchucmil on the northwest coast (Hutson et al. 2010) and for the entire east coast trading network (Golitko et al. 2012). That 86 percent of the Calakmul obsidian prismatic blades originate from this source may indicate an unusual dependence by Calakmul obsidian importers on this source. The highly valued green Pachuca obsidian from Mexico (Rovner and Lewenstein 1997:48) is second only to El Chayal frequencies (n=18, 5 percent).

At Becan and Chicanná distinctive sources of obsidian from the Kaminaljuyu cluster of quarries were detected suggesting the two sites imported obsidian from different sources even through they are virtually overlapping in spatial distribution (Rovner and Lewenstein 1997:50). Differences were also noted in regional sources; Becan imported most of its gray obsidian from Mexico while Chicanná received its obsidian in majority from Guatemala (Ixtepeque). The differences may indicate contemporary importation driven by a trade system involving gift exchange or foreign enclaves, or different timing of the imports. There is some sympathy for the idea that the architecture is later at Chicanná, but the matter awaits rigorous testing. The chert materials also imply an unusual separation between the two proximate sites.

During the Terminal Classic Period, the frequency of importation of obsidian and the number of source areas appears to have increased with a decline in the intervening Late Classic (Rovner and Lewenstein 1997:50). The peak of importation during the Early Classic and Terminal Classic may correspond to the lowest blade widths. This implies that large amounts of inferior material were being imported during these periods (Rovner and Lewenstein 1997:51).

Palace Structure III stands out with higher than expected observed counts from Pachuca and Ucareo, both of Mexican origin. Could this imply linkages between the secular authorities in the palace and the prominent polities of the Mexican highlands? This gives the main plaza of Calakmul, a major component of the Calakmul-Caracol alliance in opposition to Teotihuacan-influenced Tikal (Freidel et al. 2007), something of a split personality.

Another way to look at the frequencies of imported goods is the correlations within rooms. In **Table 22** the rooms containing only El Chayal obsidian have been ignored, but all rooms containing El Chayal and other sources are examined by a factor analysis. Factor 1 indicates a link between the El Chayal (0.8) and Pachuca (0.7) obsidians, El Chayal implying a Classic association. Rovner and Lewenstein's research indicates that the Pachuca obsidian may have been imported to the lowlands from Mexico via Kaminaljuyu, which acted as an intermediary for Teotihuacan. Thus the association between Guatemalan and Mexican sourced types is supported by our room analysis.

Factor 2 dis-associates Ixtepeque (-0.7) from Guatemala and Ucareo (0.8) from Mexico. Ixtepeque implies late imports, during and after the Terminal Classic (Golitko et al. 2012). The San Martin Jilotepeque obsidian, which was imported during the Preclassic (early) but not after (late), shares variance with both Factor 1 and Factor 2. The sharing indicates a systematic sharing within rooms of San Martin Jilotepeque across the early-late divide. Perhaps it means that by Terminal Classic times, found-pieces of San Martin Jilotepeque obsidian had lost their special significance and were simply used in a coordinated fashion with common El Chayal.

**Table 22. Factoring Obsidian Sources by Room.**

| | | Factor Pattern | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| **Source** | **Significance** | | | |
| **CHY** El Chayal Guatemala | Prominent | **0.8** | 0.1 | 0.1 |
| **IXT** Ixtepeque Guatemala | Late, Terminal C. | -0.2 | **-0.7** | -0.4 |
| **SMJ** San Martin Jilotepeque Gua | Early, Preclassic | **0.7** | **-0.4** | 0.1 |
| **PAC** Pachuca Mexico | High Value | **0.7** | 0.3 | -0.1 |
| **UCA** Ucareo Mexico | | -0.1 | **0.8** | -0.3 |
| **ZAR** Zaragoza Mexico | | -0.2 | 0.0 | **0.9** |
| % Variance | | 29.1 | 23.8 | 18.4 |
| Cumulative % Var. | | 29.1 | 52.8 | 71.3 |

Extraction Method: Principal Component Analysis

It would be interesting if any of the non-Chayal obsidian occurred in rooms exclusive of Chayal obsidian. This would indicate a room or area of rooms in which activities called for the use of uncommon obsidian. In only one room (VII, 7A--) was a non-Chayal obsidian prismatic blade found unaccompanied by El Chayal specimens. It is from Ixtepeque in Guatemala. This would align the temple Structure VII (7) summit with the east coast trading network (Golitko et al. 2012) and the nativist Calakmul-Caracol alliance (Gunn et al. 2017). This is contrary to our findings above that VII-7A—was Mexican aligned because of material types. This could mean that the activity on Structure VII was in the earlier Terminal Classic before Ixtepeque became prominent. Only one sample, however.

Because of the low sample size of the exclusive obsidian types, we conclude that at least as far as can be determined from distributions between rooms, the non-Chayal obsidian was not given very much special, exclusive rank in any part of the excavations. Perhaps an arrow pointing toward egalitarian social structure.

The analysis seems to indicate that the types of obsidian were generally used in conjunction. El Chayal was, as in most of the Lowlands, vastly more available and probably served utilitarian purposes. Pachuca is generally recognized as sacred stone and may have represented more exclusive functions. All except two of the artifacts of this type were housed in the elite residences on pyramid Structure II summit, in palace Structure III, and pyramid Structure VII summit temple (***Table 23***). Two of them are points (type 30.06).

Most of the rare obsidian was made into prismatic blades as is most of the El Chayal obsidian. However, Ixtepeque obsidian is made into a variety of forms: prismatic blades (type 30.12, n=15), flakes (type 30.05, n=2), a macro blade (type 30.08, n=1), a polyhedral core (type 30.14, n=1), and a chunk (type 30.17, n=1).

Obsidian Blade Widths. A considerable amount of information is available on obsidian blade widths because Rovner (Rovner and Lewenstein 1997:46; also Hutson et al. 2010) continued a line of research initiated by Kidder (1946) of studying the relationship between distance-to-source and blade width. When the Calakmul blade widths are compiled with the other sites for which width statistics are available, they generate a curvilinear relationship with the sites nearest the Guatemalan sources having the greatest width (***Figure 16***). In the southern lowlands widths diminish, and a slight increase in width appears along the northern coast. The operational theory behind this analysis is that cities further down the trade line from sources that have less desirable material and thus will end up with narrower blades. However, as Rovner and Lewenstein (1997:46) point out, proximity to rivers and canoe trade routes may play an important role in forming and modifying these trends. It may be that the northern Yucatan Peninsula sites were more accessible to water-borne trade and thus had access to superior material capable of yielding broader blades. In the obsidian prismatic blade context, Calakmul is more privileged than Palenque, Uaxactún and Rio Bec, but not surprisingly, less privileged than Tikal. As with other materials, this suggests that Calakmul worked around the Tikal obstruction by using brokers in Copan. Also, during the reign of Yuknoom the Great (636-686 CE), Calakmul and Caracol controlled the territory around to the west and to the south of Tikal (Grube et al. 2013; Canuto et al. 2012; Volta and Gunn 2016).

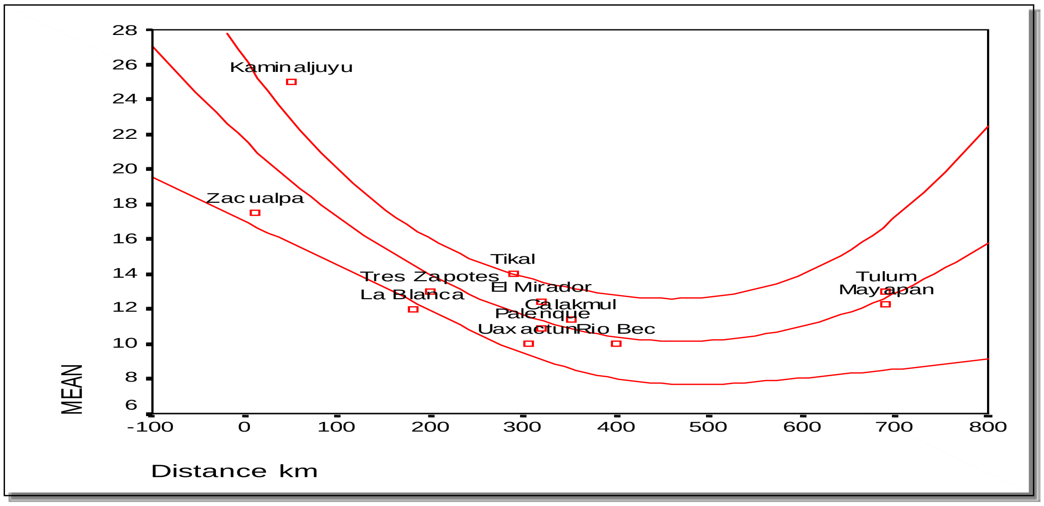


**Figure 16. Distance from Guatemalan Obsidian Sources to Major Sites * Obsidian Prismatic Blade Width. (generated from data in Rovner and Lewenstein 1997)**

## Eccentrics (Type 28)

An eccentric was found at Calakmul in room 9 on the second zone from the top (2BN2C09) near the head of the left-hand staircase. Also, 3 eccentrics were recovered from in front of Tomb 1 of temple Structure VII summit. Though not numerically important, eccentrics are a lithic oddity of the southeastern Maya lowlands and seem to have some sort of ritual significance. As mentioned above, only one was found also at Dzibilchaltun, though made of obsidian as opposed to the brown chert of the Calakmul pyramid Structure II specimen. Both of these finds correspond to Rovner's suggestion that the frequency of eccentrics declines toward the northwestern Maya lowlands.

## Large Bifaces (Artifact Types 4, 10, 11, 12, 17)

In his 1975 study Rovner (1975, Rovner and Lewenstein 1997:19-20) defined the large bifaces and unifaces as celts. In this study we called large bifaces with bits **axes** and the more nearly unifacial specimen **adzes**. **Celts** were fully ground. Figures 17, 18, 19 illustrate examples of bifaces and points. We saw no true unifaces that seem to be of ax-adz dimensions. However, it is generally the case that most implements can be made either by core or biface flaking. As a result, cultures tend to emphasize one or the other technique and use it as the preferred production method. The Calakmul knappers were clearly in a bifacing tradition. Only five prismatic blades were identified in the collection made of materials other than obsidian (chert=2, chalcedony=2, jasper=1). The attempt to introduce Belizean chert prismatic blade technology to Chicanná (see above) apparently failed because of poor material. We can suppose that prismatic blade technology was not the standard practice at Calakmul for similar reasons. Thus, bifacing in this case may be an adaptation to medium high quality local lithic materials.

Some of the large bifaces had bits set toward one of the faces rather than centered on the thickness of the implement. These were called **adzes**. **Preforms** are crude bifaces, not classifiable as point, ax, adz, or celt. Their widespread, infrequent distributions over the site suggest that they are tools rather than workshop materials. They could have been bifacial cores kept for on-the-spot flake or tool generation or implements. The bifaces were a small and highly varied population of comparable size to points. As an aggregate, the axes, adzes, celts, bifaces and preforms will be referred to as "large bifaces."

***Figure 20*** to ***Figure 25*** show the weight distributions of the total population of large bifaces, and axes, celts, adzes, and preforms separately. It is coincidental that the same number (n=91) of axes and preforms appear. Only 15 adzes and 32 bifaces were identified. The apparent multimodal, spikey, appearance of the ***Figure 20*** curve indicates multiple underlying patterns of manufacture resulting in differing weight randomly distributed around means; each of the modal means presumably represents some ideal tool type. At least six modes can be seen in the overall population histogram. This was to be expected given the variety of types in the large biface category. As we shall see, the types themselves have multiple modalities.

**Table 23. Room Distribution of Pachuca, Mexico Green Obsidian Artifact Map (Bold room numbers).**

| N | Room | Braswell # | Types* | Zones (rooms) | MAP—Green Pachuca Obsidian (Numbers = Rooms) | | | |
|---|---|---|---|---|---|---|---|---|
| 2 | 2A4- | 2A4 | 30.12 | Palaces | | | | Legend: |
| 1 | 2APE- | 2A.PZ | 30.12 | IIA | 2 3 **2** 5 | 6 7 **X** **X** **X** | | #=Number of |
| 3 | 2B-- | 2B | 30.12 | IIB | 3 C D E | F G H I | | Artifacts |
| 1 | 2--- | EII.333 | 30.12 | Zones 1 (1-7) | 7 2 | 3 5 4 | 6 | **X**= somewhere |
| 1 | 2--- | EII.337 | 30.06 | 2 (8-16) | 9 10 11 | | 16 12 13 14 15 | # = room number |
| 3 | 3A1- | 3A1.082 | 30.12 | 3 (17-18) | | | 17 | |
| 3 | 3A3- | 3A3a.04 | 30.12 | 4. (19-24) | 19 20 | | 21 22 23 24 | |
| 1 | 3B1- | 3B1 | 30.06 | 5. (25-31) | 26 | 27 28 | 29 30 31 | |
| 1 | 3B2- | 3B2 | 30.12 | 6. (32-43) | 32 33 34 35 | 3 37 38 39 40 6 | 41 42 43 | |
| 4 | 3B10- | 3B10 | 30.12 | 7. (44-58) | 45 46 47 | 4 49 50 51 52 53 8 | 54 55 56 57 58 | |
| 1 | 7B3- | 7B3 | 30.13 | 8.(59-67) | | 60 61 62 63 | 64 65 66 67 | |
| | | | | IIIA&B | 2 3 4 5 6 7 8 B 1 1 3 4 5 6 4 | | | <room 10 |
| | | | | IIIC-R | D E F G H I J K L M N O P Q R | | | |
| | | | | VII | B 1 2 1 4 | | | |

**X** = present somewhere in the zone. Pyramid Structure III rooms are published as 1, 2, 3, rather than A, B, C as in Folan et al. (1995).
* 30.06=point, 30.12=prismatic blade

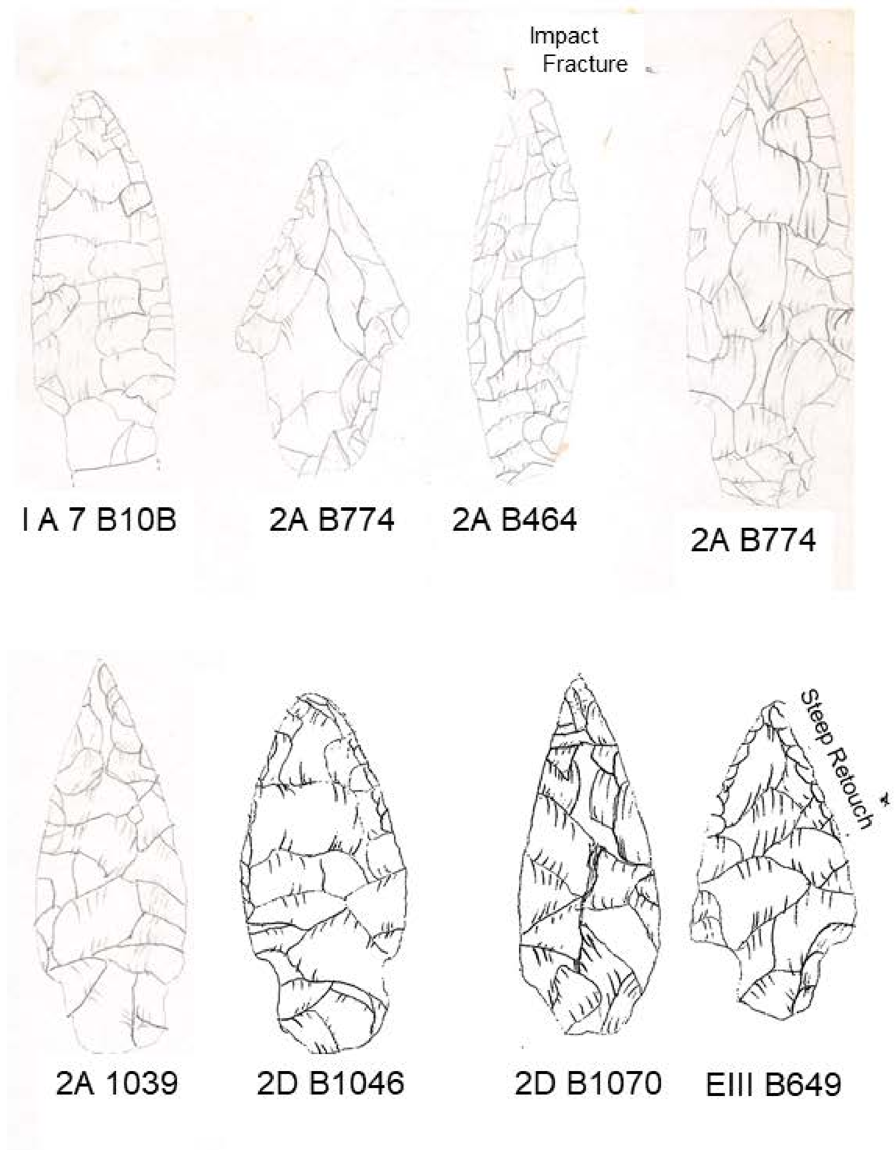


**Figure 17. Biface and Points Illustrations, Plate I.**

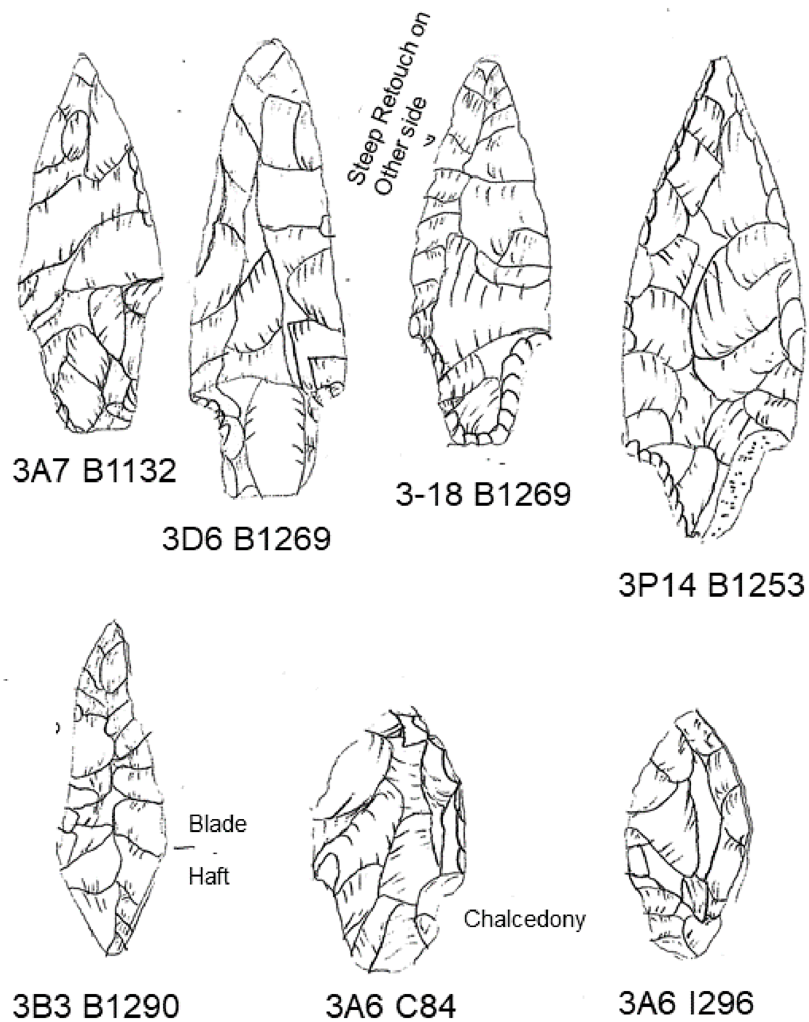


**Figure 18. Biface and Point Illustrations, Plate II.**

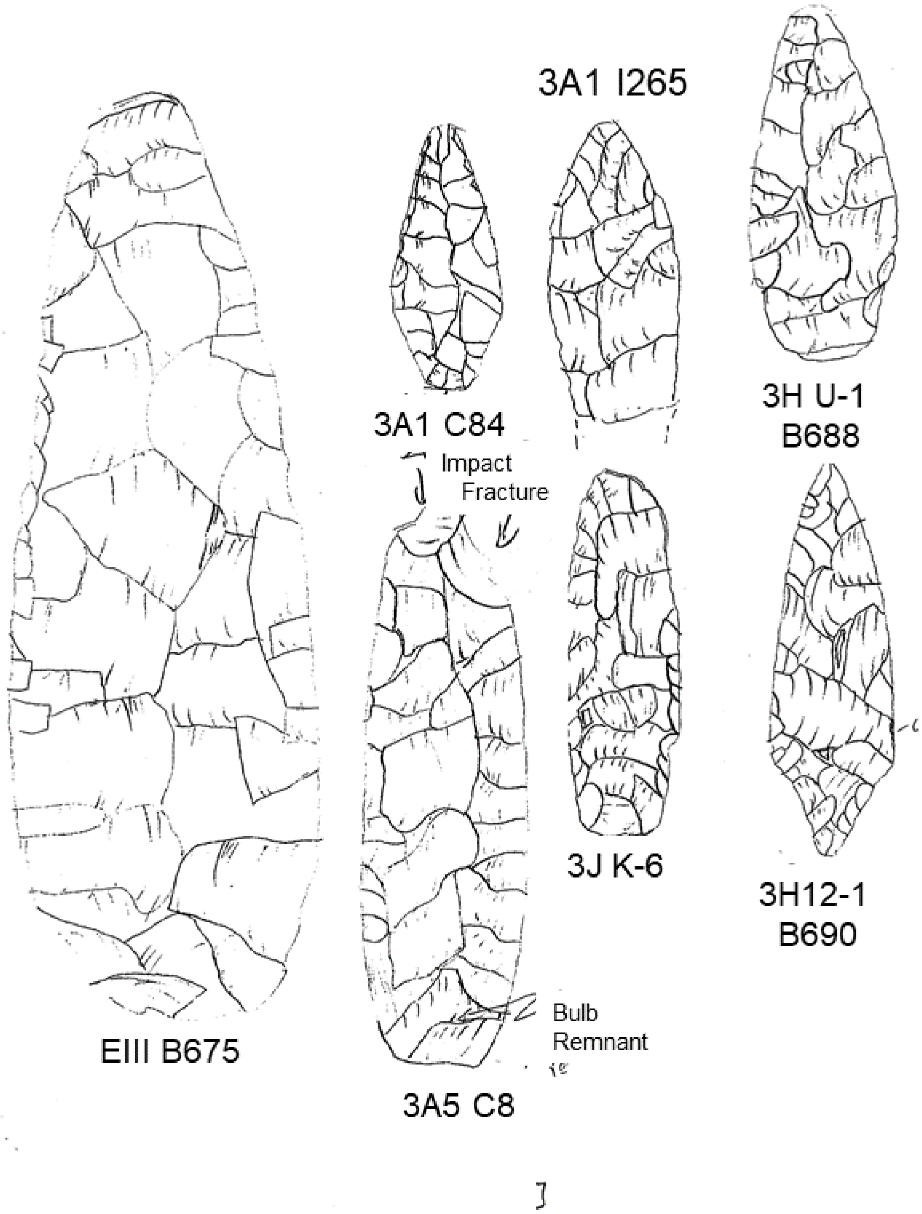


**Figure 19. Biface and Point Illustrations, Plate III.**

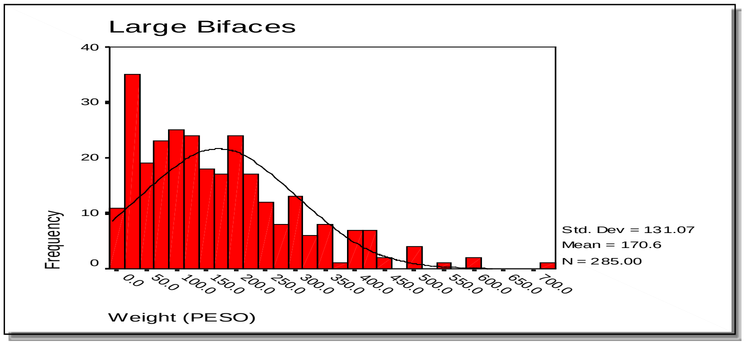


**Figure 20. Weights of Whole Axes Celts, Adzes Bifaces, and Preforms.**

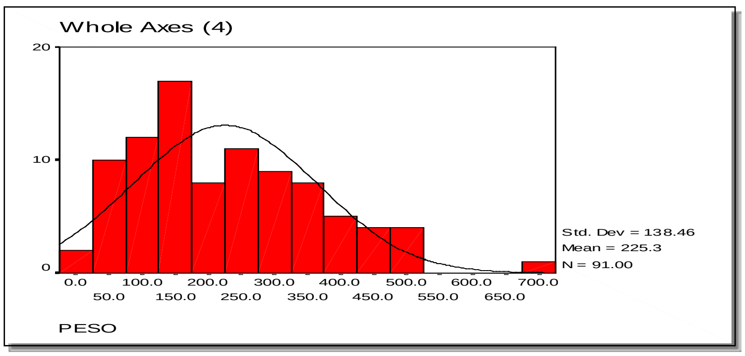


**Figure 21. Weights of Whole Axes (Type 4).**

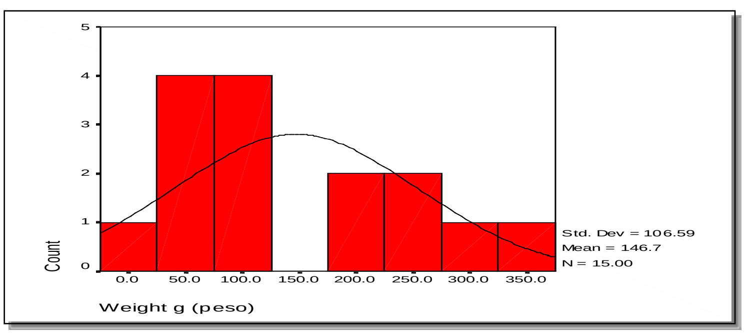


**Figure 22. Weights of Whole Celts (Type 11).**

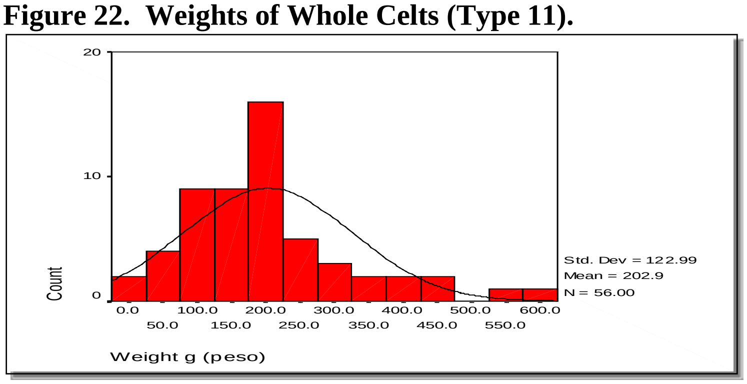


**Figure 23. Weights of Whole Adzes (Type 12).**

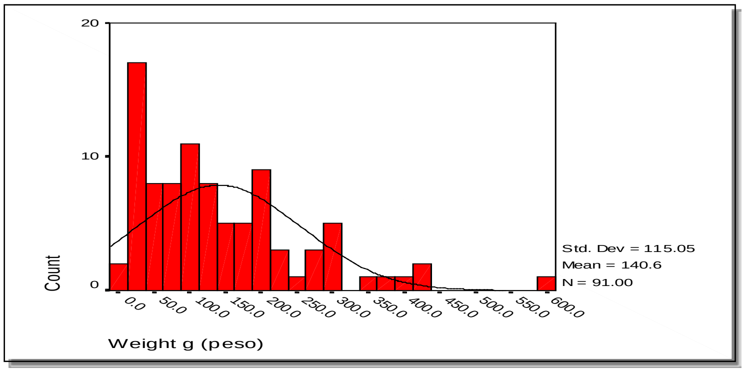


**Figure 24. Weights of Whole Preforms (Type 10).**

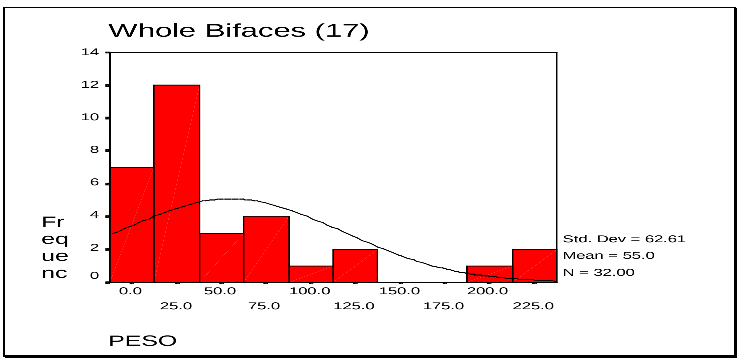


**Figure 25. Weights of Whole Bifaces (Type 17).**

The statistics on whole ax weights (***Table 24***, ***Figure 21***, mean=225.3 g) show that they tend to be large (above the population mean of 170.6 g), while adzes are smaller (202.9 g) but still above the population mean. The Coefficient of Variation (C.V.) demonstrates that while axes are larger than adzes, they both have the same relatively limited range of variability. This range of variability (C.V. = .61) is the lowest among the subpopulations of large bifaces suggesting a standardization of these types (see discussion of standardization in the research background section).

Andrieu (2013:31) also found standardization among bifaces produced from local cherts at Becan and Calakmul. She argues that the standardization implies specialists at work and "…there was no differential discard of these tools at residential and other contexts….". They must have been produced in workshops for exchange to local households.

**Table 24. Summary of Statistics on Whole Axes, Adzes, Celts, Preforms, and Bifaces.**

| | N | Mean | StD. | C.V. |
|---|---|---|---|---|
| Population of Whole Large Bifaces | 285 | 170.6 | 131.1 | 0.77 |
| Axes (Type 4) | 91 | 225.3 | 138.5 | 0.61 |
| Adzes (Type 12) | 56 | 202.9 | 123.0 | 0.61 |
| Celts (Type 11) | 15 | 146.7 | 106.6 | 0.73 |
| Preforms (Type 10) | 91 | 140.6 | 115.0 | 0.82 |
| Bifaces (Type 17) | 32 | 55.0 | 62.6 | 1.14 |

As noted above, the population histogram (see ***Figure 20***) shows a number of modes or spikes in the frequency distribution, at least seven in number. This suggests a number of subpopulations. The typology defines some subpopulations based on morphological characteristics. However, there is no reason to believe that any given type, say axes, are monolithic (so to speak) types. It would be typical of all tool kits whether they be lithic or metallurgical to have large and small versions of most morphologies such as hammers, choppers, screw drivers, saws, etc. Such within-type modes clearly show up in some of the types.

The most evident bimodal distribution is in celts with large and small celts dividing at about 150 g (**Figure 22**). Two modes are also evident in the ax histogram (***Figure 21***) suggesting that the axes come in at least two sizes, one below 150-200 g and the other above 200 g. This implies that axes and celts are made on a similar underlying template or underlying functional assumptions. Adzes on the other hand have a single mode (**Figure 23**); if there are subpopulations they are obscured by the distribution. Preforms depart from the one-or-two-mode design with as many as five size categories (***Figure 24***). This implies several functions or intended future avenues in the reduction sequence for preforms. This is an entirely reasonable finding given the many end-products and uses to which preforms could be put.

The final product of these deliberations requires an accounting of the number of types and subtypes of large bifaces. Without this accounting, the underlying spatial distributions would be compromised by the mixing of subtypes intended for different uses. ***Table 25*** shows the number of subtypes suggested by the modes in the histograms. Similar distributions of cut points were generated by axes, adzes and celts, and another pattern emerges from the preforms and bifaces. This suggests two underlying templates on which the majority of the tools were knapped.

**Table 25. Types and Subtypes of Large Bifaces.**

| Type | N | Subtypes | Wt. Cut Points & Upper Limits* | Codes |
|---|---|---|---|---|
| Axes (4) | 91 | 2 | 0 small 200 large 550 | 4.2, 4.3 |
| Adzes (12) | 56 | 2 | 0 small 150 large 350 | 12.2, 12.3 |
| Celts (11) | 15 | 2 | 0 small 150 large 400 | 11.2, 11.3 |
| Preforms (10) | 91 | 5 | 0g vvs, 50 vs, 150 small, 250 large, 325 vl, max 500 | 10.2, 10.3, 10.4, 10.5, 10.6 |
| Bifaces (17) | 32 | 4 | 0g vvs 50 vs 100 small 150 ----- --------------- | 17.2, 17.3, 17.4 |
| Total | 285 | 15 | | |

* Upper limits were defined to eliminate small numbers of extreme or outlier specimens. Vs = very small, vvs = very very small, vl = very large

The frequencies generated by the subtyping (***Table 25***) for the most part yield numbers sufficient to examine distributions, sometimes statistically but in all subtypes at least in a limited, impressionistic manner. Thirteen specimens were not considered in this analysis because they were outliers, unusually large single specimens. They may have been ceremonial in nature and need to be analyzed as a separate issue.

## Biface Spatial Distributions

The sum of the large bifaces for each structure tells the tale of the volume of excavations (***Table 27***). Of the total of 518 large bifaces and biface fragments, pyramid Structure II (n=392, 76 percent) has by far the greatest frequency. Palace Structure III (n=120, 23 percent) yielded a reasonably high frequency of bifaces per area excavated. Temple Structure I and Structure VII returned only two large bifaces each. The large number of rooms represented by relatively low frequencies of large bifaces supports an impression that arose during the observation stage of the analysis, that each room contained at least one or two large bifaces. First noted as "utility bifaces" by Kidder, it has been said that axes and adzes occur in great numbers all over the Maya lowlands during ancient times and must have served in an equivalent multiple-use role to modern machetes or axes. The uniform distribution of these implements across Calakmul rooms suggests that they also served as broad-scale utility implements in the elite precincts of Calakmul. This broadens Andrieu's (2013) similar conclusions for households.

**Table 26. Types and Subtypes of Large Bifaces Frequencies.**

| | | Artifact Types | | | | | Total |
|---|---|---|---|---|---|---|---|
| Artifact Subtypes | | 4 | 10 | 11 | 12 | 17 | |
| Axes | 4.2 | 44 | | | | | 44 |
| | 4.3 | 47 | | | | | 47 |
| Preforms | 10.2 | | 24 | | | | 24 |
| | 10.3 | | 32 | | | | 32 |
| | 10.4 | | 20 | | | | 20 |
| | 10.6 | | 5 | | | | 5 |
| Celts | 11.2 | | | 9 | | | 9 |
| | 11.3 | | | 6 | | | 6 |
| Adzes | 12.2 | | | | 17 | | 17 |
| | 12.3 | | | | 39 | | 39 |
| Bifaces | 17.2 | | | | | 21 | 21 |
| | 17.3 | | | | | 5 | 5 |
| | 17.4 | | | | | 3 | 3 |
| Total | | 91 | 81 | 15 | 56 | 29 | 272 |

**Table 27. Room * Type Large Bifaces Crosstabulation Dataset.**

| | Subtypes | | | | | | | | | | | | | | | | | | Structure/ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Types | Axes | | | Preforms | | | | | Celts | | | Adzes | | | Bifaces | | | | Total | Room |
| Room | 4.1 | 4.2 | 4.3 | 10.1 | 10.2 | 10.3 | 10.4 | 10.6 | 11.1 | 11.2 | 11.3 | 12.1 | 12.2 | 12.3 | 17.1 | 17.2 | 17.3 | 17.4 | | Totals |
| 0TE- | 1 | | | | | | | | | | | | | | 1 | | | | 2 | |
| 1--- | | | | | | | | | | | | | | | | | | | | **2** |
| 1A2- | | | | | | | | | | | | | 1 | | | | | | 1 | 1 |
| 1A7- | | | | | 1 | | | | | | | | | | | | | | 1 | 1 |
| 2--- | 18 | 2 | 5 | 7 | 2 | 1 | 4 | | 6 | | 2 | 1 | | 3 | 1 | 4 | | | 56 | **392** |
| 2--EP | 25 | | 1 | 3 | 6 | 5 | 2 | | 6 | | | 9 | 1 | 3 | 1 | 1 | 1 | | 64 | |
| 2-N2- | | | 2 | 1 | | | | | | | | | | | | | | | 3 | |
| 2-N2C08 | 2 | 1 | | | | | | | | | | | | | | | | | 3 | 3 |
| 2-N2C12 | 6 | | 2 | 1 | | 1 | | | 1 | | | 1 | | | | | | | 12 | 12 |
| 2-N3- | 2 | | | | | | | | | | | | | | 2 | | | | 4 | |
| 2-N4C21 | | | | | | | | | | | 1 | | | | | | | | 1 | 1 |
| 2-N4C23 | 1 | | | | | | | | | | | 2 | | | | | | | 3 | 2 |
| 2-N4EP | 2 | | | | | | | 1 | 1 | | | | 2 | 1 | | | | | 7 | |
| 2-N5C27 | | | 1 | | | | | | | | | | | | | | | | 1 | 1 |
| 2-N5C30 | | 1 | | | | | | | | | | | 1 | | | | | | 2 | 2 |
| 2-N5C31 | 2 | | | | | | | | 1 | | | | | 2 | | | | | 5 | 5 |
| 2-N6- | 2 | 1 | 3 | 1 | 1 | 2 | | 1 | | | | | 1 | | 1 | | | | 13 | |
| 2-N6C34 | 2 | | | | | | | | | | 1 | | | | | | | | 3 | 3 |
| 2-N6C37 | | 1 | | | | | 1 | | | 1 | | | | 1 | | | | | 4 | 4 |
| 2-N6C38 | | | 1 | | | | | | | | | | | | | | | | 1 | 1 |
| 2-N6C43 | | | 1 | | | | | | | | | | | | | | | | 1 | 1 |
| 2-N7- | 4 | | 2 | | | 1 | | | | | | | | 3 | | | | | 10 | |
| 2-N7C44 | 1 | 1 | | 2 | | 1 | | | | | | | | 1 | | | | | 6 | 6 |
| 2-N7C50 | | | | | | | | | | | | | | | 2 | | | | 2 | 2 |
| 2-N7C51 | | 3 | 1 | | | | | | | | | | | | | | | | 4 | 4 |
| 2-N7C52 | | | | | 1 | | | | | | | | 1 | | | | | | 2 | 2 |
| 2-N7C53 | 1 | | | | | | | | | | | | | | | | | | 1 | 1 |
| 2-N7C57 | | 1 | 2 | | | 1 | | | | | | | 1 | 1 | 3 | | 2 | | 11 | 11 |
| 2-N7C58 | | | | | 1 | 1 | | | | | 1 | | | | 1 | | | | 4 | 4 |
| 2-N7EP | 1 | | | | | | | | | | | | 1 | 1 | | | | | 3 | |
| 2-N8- | 5 | 1 | | 2 | 1 | 1 | 1 | | 1 | | | | | 1 | 1 | 1 | 1 | 3 | 19 | |
| 2-N8C59 | | 1 | | | | | 1 | | 3 | 1 | | 1 | | | 2 | | | | 9 | 9 |
| 2-N8C60 | | 2 | 1 | | 1 | | | | 1 | | | | | 1 | | | | | 6 | 6 |
| 2-N8C61 | | | | | | 1 | | | | | | | | | | | | | 1 | 1 |
| 2-N8C67 | 2 | 2 | | | | | | | | | | | | | | | | | 4 | 4 |
| 2-N9- | | | 1 | | | | | | | | | | | 1 | | | | | 2 | |
| 2-N9EP | 2 | 1 | | 1 | | 1 | | | 1 | | | 1 | | | 1 | | | | 8 | |
| 2-NA- | | | | | | | | | | | | | | | 1 | | | | 1 | |
| 2-SPEP | | | | | | 1 | 1 | | | | | | | | | | | | 2 | |
| 2A-- | 6 | 5 | 5 | | | 2 | | | | 1 | | | 2 | 5 | 1 | | | | 27 | **63** |
| 2A4- | | | 1 | | | 1 | | | | | | | 2 | 2 | | | | | 6 | 6 |
| 2A5- | 1 | 1 | | | | | | | | | | | 1 | | | 2 | | | 5 | 5 |
| 2A6- | 2 | 1 | | | | | | | | | | | 1 | 1 | | | | | 5 | 5 |
| 2A7- | 1 | | | | | | | | | | | 1 | | | | 4 | | | 6 | 6 |
| 2ABTR.2- | 1 | | | | | | | | | | | | | | | | | | 1 | |
| 2ABTR.GL- | 1 | | | | | | | | | | | | | | | | | | 1 | |
| 2APE- | 1 | | | 1 | | 1 | 2 | | | 1 | | | 1 | 3 | 2 | | | | 12 | |
| 2B-- | 3 | 7 | 1 | 1 | 2 | 1 | 1 | 1 | | 3 | 1 | | | 3 | 1 | | | | 25 | **32** |
| 2BH-- | | | | | 1 | | | | | | | | | | 1 | 1 | | | 3 | |
| 2BN2- | | | | | | | | | | 1 | | | | | | | | | 1 | |
| 2BN4C23 | | | | | 1 | | | | | | | | | | | | | | 1 | 1 |
| 2BNICHO- | 1 | | | | | | | | | | | | | 1 | | | | | 2 | |
| 2D-- | 2 | | | | | 1 | | | | | | | | | | | | | 3 | 4 |
| 2D6- | | 1 | | | | | | | | | | | | | | | | | 1 | 1 |
| 2F -- | 1 | 2 | 1 | | | 1 | | | | | | | | | | | | | 5 | 8 |
| 2F-- | | 2 | | | | | | | | | | | | | | 1 | | | 3 | |
| 2H-- | 2 | 1 | 1 | | | 2 | | | | | | | 1 | | | | | | 7 | 7 |

**Table 27. ROOM * Type Large Bifaces Crosstabulation. (Continued)**

| | Axes | | | Preforms | | | | | Subtypes Celts | | | Adzes | | | Bifaces | | | | Structure/ Total | Room Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Room | 4.1 | 4.2 | 4.3 | 10.1 | 10.2 | 10.3 | 10.4 | 10.6 | 11.1 | 11.2 | 11.3 | 12.1 | 12.2 | 12.3 | 17.1 | 17.2 | 17.3 | 17.4 | | |
| 3--- | 6 | | 2 | | 1 | | 1 | | | | | 1 | | 1 | | 5 | | | 17 | **120** |
| 3A--- | | | | | | | | | | | | | | | | | | | | **50** |
| 3A1- | 5 | 1 | 1 | | | | 1 | | | | | | | 2 | | | | | 10 | 10 |
| 3A2- | 1 | | | | | | | | | | | | | | | | | | 1 | 1 |
| 3A3- | 5 | 1 | | 1 | | | | | | | | | | 1 | | | | | 8 | 8 |
| 3A4- | 2 | | | | | | | | | | | 1 | | | | | | | 3 | 3 |
| 3A5- | 6 | | 1 | 2 | | 2 | | | | | | 1 | | | 1 | | | | 13 | 13 |
| 3A6- | 1 | | | | 1 | 1 | | | | | | | | | | | | | 3 | 3 |
| 3A7- | | 1 | | | 1 | | | | | | | | | | 1 | | | | 3 | 3 |
| 3A8- | 1 | | 3 | 2 | | 1 | | | 1 | | | 1 | | | | | | | 9 | 9 |
| 3B--- | | | | | | | | | | | | | | | | | | | | **11** |
| 3B1- | | | 1 | 1 | | | | | | | | | | | | | | | 2 | 2 |
| 3B2- | 1 | | 1 | | | | | | | | | | | 1 | | | | | 3 | 3 |
| 3B3- | 2 | | 1 | | | | | | 1 | | | | | | | | | | 4 | 4 |
| 3B4- | 1 | | | | | | | | | | | | | | | | | | 1 | 1 |
| 3B5- | | | | | | | | | | | | 1 | | | | | | | 1 | 1 |
| 3C-- | 1 | | 1 | | | | | | | | | 1 | | | | | | | 3 | 3 |
| 3D-- | 3 | | | | | | | | 1 | | | | | | | | | | 4 | 4 |
| 3D5- | | | | | | | | | | | | | | | | | 1 | | 1 | 1 |
| 3D6- | 1 | 1 | | | | | | | | | | | | | | | | | 2 | 2 |
| 3D7- | 1 | 1 | | | | | | | 1 | | | | | | | | | | 3 | 3 |
| 3E-- | 1 | | 1 | 1 | 1 | 1 | 2 | 1 | | | | | | | 1 | 1 | | | 10 | 10 |
| 3J-- | | | | | | | | 1 | | | | | | | | | | | 1 | 1 |
| 3L13- | | | 1 | | | | | | | | | | | | | | | | 1 | 1 |
| 3L5- | | | | | | | | | | 1 | | | | | | | | | 1 | 1 |
| 3M-- | 1 | | | | | | | | | | | | | | | | | | 1 | 1 |
| 3N-- | | | | | | | 1 | | | | | | | | | | | | 1 | 1 |
| 3O-- | | | | 1 | | | | | | | | | | | | | | | 1 | 1 |
| 3P-- | | | 1 | | 1 | | 1 | | | | | | | | | 1 | | | 4 | 4 |
| 3Q-- | | | | 2 | 1 | 1 | 1 | | | | | | | | | | | | 5 | 5 |
| 3R-- | | 1 | 1 | 2 | | | | | | | | | | | | | | | 4 | 4 |
| 7E2d | 1 | | | | | | | | | | | | | | | | | | 1 | **2** |
| 7F1- | 1 | | | | | | | | | | | | | | | | | | 1 | 1 |
| Total | 142 | 44 | 47 | 32 | 24 | 32 | 20 | 5 | 25 | 9 | 6 | 22 | 17 | 39 | 25 | 21 | 5 | 3 | 518 | |

In some rooms the concentrations of large bifaces are higher. This includes the more august sectors of the excavations such as pyramid Structure II, summit pyramid IIA (n=63), palace Structure IIB (n=32), and palace Structure IIIA (n=50). Even the whole of pyramid Structure II, zones 7 (n=36) and 8 (n=32) with their unusual counts of artifacts do not match these concentrations. We are forced to consider the possibility that whatever tasks were undertaken in the most socially elevated structures of the excavations they utilized large bifaces in large numbers. This more so than the supporting facilities on the zones of pyramid Structure II.

In palace Structure III, about half (n=63, 55 percent) of the large bifaces (n=114) were from Area A in front of the building. This is about five times the number of bifaces in the rooms with secondary numbers of large bifaces (Area B=32, Area D=4, Room 2=8, Room 4=7). However, these rooms are only about 1/5 the size of Area A, so nothing is particularly out of proportion in terms of area. When area is considered, the large bifaces are more or less uniformly distributed over the palace floor surface.

An important question is whether one type of implement was used more than another in different parts of Structure II. The distributions of large bifaces (***Table 27***) with sufficient numbers to be tested between the zones and palace Structure IIB on Structure II yield insignificant chi-square values (p=0.52). The implication is that bifacial implements were used in equal proportions whether the location be elite or common. The tools had equal utility for both classes of people or for both sizes of rooms.

**Table 28. Summit Palace/Pyramid and Zones of Pyramid Structure II * Large Bifaces.**

| | | Observed | | Expected | | | Observed-Expected | |
|---|---|---|---|---|---|---|---|---|
| | Subtype | Zones 0 | Palaces 1 | Zones 0 | Palaces 1 | Total | Zones 0 | Palaces 1 |
| **Axes** | **4.2** | 18 | 26 | 22.3 | 21.7 | 44 | -4.3 | **4.3** |
| | **4.3** | 25 | 22 | 23.8 | 23.2 | 47 | **1.2** | -1.2 |
| **Preforms** | **10.2** | 14 | 10 | 12.1 | 11.9 | 24 | **1.9** | -1.9 |
| | **10.3** | 17 | 15 | 16.2 | 15.8 | 32 | 0.8 | -0.8 |
| | **10.4** | 11 | 9 | 10.1 | 9.9 | 20 | 0.9 | -0.9 |
| **Celts** | **11.2** | 2 | 7 | 4.6 | 4.4 | 9 | -2.6 | **2.6** |
| | **11.3** | 5 | 1 | 3.0 | 3.0 | 6 | **2.0** | -2.0 |
| **Adzes** | **12.2** | 8 | 9 | 8.6 | 8.4 | 17 | -0.6 | 0.6 |
| | **12.3** | 20 | 19 | 19.7 | 19.3 | 39 | 0.3 | -0.3 |
| **Bifaces** | **17.2** | 11 | 10 | 10.6 | 10.4 | 21 | 0.4 | -0.4 |
| **Total** | | 131 | 128 | 131 | 128 | 259 | | |
| Chi-Square Test | | Value | df | Asymp. Sig. (2-sided) | | | | |
| Pearson Chi-Square | | 8.18 | 9 | 0.52 | | | | |
| N of Valid Cases | | 259 | | | | | | |

4 cells (20.0%) have expected count less than 5. The minimum expected count is 2.97.

A useful observation emerges when the distribution of whole and broken large bifaces are examined between the zones and palace/pyramid on the summit on Structure II. The distributions (***Table 29***) show that the three types of clearly-functional bifaces (axes, adzes, celts) tend to be whole in the palaces and fragmentary on the zones. *We take this to mean that the zones were provisioning the palaces with whole implements. The zones were less concerned about their own use of broken tools. In neither case, however, were the broken implements removed *en mass*? If this were so, let us say in the palace, we would expect exceptionally low frequencies of broken tools and a highly significant chi-square, which does not exist: no *en mass* movements, which is to say "cleaning" of the premises of implements.

The not-so-clearly functional biface types are the preforms and bifaces. Whole preforms nearly conform to expected values between the Structure II summit palaces (especially IIA) and zones; bifaces are more frequent than expected on the zones, whether whole or broken. Perhaps this could be explained as a uniform distribution of bifacial cores to produce flakes for utilization.

Apart from the obvious inverse pattern between zones and the summit pyramid, the overall chi-square statistic is not strong. This homogeneity of the tool distributions can be taken to mean that the large bifaces were used to perform the same functions, and perhaps by the same people, in the palaces and on the zones of Structure II. Whether or not this means that a service cast moved between the two areas needs to be considered. At Caracol Chase and Chase (2011) demonstrated a clear case of food being prepared in the lower reaches of the royal precinct and carried to the upper reaches of the structures.

Comparing the distributions of large bifaces between Structure II and Structure III yields a barely significant chi-square determination (***Table 30***, p=0.036)). In other words, little real difference is found between the proportions of implements between the two structures. This could reflect an underlying continuity of functions for the large bifaces across both structures. The largest anomaly in terms of expected values is a greater-than-expected number of adzes in pyramid Structure II (8.2). As was shown above, the adz use has a peculiar affinity for the summit palace/pyramid on Structure II, and in that location, as is shown here, are an unusual number of whole adzes. *This suggests that adzes were either used for a purpose during which they tended not to be broken, or perhaps, given the elevated social context, they were somehow of more symbolic than utilitarian value.

**Table 29. Large Bifaces Whole and Broken in Zones and Palaces.**

| | Observed | | | Expected | | Observed-Expected | |
|---|---|---|---|---|---|---|---|
| | Zones | Palaces | | Zones | Palaces | Zones | Palaces |
| **Type** | **0** | **1** | **Total** | **0** | **1** | **0** | **1** |
| **Axes 4** | 43 | 48 | 91 | 51.9 | 39.1 | -8.9 | **8.9** |
| **4.1** | 84 | 58 | 142 | 81.0 | 61.0 | **3.0** | -3.0 |
| **Preform 10** | 50 | 41 | 91 | 51.9 | 39.1 | -1.9 | **1.9** |
| **10.1** | 18 | 14 | 32 | 18.3 | 13.7 | -0.3 | 0.3 |
| **Celts 11** | 7 | 8 | 15 | 8.6 | 6.4 | -1.6 | **1.6** |
| **11.1** | 21 | 4 | 25 | 14.3 | 10.7 | **6.7** | -6.7 |
| **Adzes 12** | 28 | 28 | 56 | 32.0 | 24.0 | -4.0 | **4.0** |
| **12.1** | 16 | 6 | 22 | 12.6 | 9.4 | **3.4** | -3.4 |
| **Bifaces 17** | 20 | 12 | 32 | 18.3 | 13.7 | **1.7** | -1.7 |
| **17.1** | 16 | 9 | 25 | 14.3 | 10.7 | **1.7** | -1.7 |
| **Total** | 303 | 228 | 531 | 303 | 228 | | |

| Chi-Square Tests | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 16.29 | 9 | 0.061 |
| N of Valid Cases | 531 | | |

0 cells (.0%) have expected count less than 5. The minimum expected count is 6.44.

The second most notable anomaly is the greater than expected frequency of broken axes in palace Structure III. This is a similar pattern to that of the zones on Structure II discussed above. Apparently whoever was working in palace Structure III, like those in the zones, but unlike those in the summit pyramid Structure IIA on the summit of Structure II, did not care about the presence of broken axes. The remainder of the consistent pattern found on pyramid Structure II of broken and whole implements is not present.

Apparent in palace Structure III is a larger than expected proportion of both whole and broken preforms. If preforms are bifacial cores, then *dominant knapping and use of utilized flakes is implied in palace Structure III.

Celts are concentrated on the summit of Structure II in pyramid Structure IIA and palace Structure IIB (***Table 31***). Although the precise provenience of specimens from the summit of Structure II was lost in the Gilberto flood, it is clear that celts were concentrated in summit palace and pyramid of Structure II. Only one was found in room 8 of palace Structure III and none in pyramid Structure I and Structure VII. Five appeared along the lower zones of Structure II (zones 4-8). None were found in the upper three zones, but nine appeared on the summit. Five were in the Structure IIB palace complex representing the highest concentration. Functionally the celts are highly polished axes and as such probably a status marker.

To summarize, the distributions of tool types through the excavations of Structure II and Structure III suggest some differentiation of the implements, particularly if they are subtyped on size. Subtyping creates categories that are defined both morphologically (ax, adz, celt) and according to size (large, small). Statistical analysis shows little in the way of extreme separation of subtypes among rooms, structures, or parts of structures. This overall homogeneity implies that large bifaces were used for a uniform set of tasks in all parts of the excavated area.

### Table 30. Whole and Broken Large Bifaces from Structures II and III.

| | Artifact types Axes | | Preforms | | Celts | | Adzes | | Bifaces | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Observed** | **4** | **4.1** | **10** | **10.1** | **11** | **11.1** | **12** | **12.1** | **17** | **17.1** | |
| **Str. II 2** | 70 | 100 | 64 | 20 | 14 | 21 | 50 | 16 | 23 | 21 | 399 |
| **Str. III 3** | 21 | 39 | 26 | 12 | 1 | 4 | 5 | 6 | 9 | 3 | 126 |
| **Total** | 91 | 139 | 90 | 32 | 15 | 25 | 55 | 22 | 32 | 24 | 525 |
| **Expected** | | | | | | | | | | | |
| **Str. II 2** | 69.2 | 105.6 | 68.4 | 24.3 | 11.4 | 19.0 | 41.8 | 16.7 | 24.3 | 18.2 | 399 |
| **Str. III 3** | 21.8 | 33.4 | 21.6 | 7.7 | 3.6 | 6.0 | 13.2 | 5.3 | 7.7 | 5.8 | 126 |
| **Total** | 91 | 139 | 90 | 32 | 15 | 25 | 55 | 22 | 32 | 24 | 525 |
| **Observed - Expected** | | | | | | | | | | | |
| **Str. II 2** | 0.8 | -5.6 | -4.4 | -4.3 | **2.6** | **2.0** | **8.2** | -0.7 | -1.3 | **2.8** | |
| **Str. III 3** | -0.8 | **5.6** | **4.4** | **4.3** | -2.6 | -2.0 | -8.2 | 0.7 | 1.3 | -2.8 | |

Chi-Square Tests

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 17.9 | 9 | 0.036 |
| N of Valid Cases | 525 | | |

1 cells (5.0%) have expected count less than 5. The minimum expected count is 3.60.

### Table 31. Celts ROOM * Type Crosstabulation Count and Artifact Map (Bold).

| Struc. | Room Location | Freq. | Zone (rooms) | MAP—Celts (Numbers = Rooms) | | | | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | | | | | | | | | | | | | | | | | | | | |
| II | 2--- | 2 | Unkown | | | | | | | | | | | | | | | | | 2 |
| | 2A-- | 1 | IIA | | | | | | | **X** | **X** | | | | | | | | | 2 |
| | 2APE- | 1 | IIA | | | | | | **X** | **X** | **X** | **X** | **X** | | | | | | | 5 |
| | 2B-- | 4 | IIB | 1 | 7 | | | 2 | | | | 3 | 5 | 4 | 6 | | | | | 0 |
| | 2BN2- | 1 | 2 (8-16) | 8 | 9 | 10 | | 11 | | | | | | | 16 | 12 | 13 | 14 | 15 | 0 |
| | 2-N4C21 | 1 | 4. (19-24) | 18 | | | | | | | | | | | | | | | 17 | 0 |
| | 2-N6C34 | 1 | 6. (32-43) | | 19 | | 20 | | | | | | | | **21** | 22 | 23 | 24 | | 1 |
| | 2-N6C37 | 1 | 6. (32-43) | 25 | 26 | | | | | 27 | 28 | | | | 29 | 30 | 31 | | | 0 |
| | 2-N7C58 | 1 | 7. (44-58) | | 32 | 33 | **34** | 35 | 36 | **37** | 38 | 39 | 40 | | | | 41 | 42 | 43 | 2 |
| | 2-N8C59 | 1 | 8.(59-67) | 44 | 45 | 46 | | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | **58** | 1 |
| | | | | **59** | | | | | | 60 | 61 | 62 | 63 | | | 64 | 65 | 66 | 67 | 1 |
| III | 3L5- | 1 | | A | B | C | D | E | F | G | H | I | J | K | **L** | M | N | O | P | 1 |
| Total | | 15 | | | | | | | | | | | | | | | | | | |

**X** = somewhere in the zone

Given the overall homogeneity, there are, however, minor departures from uniformity that suggest different sorts of rather predictable preferences in different parts of the site. Celts, for example, which represent a significant investment in grinding down the surfaces of axes, appear in the palace Structure IIB on the summit of pyramid Structure II. Adzes in particular, but also other bifaces, are more frequent in the summit rooms of pyramid Structure II. However, when the proportions of whole and broken bifaces are examined, more whole than broken pieces are found in the summit Palace IIB.

In palace Structure III, the distribution of large bifaces is generally nondescript resembling that of the zones of pyramid Structure II more than the summit palace and pyramid on Structure II. This includes a tendency toward broken rather than whole axes. However, a large proportion of both whole and broken preforms, which we take to be bifacial cores for obtaining utilizable flakes, signals a locus of consumption requiring cutting more than the chopping production functions implied elsewhere.

## Ax Tools Kits

The whole and broken axes, adzes and preforms are frequent enough to be treated by numerical analysis rather than visual mapping. The combination can be taken to measure differences in chopping functions (axes and adzes) as opposed to supplying flakes for cutting (preforms). A data matrix of precisely provenienced large bifaces (***Table 32***) shows 199 such specimens. All rows were eliminated from ***Table 27*** (above) that contained general provenience such as simply Structure II without room provenience. Also all rows were eliminated that contained only one implement as they provide no information on tool type associations. Notice that some of the proveniences contain lot numbers at the end after the dash and thus are from parts of rooms.

Factoring the large bifaces (***Table 33***) will reinforce earlier discovered patterns by placing them in the broader context of an artifact type cluster. It will also help identify systematic loci of associations between artifact types.

Factor 1-- <u>Preform or Adz Rooms</u>. Rooms with preforms **(0.5** in ***Table 33***, Factor 1), preform fragments (0.**8**), and ax fragments (**0.4**) tend to occur in palace Structure III (**0.7**). These same rooms tend not to have adzes (**-0.6**) in them. Rooms with adzes (**-0.6**) (Adz rooms), but without preforms, preform fragments, and ax fragments, are on pyramid Structure II. The strongest examples of the factor 1 pattern rooms (scores with standard deviations <or>1.0) are mapped in ***Table 34***. Most of the adz rooms are in two clusters. One is on summit pyramid Structure IIA rooms 4, 5, and 6. The other cluster is on the lower zones to the right of the principle staircase rooms 30 and 31. The pyramid Structure IIA association reinforces earlier discoveries of adz concentrations on the summit of Structure II (see above). *The finding of a cluster of adzes near the bottom of Structure II façade right side adds new information and suggests an adz-related workshop or area. Adzes are usually considered to be of use in working wood such as squaring beams.

The preform rooms in palace Structure III are a cluster of lots on the portico and three interior rooms. If preforms are bifacial cores, then *the making of flakes in palace Structure III was probably for purposes of on-the-spot consumption, perhaps in food preparation or consumption. This pattern reinforces what was discovered earlier. A single preform room appears on the right side of Structure II facade in room 12.

Factor 2 <u>Ax Adz Preform (AAP) Rooms</u>. In some set of rooms not associated with either structure, axes (0.5), preforms (0.6), and adzes (0.4) tend to occur together. These same rooms tend not to have adz fragments (-0.6). The rooms with the Factor 2 combination occur in both structures (***Table 35***). The AAP rooms (red) are concentrated in the elite buildings D, F, H on the summit of Structure II. Also the back rooms of palace Structure III, rooms E, Q, R. One of the two AAP rooms outside elite circumstances is room 60, which also contained 7,000 mostly secondary flakes. *This suggests that at least part of this pattern is the use of “preforms” as bifacial cores from which to make utility flakes.

The rooms with adz fragments are also widely scattered, only appearing to cluster in Structure III back rooms. One room on the right side of Structure II façade contains adz fragments (23), the rest only one.

**Table 32. Precisely Provenienced Large Bifaces.**

| Frag | Ax (4) | Ax Frag (4.1) | Preform (10) | Preform Frag (10.1) | Celt (11) | Celt Frag (11.1) | Adz (12) | Adz Frag (12.1) | Total |
|---|---|---|---|---|---|---|---|---|---|
| 2A4- | 1 | | 1 | | | | 4 | | 6 |
| 2A5- | 1 | 1 | | | | | 1 | | 3 |
| 2A6- | 1 | 2 | | | | | 2 | | 5 |
| 2A7- | | 1 | | | | | | 1 | 2 |
| 2BNICHO- | | 1 | | | | | 1 | | 2 |
| 2D-- | | 2 | 1 | | | | | | 3 |
| 2F -- | 5 | 1 | 1 | | | | | | 7 |
| 2H-- | 2 | 2 | 2 | | | | 1 | | 7 |
| 2-N2C08 | 1 | 2 | | | | | | | 3 |
| 2-N2C12 | 2 | 6 | 1 | 1 | | 1 | | 1 | 12 |
| 2-N4C23 | | 1 | | | | | | 2 | 3 |
| 2-N5C30 | 1 | | | | | | 1 | | 2 |
| 2-N5C31 | | 2 | | | | 1 | 2 | | 5 |
| 2-N6C34 | | 2 | | | 1 | | | | 3 |
| 2-N6C37 | 1 | | 1 | | 1 | | 1 | | 4 |
| 2-N7C44 | 1 | 1 | 2 | 2 | | | 1 | | 7 |
| 2-N7C52 | | | 1 | | | | 1 | | 2 |
| 2-N7C57 | 3 | | 1 | | | | 2 | | 6 |
| 2-N7C58 | | | 2 | | 1 | | | | 3 |
| 2-N7EP | | 1 | | | | | 2 | | 3 |
| 2-N8C59 | 1 | | 1 | | 1 | 3 | | 1 | 7 |
| 2-N8C60 | 3 | | 2 | | | 1 | 1 | | 7 |
| 2-N8C67 | 2 | 2 | | | | | | | 4 |
| 2-N9- | 1 | | | | | | 1 | | 2 |
| 3A1- | 2 | 5 | 2 | | | | 2 | | 11 |
| 3A3- | 1 | 5 | | 1 | | | 1 | | 8 |
| 3A4- | | 2 | | | | | | 1 | 3 |
| 3A5- | 1 | 6 | 2 | 2 | | | | 1 | 12 |
| 3A6- | | 1 | 2 | | | | | | 3 |
| 3A7- | 1 | | 1 | | | | | | 2 |
| 3A8- | 3 | 1 | 1 | 2 | | 1 | | 1 | 9 |
| 3B1- | 1 | | | 1 | | | | | 2 |
| 3B2- | 1 | 1 | | | | | 1 | | 3 |
| 3B3- | 1 | 2 | | | | 1 | | | 4 |
| 3C-- | 1 | 1 | 1 | | | | | 1 | 4 |
| 3D-- | | 3 | | | | 1 | | | 4 |
| 3D6- | 1 | 1 | | | | | | | 2 |
| 3D7- | 1 | 1 | | | | 1 | | | 3 |
| 3E-- | 1 | 1 | 5 | 1 | | | | | 8 |
| 3P-- | 1 | | 2 | | | | | | 3 |
| 3Q-- | | | 3 | 2 | | | | | 5 |
| 3R-- | 2 | | 1 | 2 | | | | | 5 |
| **Total** | 44 | 57 | 36 | 14 | 4 | 10 | 25 | 9 | 199 |

**Table 33. Factor Analysis of Precisely Provenienced Large Bifaces. Structure numbers 2(II) and 3(III) are included to discriminate between structures: positive loadings on tools correlates with III and negative with II.**

| | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Communality |
|---|---|---|---|---|---|---|
| | Preform or Adz Rooms | Ax, Adz & Preforms | Axes | Axe & Adz Fragments | | |
| **AX (4)** | 0.1 | **0.5** | **0.6** | **-0.4** | **-0.5** | .99 |
| **AxFrag (4.1)** | **0.4** | -0.3 | **0.6** | **0.5** | 0.0 | .81 |
| **Preform (10)** | **0.5** | **0.6** | -0.1 | -0.1 | **0.4** | .72 |
| **PreformFrag (10.1)** | **0.8** | 0.3 | 0.1 | 0.0 | 0.3 | .84 |
| **Adz (12)** | **-0.6** | **0.4** | 0.3 | **0.4** | 0.3 | .90 |
| **AdzeFrag (12.1)** | 0.4 | **-0.6** | 0.3 | **-0.4** | 0.3 | .85 |
| **Structure** | **0.7** | 0.0 | -0.3 | **0.4** | **-0.4** | |
| Cumulative % Var. | 28 | 47 | 62 | 75 | 86 | |

Extraction Method: Principal Component Analysis.

**Table 34. Room Distribution of Factor 1 Scores (Preforms vs. Adzes) Artifact Map.**

| Adz Rooms | Preform Rooms | Zones (rooms) | MAP—Factor 1, Preform+ and Adz- Rooms (Numbers = Rooms) | | | |
|---|---|---|---|---|---|---|
| <-1.0 | >+1.0 | | | | | |
| 2A4- | 2-N2C12 | | | | | Legend: |
| 2-N7EP | 3R-- | IIA | 1 2 3 **4** **5** | **6** 7 | | **X > +1.0** |
| 2-N5C31 | 3Q-- | IIB | A B C D E | F G H I **X** | | Preform Rooms |
| 2A6- | 3E-- | 1 (1-7) | 1 7 2 | 3 5 4 | 6 | **X < - 1.0** |
| 2-N7C57 | 3A8- | 2 (8-16) | 8 **9** 10 11 | | 16 **12** 13 14 15 | Adz Rooms |
| 2-N5C30 | 3A5- | 3 (17-18) | 18 | | 17 | |
| 2-N9- | | 4. (19-24) | 19 20 | | **21** 22 23 24 | |
| 2BNICHO- | | 5. (25-31) | 25 26 | 27 28 | 29 **30** **31** | |
| 2A5- | | 6. (32-43) | 32 33 **34** 35 | 36 **37** 38 39 40 **X** | 41 42 43 | |
| | | 7. (44-58) | 44 45 46 47 | 48 49 50 51 52 53 | 54 55 56 **57** **58** | |
| | | 8.(59-67) | **59** | 60 61 62 63 | 64 65 66 67 | |
| | | IIIA&B | 1 2 3 4 **5** 6 7 **8** B 1 2 3 4 5 6 7 | | | |
| | | IIIC-R | C D **E** F G H I J K L M N O P **Q** **R** | | | |

**X** = somewhere in the zone. Palace Structure III rooms are published as 1, 2, 3 rather than A, B, C, … in Folan et al. 1995.

**Table 35. Room Distribution of Factor 2 Scores Ax-Adze-Preform Artifact Map.**

| Struc.Adz Frags. | AAP Rooms | Zones (rooms) | MAP—Factor 2, Ax-Adze-Preform Rooms (Numbers = Rooms) | | | |
|---|---|---|---|---|---|---|
| <-1.0 | >+1.0 | | | | | |
| 2-N4C23 | 2H-- | | | | | Legend: |
| 3A4- | 3R-- | IIA | 1 2 3 **4** 5 | 6 **7** **X** | | **X > +1.0** |
| 2A7- | 3Q-- | IIB | A B C D E | **F** G **H** I | | AAP Rooms |
| 2-N2C12 | 2-N7C44 | 1 (1-7) | 1 7 2 | 3 5 4 | 6 | **X < - 1.0** |
| 3D-- | 2A4- | 2 (8-16) | 8 9 10 11 | | 16 **12** 13 14 15 | Adz Frags |
| 3C-- | 2F -- | 3 (17-18) | 18 | | 17 | |
| | 2-N7C57 | 4. (19-24) | 19 20 | | 21 22 **23** 24 | <-2 adz fragments |
| | 2-N8C60 | 5. (25-31) | 25 26 | 27 28 | 29 30 31 | |
| | 3E-- | 6. (32-43) | 32 33 34 35 | 36 37 38 39 40 | 41 42 43 | |
| | | 7. (44-58) | **44** 45 46 47 | 48 49 50 51 52 53 | 54 55 56 57 58 | |
| | | 8.(59-67) | 59 | **60** 61 62 63 | 64 65 66 67 | |
| | | IIIA&B | 1 2 3 **4** 5 6 7 8 B 1 2 3 4 5 6 7 | | | |
| | | IIIC-R | **C** **D** **E** F G H I J K L M N O P **Q** **R** | | | |

**X** = somewhere in the zone. Palace Structure III rooms are published as 1, 2, 3, …, rather than A, B, C, …, in Folan et al. (1995).

Factor 3 Ax Rooms. In some set of rooms, axes and ax fragments occur together (***Table 35***). Over half of the rooms (lots) with the ax/ax fragment combination are on the portico of Structure III. Taken together with factor 2, *the palace Structure III portico Area A emerges as a locus of substantial activities such as chopping, or where the tools for these were kept. Most of the non-ax rooms (not mapped) are also in palace Structure IIB but in the interior rooms.

**Table 36. Room Distribution of Factor 3 Scores Ax Artifact Map.**

| Struc.Non-ax Rooms | Ax Rooms List | Zones (rooms) | MAP—Factor 3, Ax Rooms (Numbers = Rooms) | | | |
|---|---|---|---|---|---|---|
| <-1.0 | >+1.0 | | | | | |
| | 3A8- | | | | | Legend: |
| | 2-N7C57 | IIA | 1 2 3 4 5 | 6 7 X | | **X > +1.0** |
| | 3A3- | IIB | A B C D E | **F** G H I | | Ax Rooms |
| | 3A1- | 1 (1-7) | 1 7 2 | 3 5 4 | 6 | **X < - 1.0** |
| | 3A5- | 2 (8-16) | 8 9 10 11 | | 16 **12** 13 14 15 | |
| | 2F -- | 3 (17-18) | 18 | | 17 | |
| | 2-N2C12 | 4. (19-24) | 19 20 | | 21 22 23 24 | |
| | | 5. (25-31) | 25 26 | 27 28 | 29 30 31 | |
| | | 6. (32-43) | 32 33 34 35 | 36 37 38 39 40 | 41 42 43 | |
| | | 7. (44-58) | 44 45 46 47 | 48 49 50 51 52 53 | 54 55 56 **57** 58 | |
| | | 8.(59-67) | 59 | 60 61 62 63 | 64 65 66 67 | |
| | | IIIA&B | **1** **2** 3 4 **5** 6 7 **8** B 1 2 3 4 5 6 7 | | | |
| | | IIIC-R | C D E F G H I J K L M N O P Q R | | | |

**X** = somewhere in the zone. Palace Structure III rooms are published as 1, 2, 3 rather than A, B, C, … in Folan et al. (1995).

Factor 4 Axes and Adzes. Ax fragments (**0.5**) and whole adzes (**0.4**) tend to occur together in palace Structure III (**0.4**). In pyramid Structure II, whole axes (**-0.4**) and adz fragments (**-0.4**) also co-occur. This seems to suggest some sort of cross relationship between ax and adz production and use, and differentiated associations between structures. Two observations arise from the mapping of these relationships (***Table 37***). One is that the presence of axes and adzes and their fragments on the portico of palace Structure III, once again reinforces the impression of heavy workmanship there. Furthermore, in pyramid Structure II, Room II-60, the lithic workshop, axe and adz fragments could point to the manufacture of these implements, possibility suggested by the presence of several thousand waste flakes there.

**Table 37. Room Distribution of Factor 4 Scores Artifact Map (Bold).**

| .Ax-Adz Frag | . Ax Frag-Adz | Zones (rooms) | MAP—Factor 4, Ax-Adz Cross (Numbers = Rooms) | | | |
|---|---|---|---|---|---|---|
| Z<-1.0 | Z >+1.0 | | | | | |
| -2.22F -- | 1.13A5- | | | | | Legend: |
| -2.12-N4C23 | 1.32-N5C31 | IIA | 1 2 3 4 5 | 6 **7** X | | **X > +1.0** |
| -1.92-N8C59 | 1.53D-- | IIB | A B C D E | **F** G H I | | Ax Frag-Adz |
| -1.53A8- | 2.13A1- | 1 (1-7) | 1 7 2 | 3 5 4 | 6 | **X < - 1.0** |
| -1.42-N8C60 | 2.33A3- | 2 (8-16) | 8 9 10 11 | | 16 12 13 14 15 | Ax-Adz Frag |
| -1.12A7- | | 3 (17-18) | 18 | | 17 | |
| | | 4. (19-24) | 19 20 | | 21 22 **23** 24 | |
| | | 5. (25-31) | 25 26 | 27 28 | 29 30 **31** | |
| | | 6. (32-43) | 32 33 34 35 | 36 37 38 39 40 | 41 42 43 | |
| | | 7. (44-58) | 44 45 46 47 | 48 49 50 51 52 53 | 54 55 56 57 58 | |
| | | 8.(59-67) | **59** | **60** 61 62 63 | 64 65 66 67 | |
| | | IIIA&B | **1** 2 **3** 4 **5** | 6 7 **8** B 1 | 2 3 4 5 6 7 | |
| | | IIIC-R | C **D** E F G | H I J K L M | N O P Q R | |

**X** = somewhere in the zone. Palace Structure III rooms are published as 1, 2, 3 rather than A, B, C, … in Folan et al. (1995).

An examination of the factor scores shows that this association is fragile as it only involves a couple of dozen artifacts. It therefore must be taken as suggestive. It is, however, intriguing and might signal an important set of relationships or just a chance set of proportions among artifacts that commonly co-occur.

Factor 5. Axes and preforms tend not to occupy the same rooms. The axes are in palace Structure III and the preforms are in Structure II. The mapped pattern (***Table 38***) seems to support the contention that *heavier (ax) activities were performed on the portico of the palace Structure III. Concentrations of *preforms appear on the lower reaches of the Structure II.

**Table 38. Room Distributions of Factor 5 Scores Axes and Preforms Artifact Map.**

| Struc.Axes | Preforms | Zones (rooms) | MAP—Factor 5, Preforms-Axes (Numbers = Rooms) | | | |
|---|---|---|---|---|---|---|
| <-1.0 | >+1.0 | | | | | |
| 2F -- | 2-N7C52 | | | | | Legend: |
| 3B3- | 2-N7C58 | IIA | 1 2 3 **4** 5 | 6 7 X | | **X > +1.0** |
| 3D6- | 3A5- | IIB | A B C D E | **F** G H I | | Preforms |
| 3D7- | 3E-- | 1. (1-7) | 1 7 2 | 3 5 4 | 6 | **X < - 1.0** |
| 2-N8C67 | 3Q-- | 2. (8-16) | 8 9 10 11 | | 16 12 13 14 15 | Axes |
| 3B2- | 2-N4C23 | 3 (17-18) | 18 | | 17 | |
| 3B1- | 2A4- | 4. (19-24) | 19 20 | | 21 22 **23** 24 | |
| 3A7- | 2-N7C44 | 5. (25-31) | 25 26 | 27 28 | 29 30 31 | |
| 3D-- | | 6. (32-43) | 32 33 34 35 | 36 37 38 39 40 | 41 42 43 | |
| | | 7. (44-58) | **44** 45 46 47 | 48 49 50 51 **52** 53 | 54 55 56 57 **58** | |
| | | 8. (59-67) | 59 | 60 61 62 63 | 64 65 66 **67** | |
| | | IIIA&B | 1 2 3 4 **5** 6 **7** 8 B **1** **2** **3** 4 5 6 7 | | | |
| | | IIIC-R | C **D** **E** F G H I J K L M N O P **Q** R | | | |

**X** = somewhere in the zone. Palace Structure III rooms are published as 1, 2, 3 rather than A, B, C, … in Folan et al. (1995).

Summary. The distribution of large bifaces across the excavations seems to reflect a great deal of commonality between the various areas of the excavations. It suggests that similar functions were performed in all three major vicinities, the summit palace of Structure IIB, the zones of Structure II, and the rooms and porticos of palace Structure III. Some anomalies may be significant. *Celts seem to hold an interesting, perhaps non-utilitarian, position on the summit of Structure II. *More broken pieces of axes, adzes and preforms are found on the zones of Structure II and in palace Structure III. Structure III is marked by more than the expected numbers of broken axes and whole and broken preforms.

## Points (Artifact Type 3)

Points, or "projectile points," form a significant portion of the lithic assemblage. The total collection of points consists of 475 specimens with a mean weight of 23.6 g (std dev 15.8). Because of the distinctive morphology of points, it was possible to discriminate between whole and broken specimens. The whole points were 320 in number and the mean weight is 25.7 g (std dev 17.43). The distribution of weight is strongly skewed by two points of unusual weight (*Figure 26*). One point weighting 207 g of jasper is clearly a very large ceremonial object. A second outlier of 114 g was a large, thick, straight stemmed specimen of dark brown chert. It is of the type identified by Rovner (1975; Rovner and Lewenstein 1998) as associated with the Puuc Hills lithics assemblages and nearby regions such as Becan. Without these outliers the statistical population settles in at a mean of 24.8 g (std dev 13.8). There are no multiple modes in the size distribution, so all subtypes were defined on the basis of point morphology using traditional categories.

## A Theory of Points

The functional character of points as understood from their morphology has been a sustained interest in the lithic technology community virtually since its inception (Hughes 1998; Gunn and Prewitt 1975). A pivotal breakthrough was the realization that so-called "projectile points" contained a great deal of variation that undoubtedly includes knives but is not limited to knives. More recent studies (Gunn and Brown 1982; Hughes 1998) have resorted to sophisticated engineering analyses of penetration and flight properties to achieve a more comprehensive understanding of points. Points remain a justifiable focus of research because for whatever reason, they always seem to have been a locus of stylistic and functional morphological design, the engineering fixations, of many past societies. Of course, since we are largely dealing with the imperishable aspect of archaeological societies, we must add that we are viewing them through the hard-technological side of their overall extrasomatic equipage.

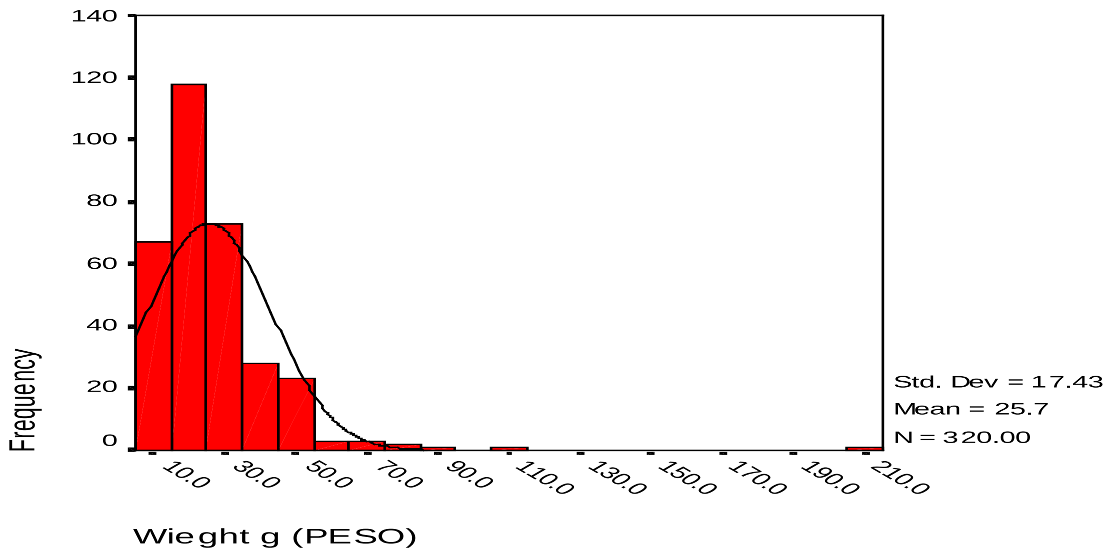


**Figure 26. Weights of Whole Points.**

The distinctions between projectiles and knives, and probably other functions, are clearly evident in the Calakmul assemblage. Many of its points, and others from all over the Americas, exhibit blunt and even round tips on wide blades that would be inappropriate for any kind of projectile (***Figure 27***E). On the other hand, there are specimens that possess slim, thin blades and needle-sharp tips that would be entirely appropriate on the end of a weapon (***Figure 27***A&D). In the Calakmul assemblage they range in sizes that suggest atlatl darts and spears, but nothing fits the usually recognized small profile of an arrow projectile point. However, anything with a point can be used as an arrow point such as thorns, bone, and other perishable materials. For that reason, the absence of arrow points does not preclude the presence of bow and arrow technology in the living assemblages.

To understand the potential range of applications of point-like implements, the following model is offered. It is drawn from various previous research projects. In this concept, the point is viewed as being designed to sustain various stresses that it will be subjected to during its useful life. These stresses can either be point on or lateral. These stress sources suggest the following forms and constraints to meet the requisite conditions.

Penetrating. This design is most likely some sort of projectile or thrusting design engineered to sustain substantial stress on impact (point stress) such as when a spear, dart, or arrow strikes a target (***Figure 27*A**). The base has to be robust. Thus, the penetrating point will have a needle-sharp tip, a narrow blade and wide base following. The exceptional case is piercers such as those found by Gunn and Stanyard (Gunn and Stanyard 1999) in a Late Archaic site in the US. Hafted piercers had needle sharp tips but robust and ill-formed or deformed (from sharpening) blades.

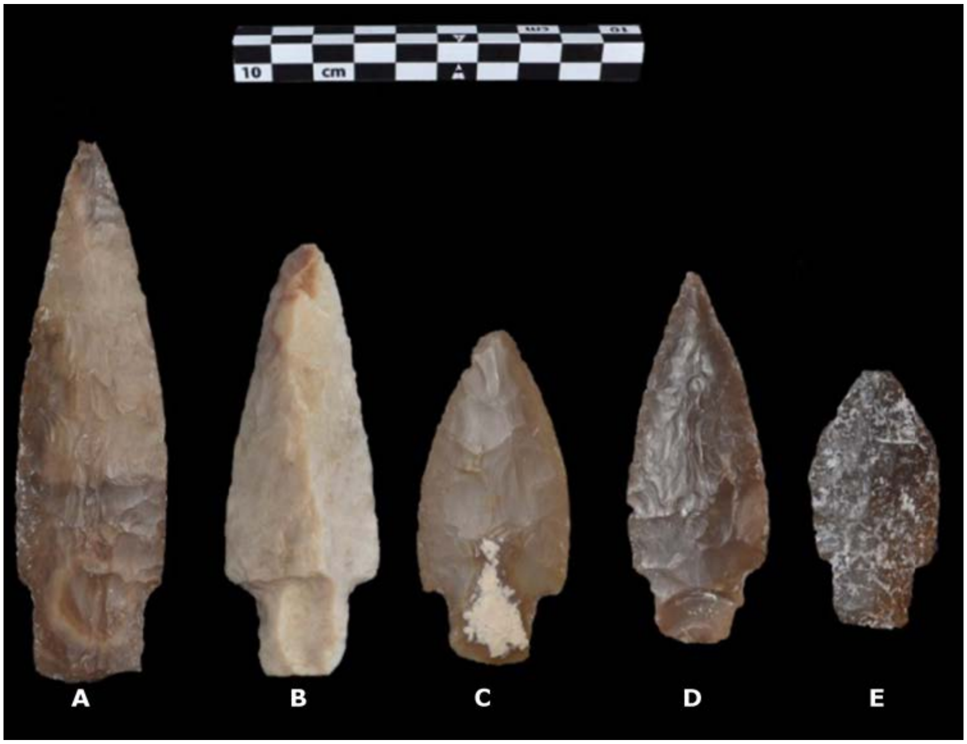


**Figure 27. Sample of pointed (left) and rounded (right) tipped stemmed points.**

Slicing. Slicing points are designed to sustain lateral stress (**see *Figure 27*B&C&E**) (Gunn and Brown 1982).

Drawing. The sophisticated Calakmul assemblage of "points" bring our attention to another point function. The draw point is intended to cut easily tractable material that can sustain and benefit from a clean cut. Meat is an example. The handle, probably hafted, of a draw point would be engineered to remove the hand of the user from interfering with the motion, and thus be offset at an angle. A kitchen cleaver is a modern example.

## A Typology of Calakmul Points

To organize a typology of the Calakmul points, they were laid out on a table and sorted into categories of like specimens. Consideration was given to standard forms of stem and notched shape such as basal (straight, concave, convex), stem form (contacting, straight, expanding), notch (basal, corner, side), length, width, and thickness. A large number of references are available for point typologies. The ones that the authors are most familiar with are Suhm and Jelks (Suhm 1962) and Coe (1964). Some reference is therefor made to these standard works. However, as in all regions, the Maya lowlands are a unique expression of human adaptation of a widely available mineral, silica, found locally in a number of forms depending on geological conditions, and traded in some cases from distant places as taste and need dictate. Additional methodological and regional insights were obtained from works by Rovner (1975).

The point types observed in the Calakmul collection were numbered to conform to the general lithics coding protocol (***Table 39***). They were assigned decimal values following the number 3 which is the general number for points. Point fragments were assigned 3.11 if they could not be identified as a type.

***Table 40*** shows descriptive statistics for the weights of the typeable points and the Maximum Width and Neck Width (narrowest dimension of the haft) of selected whole points. An analysis of variance (***Table 41***) shows that the types are significantly different from each other on these dimensions. The type descriptions that follow provide the basic data of one of the recognized types along with examples.

**Table 39. Numbers and Names of Calakmul Point Types.**

| No. | Name | Morphology |
|---|---|---|
| 3.1. | Pointed | stemmed |
| 3.2. | Small | stemmed |
| 3.3. | Bipoint | |
| 3.4. | Lanceolate | |
| 3.5. | Expanding | stemmed |
| 3.6. | Contracting | stemmed |
| 3.7. | Side | notched |
| 3.8. | Broad | stemmed |
| 3.9. | Broad | stemmed spatulated |
| 3.11 | unidentifiable point | fragment |

**Table 40. Descriptive Statistics on Point Types.**

| | Point Types | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Mini-mum | Maxi-mum |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound | | |
| Weight g | 3.1 | 25 | 15.5 | 6.9 | 1.4 | 12.6 | 18.3 | 6 | 35 |
| | 3.2 | 12 | 19.6 | 5.3 | 1.5 | 16.2 | 23.0 | 11 | 27 |
| | 3.3 | 9 | 46.9 | 18.0 | 6.0 | 33.1 | 60.7 | 26 | 90 |
| | 3.4 | 40 | 26.3 | 12.9 | 2.0 | 22.2 | 30.4 | 10 | 68 |
| | 3.5 | 55 | 25.4 | 16.5 | 2.2 | 21.0 | 29.9 | 9 | 114 |
| | 3.6 | 51 | 24.3 | 10.6 | 1.5 | 21.3 | 27.2 | 5 | 54 |
| | 3.7 | 31 | 28.0 | 11.2 | 2.0 | 23.9 | 32.1 | 8 | 50 |
| | 3.8 | 27 | 25.2 | 7.2 | 1.4 | 22.3 | 28.0 | 11 | 48 |
| | 3.9 | 8 | 45.4 | 20.5 | 7.2 | 28.2 | 62.5 | 21 | 77 |
| | Total | 258 | 25.8 | 13.9 | 0.9 | 24.1 | 27.5 | 5 | 114 |
| Max. Width | 3.1 | 3 | 27.0 | 4.6 | 2.6 | 15.6 | 38.4 | 22 | 31 |
| | 3.2 | 2 | 27.5 | 0.7 | 0.5 | 21.1 | 33.9 | 27 | 28 |
| | 3.3 | 3 | 44.3 | 9.0 | 5.2 | 22.1 | 66.6 | 34 | 50 |
| | 3.4 | 5 | 26.8 | 5.4 | 2.4 | 20.1 | 33.5 | 22 | 36 |
| | 3.5 | 2 | 52.0 | 21.2 | 15.0 | -138.6 | 242.6 | 37 | 67 |
| | 3.6 | 4 | 38.3 | 5.9 | 2.9 | 28.9 | 47.6 | 32 | 45 |
| | 3.7 | 6 | 40.3 | 6.9 | 2.8 | 33.1 | 47.6 | 32 | 50 |
| | 3.8 | 3 | 43.3 | 3.8 | 2.2 | 33.9 | 52.7 | 39 | 46 |
| | 3.9 | 2 | 55.5 | 2.1 | 1.5 | 36.4 | 74.6 | 54 | 57 |
| | Total | 30 | 38.1 | 11.1 | 2.0 | 33.9 | 42.3 | 22 | 67 |
| Neck Width | 3.1 | 3 | 16.7 | 3.1 | 1.8 | 9.1 | 24.3 | 14 | 20 |
| | 3.2 | 2 | 13.8 | 1.8 | 1.3 | -2.1 | 29.6 | 12.5 | 15 |
| | 3.3 | 3 | 29.0 | 4.6 | 2.6 | 17.6 | 40.4 | 24 | 33 |
| | 3.4 | 5 | 21.0 | 5.7 | 2.5 | 14.0 | 28.0 | 15 | 28 |
| | 3.5 | 2 | 29.3 | 1.8 | 1.3 | 12.8 | 45.8 | 28 | 30.6 |
| | 3.6 | 4 | 20.8 | 5.9 | 3.0 | 11.4 | 30.3 | 15.3 | 29 |
| | 3.7 | 6 | 23.0 | 5.4 | 2.2 | 17.3 | 28.6 | 15 | 28.9 |
| | 3.8 | 3 | 31.3 | 1.2 | 0.7 | 28.5 | 34.2 | 30 | 32 |
| | 3.9 | 2 | 33.5 | 2.1 | 1.5 | 14.4 | 52.6 | 32 | 35 |
| | Total | 30 | 23.7 | 6.9 | 1.3 | 21.1 | 26.3 | 12.5 | 35 |

**Table 41. Analysis of Variance of Point Types.**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Weight g | Between Groups | 10494.1 | 8 | 1311.8 | 8.4 | <0.001 |
| | Within Groups | 38826.0 | 249 | 155.9 | | |
| | Total | 49320.1 | 257 | | | |
| Max Width | Between Groups | 2453.5 | 8 | 306.7 | 5.6 | 0.001 |
| | Within Groups | 1143.2 | 21 | 54.4 | | |
| | Total | 3596.7 | 29 | | | |
| Neck Width | Between Groups | 933.1 | 8 | 116.6 | 5.4 | 0.001 |
| | Within Groups | 451.7 | 21 | 21.5 | | |
| | Total | 1384.9 | 29 | | | |

The perspective we take in this analysis is that points differ in the stresses they are intended to bear in use:

> [Treating points as] levers, the base is the effort arm of a point and the blade--the load arm. Such an identification allows an examination of various point styles in the context of the equilibrium potential of the various point forms. Figure 67 illustrates some well-known point styles consistently divided at the blade-haft interface. Lanceolates have a prominent effort arm, perhaps one-fourth to one-third the length of the load arm. In contrast, notches have the effort arm embedded in the load arm, and it is proportionally so short that it is almost vestigial. (Gunn and Brown 1981: 246-248)

## Point Type Descriptions.

Point types are described in a shorthand that follows this formula: Description>Workmanship>Crossection>Material>Color. A zero in a field means the component of the description is not included and not relevant to the point type.

### Pointed stemmed (3.1)

Pointed stemmed type (***Figure 28***) has a haft that narrows to a point from the widest dimension of the implement. It is distinctly like the Morrow Mountain (Coe 1964) points of Eastern United States. Morrow Mountain, however, dates to at least 3,000 years earlier than Calakmul. Example: >Fine to Medium>Biconvex>0>0.

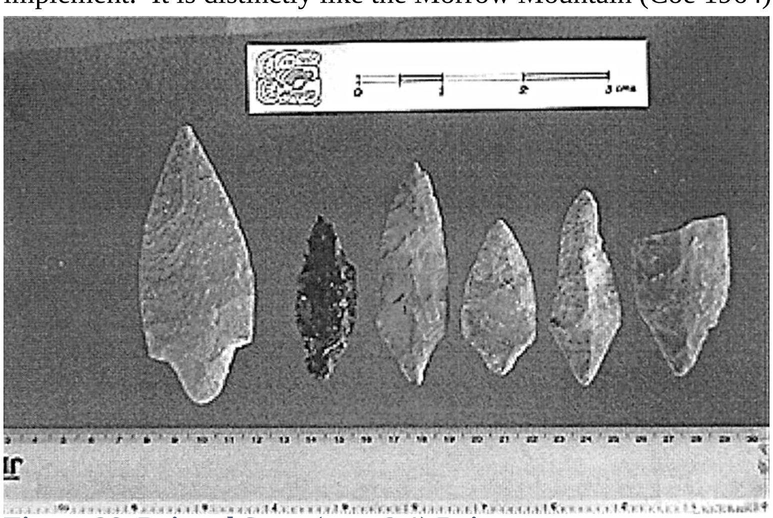

**Figure 28. Pointed Stem (type 3.1) Points.**

### Small straight stemmed (3.2)

The small stem type (***Figure 29***) has a distinctive diminutive stem, generally slightly asymmetrical. The morphology is generally long and of medium thickness. The workmanship is medium to crude.>varies>0>0

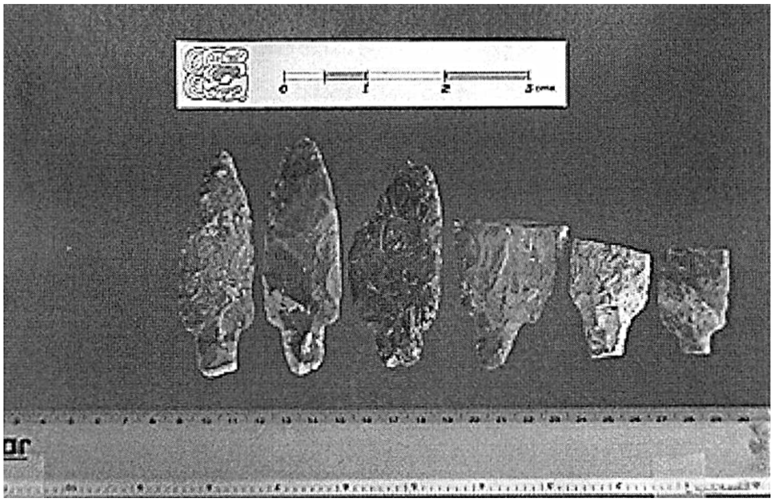

Figure 29. Small Stem (type 3.2) Points.

Small straight stemmed, thick points on exotic materials, retouch and resharpenning is a little rough. They resemble small Savannah River Points of the southeastern United States, >medium>Biconvex>Tuff>Black. Specimen **Figure 27**C has a convex side. The plano-convex cross section probably indicates it was made on a flake. Most are neatly biconvex in cross section. Rovner (1975) believes this type occurred in Preclassic and Terminal Classic times but not during the Early and Late Classic. Example: >medium>Plano-convex> Jasper> Yellow.

## Bipoint (3.3)

Bipoints are pointed, though not needle sharp, on both ends (***Figure 30***). They are unusually wide across the middle section. The bipoint bifaces are nicely thinned. On one of the bipoints, one end is sharp and the other seems to have been broken creating a small shoulder. >fine>Biconvex>Mottled chert>Black

Figure 30. Bipointed (type 3.3) Points.

## Lanceolate (3.4)

Lanceolates are long and narrow with parallel sides (***Figure 31***). If these points were found on the east coast of the U.S., they would be classified as Guilfords of the fine variety (Coe 1964). Example: Basil fragment with an incurvate base. Example: >medium>Biconvex>Novaculite>Tan and black mottled. The large lanceolates are works of knapper art (see also specimens 2A P\E 1418 and 2A P.E. 1631). However, it is clear that they had utilitarian life histories. Three lanceolates have been shortened to 40-50 mm by resharpenning. They range up to 150 mm in length and have thick (20 mm) to thin (7 mm) cross sections suggesting varied applications. The lanceolates are distinguished from the bipoints (maximum width = 50 mm) by rounded bases and a narrower width (maximum width = 36 mm). The bipoints also have a distinctive flat cross section while the lanceolates are carefully biconvex.

Figure 31. Lanceolate (type 3.4) Points.

### Straight-expanding stem (3.5)

Straight-expanding stems are generally long and thick (***Figure 32***). The stems tend to be rather squarish to rectangular with slightly convex bases. Straight-Expanding stems have stems that are parallel to expanding in outline. This contrasts with the wide, short stems of the broad stems (type 3.8). One reconstructed point shows evidence of end-on impact fractures on both sides of the tip. The stem expands toward a straight base. Example: >medium>Biconvex>Tuff>Black. Many of the stems are flat across the base because they were platform remnants. Some tendency was found for small stems and straight stems to overlap. The small stems, however, have the oblique stem axis and tend to be long narrow blades. The straight stems are more robust than most point types, both in thickness and width of the blade.

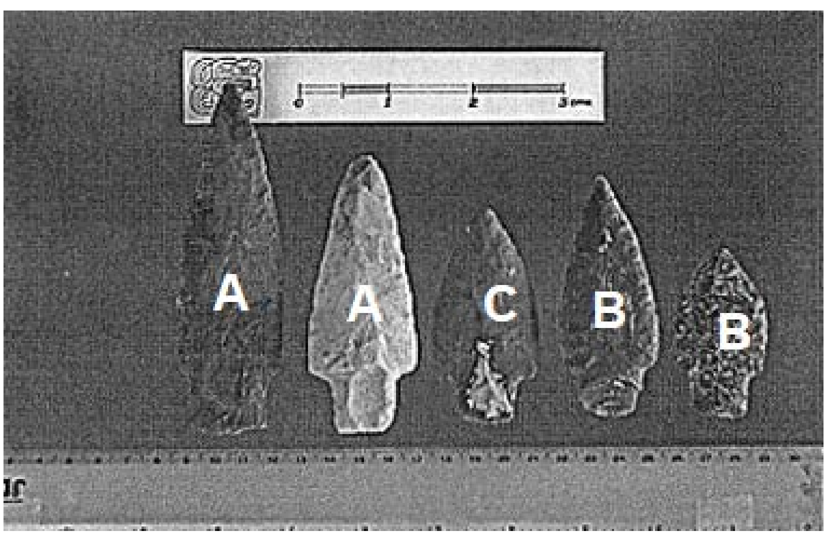


Figure 32. Straight Stem (type 3.5) Points.

Three varieties of straight stemmed points are evident.

A. The **standard variety** is most frequent (n=55, see ***Table 40***. ***Figure 32***A). It exhibits a pronounced shoulder, a long lanceolate blade, and varies greatly in thickness. Rovner (1998:73, d-3) illustrates two of a number of long, narrow, stemmed points from Becan. He reports that they are found at Xpuhil, in the Puuc Hills, and at Dzibilchaltun, but not at Chicanná (Rovner 1981).
B. The **barbed variety** is short, usually relatively thick, sometimes made on a flake with the curvature of the inner face of the flake evident, and has a pronounced shoulder, sometimes approaching a Christmas tree outline (see ***Figure 32*** C). Rovner believes this morphology is characteristic of the Preclassic and Postclassic, but infrequent between the two periods.
C. A **robust variety** (n=4, see ***Figure 32*** B) has a very slight shoulder, and ranges from 11-14 mm in thickness. The blades are distinctly lanceolate and all are broken in mid blade.

## Contracting stemmed (3.6)

Two varieties of **contracting stemmed** points are evident, long (left) and short (right). The short stems range from shouldered to Christmas tree-like (center). The long stems include one incurvate base. Generally the bases are convex or straight, often on a platform. Contracting stems are distinguished from pointed stems by a slight shoulder, a generally large format and 1-2 cm of straight to convex base. One specimen has a concave base (3.A.6.10). >>>0>0

## Side notches or side notched stems (3.7)

**Side notches or side notched stems** are generally long with a distinctive out flaring, convex base. The out flaring base would obstruct use of the implements for drawing, making them a strong candidate for a knife. This is also suggested by the lengthy blade. Some of the side notches are straight stemmed points with a couple of notching flakes removed from the upper part of the stem. Almost all of the tips are broken off the notched points. The notching is very inconsistent. Specimen 2.N5.C26.2 is a long, thin side notch; one side is blunted and the other is serrated. It would have made a good steak knife (***Figure 33***). Specimen 2.EP.N7.C58.41 is blunted on both sides but along the first 20 mm from the tip on one


**Figure 33. Side Notched (type 3.7) 2.N5.C26.2 (left) and 2.PE.N7.C58.41 (right)**

side, perhaps the knife of a cautious person; it is exceptionally fine craftsmanship showing little by way of pronounced flake scares. Many if not most of the side notches are heat treated. The aggregate suggests a reasonably well manufactured implement, constructed from carefully prepared material, and used for cutting. Two notches are made on a very high-quality yellow jasper. The care in the notching is evident and the craftsmanship careful to produce very flat flake scars and a thin cross section. One of the specimens was found on an altar in Structure IIB. It was intentionally crushed by a strong blow deep into the middle of the blade with a hard object. The blow produced a crescent-shaped gap in the otherwise even excurvate edge of the blade. The hardness of the striking object is evident in step fractures on the lower surface of the biface. The biface was apparently simultaneously shattered into six fragments. A side notched point with an excurvate base has a tip that is twisted and may have been used as a drill. The retouch is finer on one side than the other, as in many other specimens, maybe due to manufacture on a flake with more use of one side than the other. The side notch also generally implies an expanding stem. Rovner (1997:73, c) shows a specimen from Rio Bec with barely perceivable notches and another with marked notches (Rovner 1997:73, f). Example: >fine>Biconvex>Jasper>Yellow

## Broad stem (3.8)

**Broad stems** (***Figure 34***) appear to be expended spatulates (type 3.9). Many have the carefully flattened body of the spatulates. Specimen 2.EP.N2.1626 appears to be a fully expended specimen and is distinctly alternately beveled in final resharpenning. In spite of the apparent large-utility domain of the broad stems, many are carefully pointed. Some of the broad stems have small stems and could be part of the straight stemmed type. One of the broad stems was discovered in a wall niche (II-G-1, see ***Figure 3***). Even though the broad stems are questionable candidates for projectiles, virtually all of the expended blades have carefully maintained, needle sharp tips. The implications of this could be as different as thrusting spear points for combat to hafted piercers for scraping bark or hides.

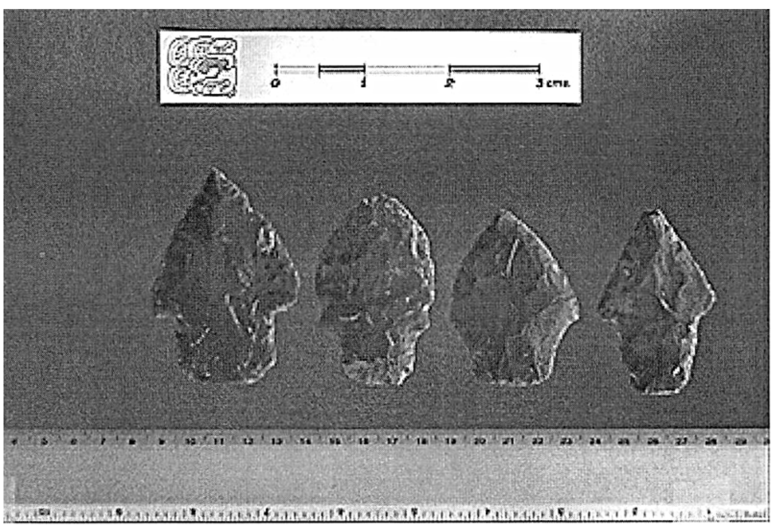

**Figure 34. Broad Stem (type 3.8) Points.**

## Spatulated broad stems (3.9)

**Spatulated broad stems** are generally very thin with a broad square stem. They sometimes have needle-sharp tips. Cortex is sometimes left on the base. The broad stems (above) are most likely spatulates that have been resharpened to exhaustion. The spatulates also share uniquely with the broad stem beveling of the blade edges.

## Some Points Worth Mentioning

Several points appear to be worthy of special notice, either because of inherent characteristics or a combination of location and characteristics.

Killed Knife. Specimen 2APE-1 bears special mention because of its unique characteristics, location of discovery, and post-manufacture treatment. It is one of two points in the collection made on very high quality brownish yellow jasper (see ***Figure 33*** left). The only other such point is also a notched point. The tip is damaged by lateral pressure that removed a spall from the tip. The most unique characteristic of the point is that it appears to have been "killed." It was struck with a heavy blow to the side of the blade with a hard object that shattered the middle portion of the point leaving numerous, small step fractures. It was also broken into six pieces, perhaps by the same or another blow. The point was found in a pit in Structure IIA. Objects similarly buried such as obsidian caches (Moholy-Nagy 1997) and jade caches (Guderjan 1998) have been thought to be special offerings or sacrifices.

The Biggest Point in Calakmul. Specimen 2EPN6-1 (Structure II, Escalera Principal, Zone N, Room 6, Artifact 1), is the broadest point in the collection. Although morphologically it is a straight stem (***Figure 35***), it is also similar to the large spatulate broad stems. It, however, is exquisitely crafted. It is no thicker than the thinnest points of any size. It is a *tour de force* of workmanship, both in thinning and edge preparation. It is made of brown chert, albeit of unusually high quality. No evidence of heat treating such as reddening is evident. However, the material is lustrous and extremely fine grained. The point was found half way down the primary staircase of Structure II lying on the steps in perfect condition. Perhaps the lesson to be learned from the largest point in Calakmul is that the straight stem design has a great range of utility. Specimens range from this magnificent, obviously very special piece, to the smallest and crudest of tools.

In the end one has to muse over why a craftsman would make something like specimen 2EPN6-1. In outline it is a normal straight stemmed morphology, but in size it weighs 114 g, much more than any other point of similar design. The edges are not especially blunted, but they are probably intentionally dulled.

Bipoints for Snaps? The excurvate outline of the edges of the snapped points resembles that of the bipoints. It is possible that the bipoints were made to be snapped in two to make the characteristic symmetrical snapped points found on the right side of the principle staircase.


**Figure 35. Largest Point (2EPN6-1).**

## Summary: General characteristics and observations on the point assemblage

Several characteristics are typical of the assemblage.

*The edges of points are extensively ground. The grinding is frequently on one edge, apparently for protection of the user's hand.

The base of many points is flat, either from a break or the remains of a flake platform. This is especially the case in the more robust contracting stem points and could have been intentional *to sustain head-on-stress without splitting the haft.

Some of the point types contain important internal variation. We have made an effort to indicate in the more varied types the junctures in the morphological space (see analysis of morphological space below) that grade into other types. Most notable are the broad stems that grade into straight stems. Also, the straight stems contain a subtype that exhibits a long stem (see Rovner 1975 observed specimens elsewhere), slight shoulder, and thick blade. Although intermediate specimens exist, there are only two broken examples of this morphology; it could, however, easily appear as a distinctive subtype in an enlarged collection.

The objective of the cross-tool type analysis (see below) was to determine if the apparent morphological coherence of the types could be correlated with a function.

### Point Morphology Space

To provide a sense of the range of shapes in the Calakmul assemblage, 31 selected, whole specimens characteristic of the various types were analyzed through a battery of measurements. The measurements consisted of five rays emanating from the center of the haft-blade interface (***Figure 36*** A). Most of the rays are concentrated in the lower left quadrant of the outline of points to gather detailed information on the shape of the haft element. More complex radial graph designs of rays have been used elsewhere (Montet-White 1973; Gunn and Brown 1982; Gunn et al. 1984). However, none of the Calakmul points possessed long barbs that necessitated an essentially recurved haft element such as in deep basal notches. There were no notches that could be classified as classic side notches. One point might be classified as corner notched, or more likely expanding stemmed, in some nomenclatures. Weight was included to measure mass and thickness of the points.

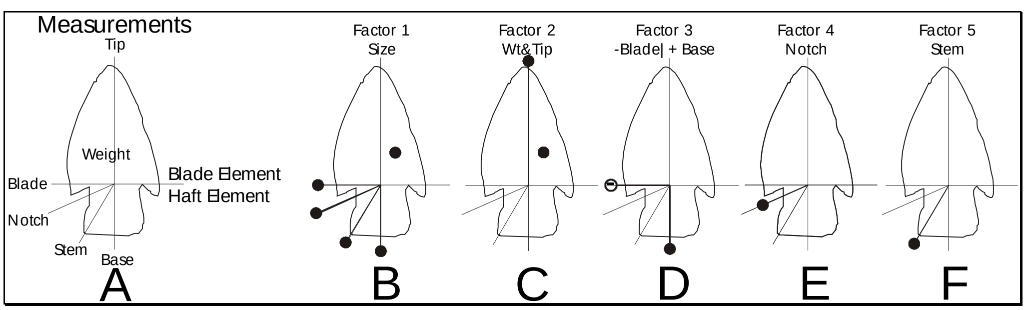


**Figure 36. Point Radial Measurements and Results of Factor Analysis. (see Table 38). Factoring of selected whole points for morphology space (n=31). The dots show which elements of the point are important on a factor, distance along the ray proportional to the loading. A solid dot is positive on the factor and an empty dot is negative.**

<u>Factor 1, Point Size</u>. A factoring of weight and radial measurements of the selected whole points (***Table 42***) show five important dimensions. The first dimension (lower panel, Factor 1) represents the size of the assemblage and is unimportant for the study of shape except to note that the tip size (0.62) does not correlate to a statistically significant level with the rest of the point. This is a frequently observed pattern in points and is usually attributed to reshaping of the blade elements. As a result, the tip becomes of unpredictable size relative to the haft element (blade, notch, stem measurements) and does not conform to any overall design. It rather responds to the contingency of material and use. However, all of the points used in this analysis were relatively large and appear to not be extensively resharpened. This

suggests that some other element is contributing to the unpredictability of tip length. It might be, for example, size of the original material from which the points were manufactured. Weight does correlate to the tip dimension (see factor 2). This is because the tip is the largest element of the point, as opposed to the base and thus significantly correlated to size.

**Table 42. Factoring of Selected Whole Points for Morphology Space (n=31).**

| | | Pearson R Correlation above Diagonal | | | | | |
|---|---|---|---|---|---|---|---|
| | | Tip | Blade | Notch | Stem | Base | Weight |
| | Tip | **1.00** | 0.35 | 0.36 | 0.33 | 0.38 | 0.83 |
| | Blade | 0.0284 | **1.00** | 0.76 | 0.81 | 0.58 | 0.70 |
| Significance (1-tailed) | Notch | 0.0241 | 0.0000 | **1.00** | 0.82 | 0.69 | 0.65 |
| below Diagonal | Stem | 0.0332 | 0.0000 | 0.0000 | **1.00** | 0.73 | 0.64 |
| | Base | 0.0188 | 0.0003 | 0.0000 | 0.0000 | **1.00** | 0.57 |
| | Weight | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0004 | **1.00** |

| | Factors | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | Communality |
| Variables | Size | Wt&Tip | Blade\|Base | Notch | Stem | |
| Tip | **0.62** | **0.76** | 0.06 | -0.04 | 0.06 | 0.94 |
| Blade | **0.86** | -0.22 | **-0.37** | 0.22 | -0.15 | 0.98 |
| Notch | **0.88** | -0.26 | -0.04 | **-0.38** | -0.10 | 0.95 |
| Stem | **0.89** | -0.31 | -0.04 | 0.04 | **0.33** | 0.93 |
| Base | **0.80** | -0.19 | **0.54** | 0.13 | -0.10 | 0.84 |
| Weight | **0.87** | **0.42** | -0.10 | 0.04 | -0.05 | 0.97 |
| % Variance Explained | 68.5 | 16.8 | 7.4 | 3.6 | 2.6 | |
| % Cumulative Variance | 68.5 | 85.3 | 92.7 | 96.2 | 98.8 | |

Extraction Method: Principal Component Analysis.

With the effect of size removed to the first factor, the second, third and fourth factors are focused on shape dimensions.

Factor 2, Blade Element. The second factor (Wt&Tip) indicates that in this collection, the overall size of a point (weight) predicts the length of the tip. Weight is primarily a function of thickness, so the large size of the blade element relative to the haft element makes this a reasonable finding, and the relatively large proportion of variance accounted for among the shape factors (16.8 and 7.4 percent) make it the most important characteristic of shape.

Factor 3, Haft Element. The third factor indicates that the width of the blade element (blade) tends to be inverse to the length of the haft element (base). This is an interesting finding. It indicates that across the range of variation of Calakmul points, the Maya craftsmen executed a design that made longer haft elements on narrower blades and shorter haft elements on wider blades. *It may suggest a dichotomous correlation with the load bearing model suggested above. Probably the broad blades with short hafts being made for point-on impact such as spears. The long haft elements with narrow blades are for side stress such as cutting. This is the second most important component of point shape at Calakmul accounting for 7.4 percent of the variance.

Factor 4, Notch Dimension. The fourth factor gathers variance of the notch dimension. Since notch variance occurs alone on this factor, the shape of the haft element upper lateral modification as represented by the “notch” measurement varies independently of the other point shape dimensions. Thus, we cannot say that points with more indented (notched or stemmed) haft elements, or more exterior (pointed or lanceolate) haft elements, are related to one of the other size dimensionalities (Wt&Tip or Blade|Base).

Factor 5, Stem Dimension. The same can be said for the stem shape. It too appears on a factor by itself indicating that it varies independently of other shape characteristics. Factors 4 and 5 would seem to indicate that the precise shape of the base varies on some kind of contingency basis rather than consistently with the haft and blade element morphological template. However, clearly some points were made according to the dictates of one template and others by another. Observation of the assemblage also clearly supports the observation that no particular size of point is associated with a particular shape (***Figure 37***). As apparently identifiable as the type morphologies are, they have distant overlapping size ranges.

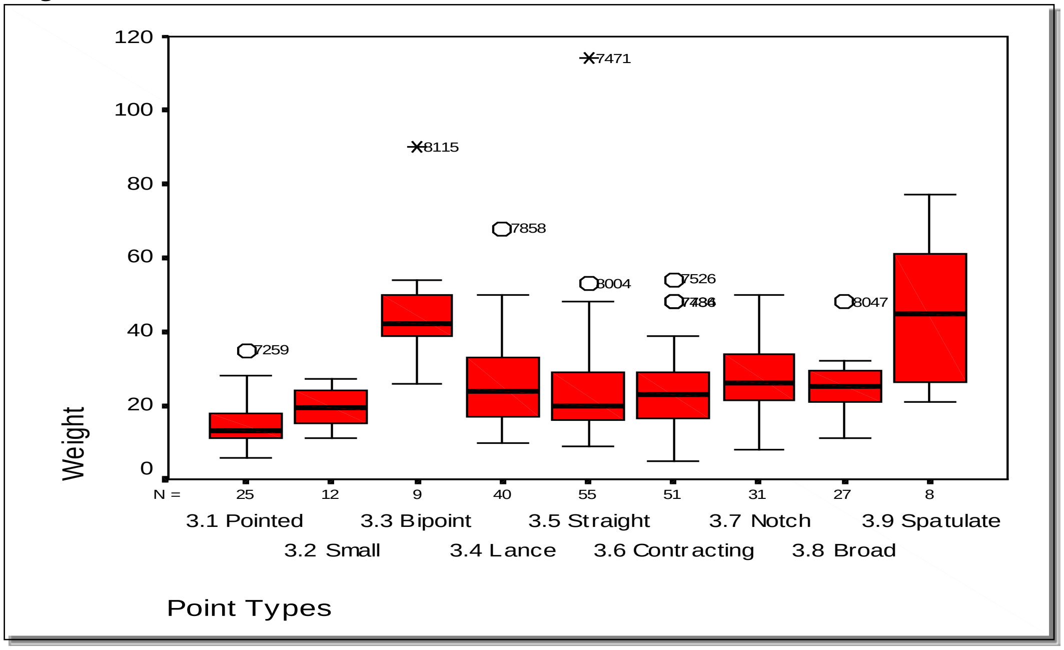


**Figure 37. Overlapping Ranges of Weights Across Point Types. Single point plotted above the stem and leaf diagrams are outliers not included in the mean and standard deviation determinations.**

Summary. Factoring of the range of shapes found in the Calakmul assemblage reveals some broad patterns that largely superpose point types based on various traditional criteria such as shape of the haft element. Next to size, which dominates the variance spectrum with 68.5 percent of the variance, relationships between the weight and tip length (16.8 percent), and blade width and base length (7.5 percent) also cross-cut point types. Variance in the notch and stem aspect of point morphology account for only 3.6 and 2.6 percent respectively.

Conclusions that can be drawn from these relationships suggest at least *two functional supertypes based on stress load bearing characteristics: broad, short-based points for end-on stress and long-based points with narrow blades to bear lateral stress. In detail the variance relationships suggest the following conclusions.

1. The blade element is typically the greater part of a point providing a strong relationship between the tip length and the overall weight (***Figure 32***C).
2. The haft element varies unpredictably relative to the blade element.
3. A dichotomy between wide, thin points and narrow, thick points appears in the data (***Figure 36***D). *This also probably describes the distinction between the thin, well-made, broad-bladed bipoints, notches, spatulates, and some of the lanceolates, and the cruder, thicker stemmed points of various configurations. The later were also heavily and crudely resharpened and reshaped.
4. The measures to sense the shape of the haft element in its lateral aspect, notch and stem interface (***Figure 36***F), proved to be independent of the rest of the morphology in the selected

collection. This is a result of the weight-tip length and inverse width-base relationships dominating the overall shape characteristics of the collection. Later we will experiment with weighting the notch and stem features to obtain a more focused understanding of haft element shapes.

# PART II: ARTIFACT DISTRIBUTIONS

In this part we turn our attention the distributions of artifacts in rooms and the importance that brings to quality of life as regards the frequency of artifact and the networks they represent. Analyzing quality of life from archaeological finds is no small order. A possible avenue of approach is outline in Smith (2019). There are two main components to be recovered: income and capacities. Income is the most accessible. In our case we can estimate income by room size, or as we will attempt to do here, the number of artifacts in rooms and the area of rooms, actually their square area. This overlooks the likelihood that a single household might occupy more than one room. This however creates redundancy in the data if the household populates its rooms with similar complexes of tools in similar sized rooms. Factor analysis can be used to identify and combine redundancies so we will use it to simplify the outcome in that regard. In Smith's approach capabilities are addressed as the number of choices that a household or community have access to. This will be reflected in the number of types of tools they use and the number of networks they have access to. A household or community for example that has obsidian in its inventory of tools and ritual objects has access to the obsidian distribution network and its quality of life enriched thereby. As we shall see in this part of the report, many of the quantities to identify both income and quality of life a petty commonly available in archaeological datasets. They just need to be brought forward and evaluated in light of the quality of life paradigm. In this part we will look at the distributions of lithics from the Calakmul excavation and then conjoin them with other components of the rich inventory of ceramics such as figurines representing ritual networks and wares revealing the food equipage and preparation networks.

### Point Distributions

The point types are distributed relatively evenly across the excavated premises with occasional concentrations (***Table 43***). A very few points occur in the smaller excavations on Structure I (1) and Structure VII (7). It may be of interest that three rooms contain points in temple Structure VII and two of these are the war-sacrifice symbolically important bipoints. Pyramid Structure I, which might seem to be an appropriate platform for life-and-death issues, has seven points, none of which are bipoints. All are of the stemmed-lanceolate configuration. No bipoints were found on the summit of pyramid Structure II but were found on the zones of Structure II.

**Table 43. Suboperation/Zone/Room *Point Type*Structure Crosstabulation Quantitative Dataset.**

| Structure | Subopera-tion Zone Room | Pointed Stem 3.1 | Small Stem 3.2 | Bipoint 3.3 | Lanceo-late 3.4 | Types Straight Stem 3.5 | Contract-ing Stem 3.6 | Notch-ed Stem 3.7 | Broad Stem 3.8 | Spatu-late 3.9 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | **SP** | 1 | 1 | | | 1 | | | | | 3 |
| **1** | | | | | | | 1 | | | | 1 |
| | **A** | | | | 1 | 1 | | 2 | 1 | | 5 |
| | **SP** | | | | 1 | | | | | | 1 |
| | **Total** | | | | 2 | 1 | 1 | 2 | 1 | | 7 |
| **2** | | | | | 4 | 7 | 4 | 1 | 1 | 3 | 20 |
| **Pyramid Palaces II (2)** | **A** | 2 | 1 | | 6 | 8 | 7 | 8 | 3 | 2 | 37 |
| | **B** | | 1 | | 1 | 9 | 1 | 3 | 2 | | 17 |
| | **D** | 2 | | | | 1 | 1 | 2 | 2 | | 8 |
| | **F** | 3 | | | | 2 | 2 | 3 | | | 10 |
| | **H** | 1 | | | 3 | | 2 | | 1 | | 7 |
| | **Subtotal** | 8 | 2 | 0 | 14 | 27 | 17 | 17 | 9 | 5 | 99 |
| **Zones** | **N2** | | | | 1 | 2 | 3 | | 1 | | 7 |
| | **N3** | | | 1 | | | 1 | | | | 2 |
| | **N4** | | 2 | | | | 1 | | 1 | 1 | 5 |
| | **N5** | | | 1 | 2 | 1 | | 2 | 2 | | 8 |
| | **N6** | | 1 | | 3 | 4 | 4 | 3 | 3 | 1 | 19 |
| | **N7** | | 2 | 1 | 4 | 3 | 3 | 4 | 2 | | 19 |
| | **N8** | | | | 2 | 6 | 7 | 2 | 2 | | 19 |
| | **N9** | | 1 | | | 1 | 3 | | | | 5 |
| | **Subtotal** | 0 | 6 | 3 | 12 | 17 | 22 | 11 | 11 | 2 | 84 |
| | **Total** | 8 | 8 | 3 | 26 | 44 | 39 | 28 | 20 | 7 | 183 |
| **3 Palace Str III (3)** | | | | | | | 2 | | | | 2 |
| | **A** | 7 | | 4 | 6 | 1 | 4 | | 1 | | 23 |
| | **B** | 1 | | | | | | | 2 | | 3 |
| | **C** | | 1 | | | | | | | | 1 |
| | **D** | | | | | 1 | | 1 | | 1 | 3 |
| | **E** | 1 | | | 2 | 1 | | | | | 4 |
| | **G** | | | | | 1 | | | | | 1 |
| | **H** | 3 | | | | 1 | 1 | | | | 5 |
| | **I** | | | | | | 1 | | | | 1 |
| | **J** | | | | | 1 | | | | | 1 |
| | **L** | | 1 | | | | | | 1 | | 2 |
| | **P** | | | | 1 | | 1 | | | | 2 |
| | **Q** | 3 | | | | 1 | | | | | 4 |
| | **R** | 1 | | | | | 1 | | | | 2 |
| | **Total** | 16 | 2 | 4 | 9 | 7 | 10 | 1 | 4 | 1 | 54 |
| **7 Palace Str VII (7))** | **E** | | | 1 | | | | | | | 1 |
| | **H** | | | 1 | | | | | | | 1 |
| | **Mte** | | | | | | 1 | | | | 1 |
| | **Total** | | | 2 | | | 1 | | | | 3 |

Several qualitative issues can also be observed within the large populations of points in Structure II and Structure III. *The pointed stems, which appear to be atlatl dart tips (see tool kits below) appear only in palace structures (***Table 43***). Pyramid Structure II yielded 8 pointed stems from temple II-A and Structures II-D, II-F, II-H. Palace Structure III revealed 16 pointed stems from rooms III-A, III-B, III-E, III-H, III-Q, and III-R They do not appear on the zones of Structure II. This distribution indicates that the pointed stems were only made and maintained in quarters associated with well to do residents and ritual activity. The location might imply either that hunting functions were stationed in these contexts, or that the atlatl served as weapons for guards or military personal resident in these buildings. The pointed stems could have served as effective spear tips. If pyramid Structure II was serving as a fortification in the Terminal Classic, the large upper rooms may have served as an armory.

Notched stems are almost exclusively found in pyramid Structure II (n=39), and the greater number of these are in palace Structure IIA (n=8). However, the notched stems are accompanied by similar distributions of straight stems and broad stems, possible co-functional analogs as we saw in the morphological analysis above, but with notable concentrations in pyramid Temple IIA and palace Structure IIB. The contracting stems and pointed stems, also possible co-functional analogs, appear to focus more of a presence in buildings II-D, II-F, and II-H.

A chi-square analysis of points across Structure II and Structure III (***Table 44***) sustains these observations with a highly significant probability (p<.001) that the distributions are not a result of chance. *Pointed stems and bipoints have the greatest degree of deviation from expected values in palace Structure III, while in Structure II notched stems straight stems and bipoints along with broad stems generate the highest deviations from expected values in Structure II.

**Table 44. Crosstabulation of Point Types * Structures.**

| Point Type | | Structure 2 | Structure 3 | Total | Index (1.0= Expected) SII(2) | SIII(3) |
|---|---|---|---|---|---|---|
| **Pointed Stem** | **3.1** Observed Count | 8 | **16** | 24 | | |
| | Expected Count | 18.7 | 5.3 | | 0.4 | 3.0 |
| **Small Stem** | **3.2** Observed Count | 9 | 2 | 11 | | |
| | Expected Count | 8.6 | 2.4 | | 1.0 | 0.8 |
| **Bipoint** | **3.3** Observed Count | 3 | **4** | 7 | | |
| | Expected Count | 5.5 | 1.5 | | 0.5 | 2.7 |
| **Lanceolate** | **3.4** Observed Count | 29 | 9 | 38 | | |
| | Expected Count | 29.6 | 8.4 | | 1.0 | 1.1 |
| **Straight Stem** | **3.5** Observed Count | **46** | 7 | 53 | | |
| | Expected Count | 41.3 | 11.7 | | 1.1 | 0.6 |
| **Contract. Stem** | **3.6** Observed Count | 39 | 10 | 49 | | |
| | Expected Count | 38.2 | 10.8 | | 1.0 | 0.9 |
| **Notched Stem** | **3.7** Observed Count | **28** | 1 | 29 | | |
| | Expected Count | 22.6 | 6.4 | | 1.2 | 0.2 |
| **Broad Stem** | **3.8** Observed Count | **22** | 4 | 26 | | |
| | Expected Count | 20.3 | 5.7 | | 1.1 | 0.7 |
| **Spatulate** | **3.9** Observed Count | 7 | 1 | 8 | | |
| | Expected Count | 6.2 | 1.8 | | 1.1 | 0.6 |
| **Total** | Count | 191 | 54 | 245 | | |

Chi-square 42.4, d.f. = 8, p < .001, higher than expected observed values in bold

Lanceolates, contracting stems, and spatulates approach the expected frequencies for their types in all structures. *This suggests they were used indiscriminately between the two structures. The underlying process could be related to function here as well. The small stems, for example, seem to be related to a woodworking toolkit (see below). It is reasonable to expect that the need for wood products would be equally distributed among the palace components, whether secular or sacred, of the elite precinct.

A pattern of note in palace Structure III is that the broken tips of points constitute a higher than expected number (***Table 45***, 52), while fewer than expected were found in and on Structure II. In theory, the *tips could represent the remains of use-actions in which points were broken. If the breaks were accidental during use, then the predominance of tips in palace Structure III implies a focus of application and consumption rather than manufacture and distribution. This conforms with the general overview picture of the palace as a consumption node rather than a production facility. As will be discussed below, the breaking of points to obtain tips may have been intentional in some forms creating exceptions to this assumption.

**Table 45. Condition of Points (whole vs. fragmentary) in Pyramid Structure II(2) and Palace Structure III(3).**

| Point Condition | | | Structure 2 | Structure 3 | Total |
|---|---|---|---|---|---|
| **Broken** | **3.11** Observed Count | | 98 | **52** | 150 |
| | | Expected Count | 109.7 | 40.3 | |
| **Whole** | **3.12** Observed Count | | **191** | 54 | 245 |
| | | Expected Count | 179.3 | 65.7 | |
| Total | | Count | 289 | 106 | 395 |
| Chi-Square Tests | Value | df | Asymp. Sig. (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
| Pearson Chi-Square | 7.55 | 1 | 0.006 | | |
| Likelihood Ratio | 7.43 | 1 | 0.006 | | |
| Fisher's Exact Test | | | | 0.007 | 0.004 |
| 0 cells (.0%) have expected count less than 5. The minimum expected count is 40.25. | | | | | |

The pattern of fragmentary points continues to dominate the pattern when the palaces and zones of pyramid Structure II are separated out (***Table 46***). However, the greatest discrepancy between observed and expected values is on the zones of Structure II. There are more whole points (102) than would be expected and fewer than expected broken points (48). This implies that *the source is on the Zones and consumption of points is in the palace and pyramid on pyramid Structure II and in palace Structure III. Insufficient debitage was found on the zones of pyramid Structure II to suggest that the bifaces were being manufactured there. However, it could mean that fresh supplies were brought in via the zones and distributed to the palaces.

**Table 46. Condition of Points (whole vs. fragmentary) in pyramid Structure II Palace (II-B), Structure II Zones, and palace Structure III Palace.**

| Point Conditions | | | Str. II-B Palace 2 | Str. II Zones 2.1 | Str. III 3 | Total |
|---|---|---|---|---|---|---|
| **Broken** | **3.11** | Observed Count | 50 | 48 | **52** | 150 |
| | | Expected Count | 52.8 | 57.0 | 40.3 | |
| **Whole** | **3.12** | Observed Count | **89** | **102** | 54 | 245 |
| | | Expected Count | 86.2 | 93.0 | 65.7 | |
| Total | | Count | 139 | 150 | 106 | 395 |

| Chi-Square Tests | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 8.0 | 2 | 0.018 |
| Likelihood Ratio | 7.9 | 2 | 0.019 |

0 cells (.0%) have expected count less than 5. The minimum expected count is 40.25.

Summary. The distribution of points in the structures indicates differences in the supply chain statuses between the various buildings and building parts (operations). Starting from the top of ***Figure 38***, pyramid Structure I has only the thick stemmed varieties while temple Structure VII has more of the thin wide points. These bipoints seem to be associated with sacrifice and war in murals. *The distinctions might be taken to indicate that temple Structure VII was dedicated to the warrior side of ritual. The steep and unobstructed side of the building would fit the profile of this sort of activity where sacrifices were cast done the sides of the temples. Pyramid Structure I could be oriented to a more peaceful enterprise, such as encouraging crops, astronomical observation, or funerary purposes. Its early architectural date would be comfortable with such enterprises since warfare seems to have come to the Maya late in the Classic Period.

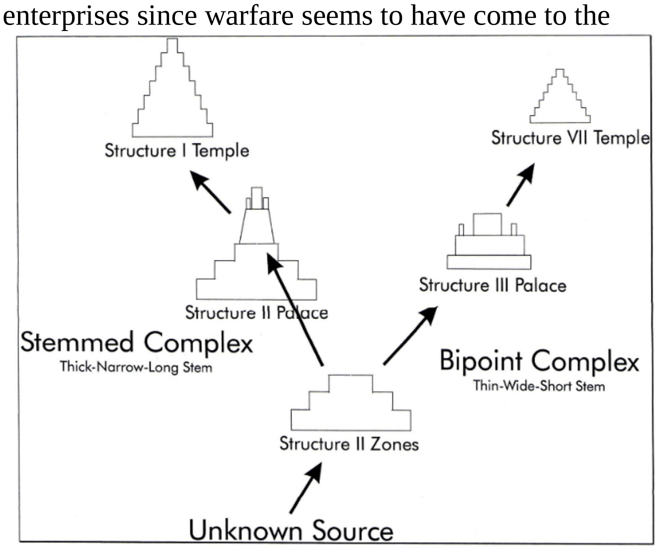


**Figure 38. Flow of Points as Suggested by Point Distribution.**

Following the thick-thin argument in structure II and III where the populations of points are much larger, the dichotomy seems to hold up and add additional insight to the distinction. The *thin, pointed-stemmed points are probably atlatl darts or spears and are associated with the palace and summit pyramid on Structure II and with the palace Structure III. They could have been the armaments of guards or the palaces were the seat of hunter enterprises.

Supporting a military outlook is an association of bipoints with palace Structure III. This implies a link between secular authority in place Structure III and whatever the bipoint activity was on pyramid Structure VII. Bipoints are also to be found on the zones of Structure II. This may be at odds with the concept of bipoints being associated with upper caste war and sacrificial activities. However, it again opens the possibility of activity on the zones being that of supplier of lithics, though again not manufacturer in those locations, i.e., no fine-grained chocolate brown flakes.

## Chocolate and Chocolate Brown Points, Obsidian Alone

An examination of the chocolate brown point fragments shows that they are distributed on pyramid Structure II and occur exclusively west of the central stairway. The point's bases had been broken off leaving 5-10 cm of flat blades. A room that contained three chocolate brown point fragments also contains an obsidian blade. The points west of the stairway had black spots. To the east of the principal stairway snapped points were also found, but they were made of a lesser quality of materials and did not exhibit black spots.

The snapped points almost always occur one per room. There were also instances of singular point fragments in the other structures. On the west side of pyramid Structure II all breaks are straight across the base of the blade yielding a symmetrical form. They are not, like those on the west side of the Structure II, of chocolate brown chert. They were also not consistently symmetrical in their breaks.

There appear to be other activities on the east side of the uncompleted central stairway involving exotic materials such as black basalt "manos" that suggest an area of special functions not immediately apparent from this analysis.

> "...the powder, and other small seeds are ground, and this power is put into certain basins with a point, and then they put water on it and mix with a spoon. And after having mixed it very well, they change it from one basin to another, so that a foam is raised..." Coe & Coe

The rich brown color of the chocolate brown point fragments could well allude to the color of chocolate, which served both symbolic and monetary functions. What were the functions of the point fragments? It may be that they served in the preparation of chocolate; perhaps they were used to open the chocolate pods thus explaining their frequent breakage. It is also possible that they were intentionally manufactured with a snapped base. If they were hafted by the point tip, the same operation as hafting the pointed-base points, they may have served as paddles to stir the chocolate by spinning the haft between the hands. See Fig 3 niche in which the tip, not the base, of a point is oriented out toward the room. If the haft decayed away, this would be the result. A "gentleman of Hernán Cortés" reported in 1556 that "a point" was used in the preparation of chocolate much like the Maya (Coe and Coe 1996:86). Could it be of ritual significance or did chert somehow catalyze the flavor of the chocolate? It seems most likely a point was just a way of making a flat fin for the paddle but other perspectives of this should be investigated.

On the obsidian blade side of the balance sheet, there are few instances of rooms with obsidian blades in Structure II. The rooms that do have singular obsidian blades are clustered around room 31 with the multiple chocolate point fragments. Singular obsidian blades occur consistently in the other structures, especially palace Structure III. In some rooms there are collections of obsidian blades. Perhaps the obsidian blades went with the barkbeaters to trim bark paper.

A locational phenomenon that was observed once during the excavation of pyramid Structure II was the placement of a point in a niche in the wall of a room (see ***Figure 3***). Excavation records indicate that a point was positioned with the point tip directed outward from the niche, perhaps indicating that it may have been hafted by the tip rather than the more usual base. It would have been hafted using the same hafting technology as the pointed-based points but on the opposite end.

## Activity Trace Analysis by Flakes

The study of formal tools (see above) such as points and scrappers were studied to determine typological diversity. However, a great deal of emphasis in Calakmul lithic studies was placed on flakes. The reason for this is that tools *per se* represent the end position of an implement after its useful life span or cycle, or the cessation of its use somewhere along the life cycle. Flakes, on the other hand, represent the life history, or the activity trace, of tools. A tool is first shaped, usually from a flake, although occasionally from a core. It is then used until it is no longer sharp at which time it is resharpened. At some point, or points, in the history of a tool it will be dulled and resharpened so extensively that its condition necessitates reshaping. Also, if it is broken, it will require reshaping and resharpenning. After multiple episodes of resharpenning and reshaping, it will be either lost or discarded. If discarded at the end of its useful life, it may reside in its use context, or it may be relegated to a non-use context refuse heap.

The flakes will probably be discarded in the use context. The flakes are, therefore, most likely to trace a spatial history of the use of the implement (***Figure 39***). There is potential for a temporal history if stratigraphy somehow accrues. Flakes, we assume, have the potential to reveal the history of use and reformulation, the activity trace of a tool, or tools if more than one tool is formulated from the same lithic over its lifetime.

The refuse heap seems to have been a frequent fate of stone tools in the large central places of the Maya who appear to have kept the premises swept, at least during the pre-Terminal Classic periods. This sweeping function seems to have been suspended during the Terminal Classic, which appears to be the temporal provenience of the collection from Calakmul. If not removed during sweeping, flakes, are probably discarded in the use context. They will therefore form a spatial history of the use of an implement. There is potential for a temporal history if stratigraphy accrues. Flakes, therefore, have the potential to reveal the history of use and reformulation, the activity trace of a tool, or tools if more than one tool is formulated from the same lithic material over its lifetime. Ideally the edges of resharpenning flakes would be studied for use wear as they would contain the historical trace of uses of a tool.

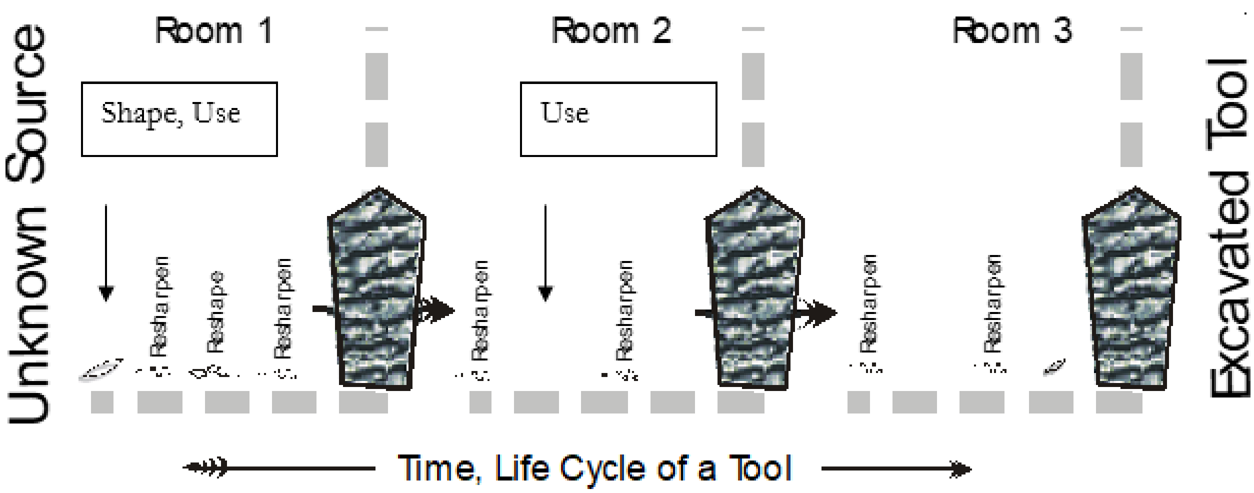


**Figure 39. Theoretical Activity Trace of a Tool is Marked by Flakes.**

Flakes in the activity trace will take on differing characteristics depending on the roles of the tools intersecting with a room and what happens to them while in the room. The flakes generated by reshaping will be relatively large. Those produced by resharpenning will be small. Because the platforms of the resharpenning flakes are removed from the degenerate working edge, they will contain the wear patterns of the old working edge. During the recovery of the Calakmul lithic assemblage, there was no 1/16 inch or 1/8-inch screening. Lithics were gathered by sorting through sediments removed from the surfaces of structures. Probably most of the resharpenning flakes (ca. 1-5 mm) were lost, but the reshaping flakes (ca. 5-30 mm) were recovered. Ideally, activity traces would be followed by refitting, i.e. rebuilding the cores from flakes, and thus backtracking through use areas and manufacturing workshops. This would require more resources than available for this study. In theory, the activity traces could be followed in a more general sense by material types. This presumes that different social groups in the palace and pyramid precincts were selective in their use of lithics by material types. As discussed above, there is some evidence for this. The residents of Structure II, for example, tended to use dark brown chert for their points. Some basic assumptions about the cognitive content of various colors were obtained from ethnographic studies in the Edzna area.

Another assumption that may contribute to understanding the distribution of activities between the various structural types is the concept of conspicuous consumption. If we suppose that the elite had, through wealth, access to the more desirable types of silicates, and that they were able to acquire these materials in sufficient quantities to be less focused in their expenditures of material and less tolerant of more expended implements, then a condition of conspicuous consumption would exist. This state could be observed by measurements of size (weights) of similar tool types. Scrapers found in different rooms, for example might be determined to be of significantly different sizes.

As reported by various authors (Gunn 1974; Hill 1977; Nassaney and Sassaman 1995), lithics studied at the individual level of activity could potentially reveal interactions of individuals, or more likely social interactions. Exactly how to evaluate individual level lithic activities in the Calakmul context is a matter of interest in this study though not one of its main foci. A method developed by Hughes (1998) on northern Plains Paleoindian points was used. It involves using flake scar attributes to cluster points. The concept introduced by Redman (1977) of the "analytical individual" is probably more the target of this study. The analytical individual probably represents groups of knappers whose close association dictates clustered habits of production. Among modern flint knappers, for example, one might suppose that there are groups of knappers who learned from Bordes, Crabtree, Tixier, Bradley, and Callahan who would cluster as analytical individuals.

### Room II-60 Manufacturing Locus

Several tactics were used to search out the loci of manufacture and use. First was the quantity of flakes. This pointed immediately to Room 60 at the base of the pyramid Structure II facade built over the original stairway. Room 60 was located behind the early stelae at the foot of the Structure II pyramid. There was burning at the foot of the stelae and two ceramic jars with boa constrictors in them. Two other stelae fragments (115, 116) were found on the 2 m high terrace that formed the back wall of the room. Facing the front of the pyramid were two openings formed by jambs.

Room 60 contained about 4,500 flakes (***Figure 40***). Careful examination of a randomly selected sample of 78 of the flakes revealed that they were mostly secondary flakes (n=50, 64%). This indicates that the cores were largely cleaned of their cortex at the quarry but not entirely. They were then taken to Room 60 where cleaning the cores of cortex was finished. Most of the flakes were complete flakes. Since not all flakes were retained during excavation, it is not clear if the tendency toward whole flakes in room II-60 is typical of the room assemblage or a product of excavation procedures. If typical, it indicates that the knappers were very skilled at obtaining thick, substantial flakes to termination without shatter. This indicates consistent thinning of bifaces by most removals; knappers that expertly took down cores to their desired proportions.

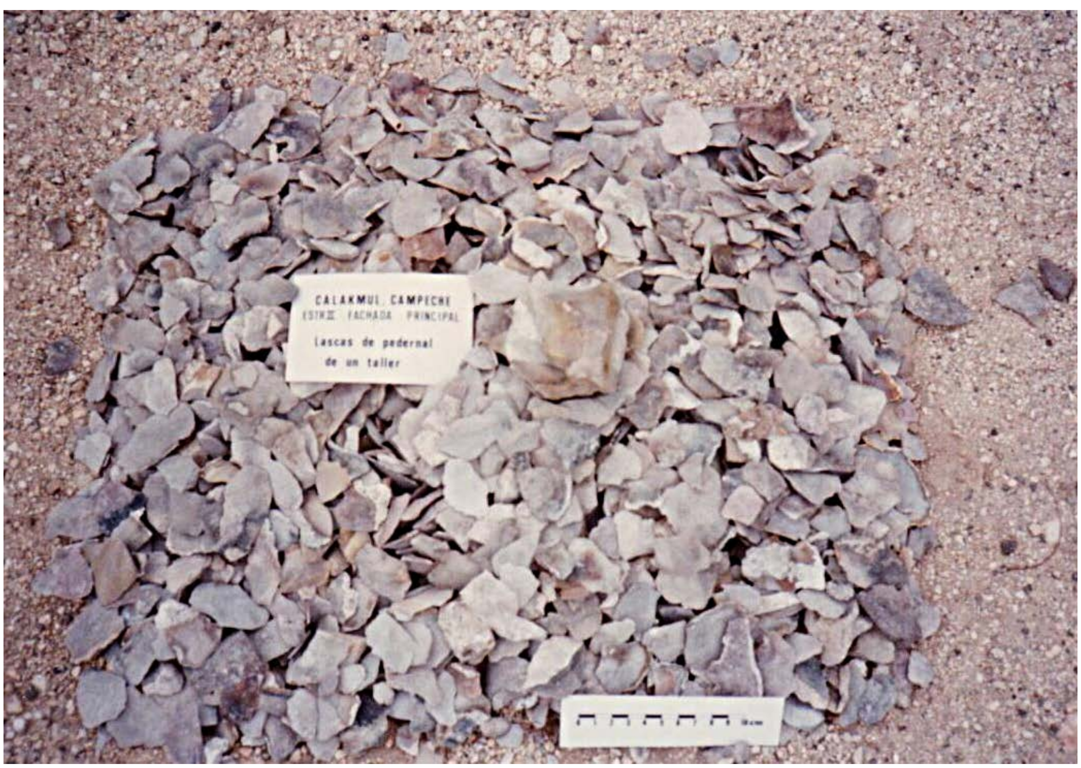


**Figure 40. Structure II, Room 60 Flake Collection. (photo by L. Florey Folan)**

The room was excavated beginning on the stairway on the left, then proceeding across the room to the right. Excavation revealed an assorted arrangement of domestic and manufacturing refuse including four metates. Forty cm from the back wall was a pile of chipping debris 1.8 m long and 1.4 m wide. It was about 7 cm thick and weighted 26 kilos. Seven points were found in the room (see ***Table 43***). A black obsidian core was found. The flakes were on the floor close to the door jams and the points were slightly above it. The points could have come down from up-pyramid with the refuse, or perhaps from a recess(es) in the room walls. There was a spindle whorl on the west area of the floor with a cream (light gray) point. A small polishing stone was present. There was a great amount of Terminal Classic domestic and ceremonial wares. Figurine heads were above the flakes. There were two antlers in the right-hand doorway. In relative terms, in the judgement of the excavator, L. Florey Folan who carried out the excavation of about half of the activity areas on the Structure II facade, the room was "very special."

The material range in the sample was very limited. Sixty-nine specimens (88%) were chert and nine (12%) of chalcedony. The areas near the cortex on a large proportion of the secondary flakes were rose or purplish color. This indicates that the cores were heat treated after initial shaping of bifacial cores.

The quality of the material was based on simple judgments of the fineness of the grain. Fine material possesses a luster. Medium material was visibly cryptocrystalline but not textured to the feel. Course material was rough to the touch. In a random sample drawn for special study discussed below, nine specimens (12%) were fine, 49 (63%) medium and 20 (26%) course. The course flakes were from near cortex and represent final decortication efforts. Thus, the ideal was clearly medium grain material.

The sample assemblage was in majority of secondary flakes (n=50, 64%). The near absence of primary flakes indicates an advanced stage of work in the room. However, there were also few tertiary flakes (n=23, 29%). This suggests that the final manufacture of flakes was performed in other rooms, or that most of the tertiary flakes were carried away for a use elsewhere. In the rooms at large, nine percent of the flakes were primary. However, approximately equal numbers of secondary (44%) and tertiary (46%) flakes appeared.

The assemblage is clearly dominated by bifacing rather than core flaking technique. Sixty of the 78 sample specimens in Room 60-61 were bifacing (60%); 12 (15%) were core flakes and six (8%) were either terminal or indeterminate fragments. Again, the near total absence of terminal fragments in a bifacing assemblage indicates great skill at achieving unshattered, intentional terminations and thinning of bifaces. It may also indicate predominantly flakes of bifacial cores rather than bifaces. This could suggest the importation of thinned bifaces such as points, or their manufacture in other parts of the city. The low frequency of core flakes suggests that they were only produced during the initial stage of bifacial core cortex cleaning and reduction. *The knappers at Calakmul clearly favored bifacing over core lithic reduction techniques.

The reduction stages of flakes excluding Room II-60 are approximately equally divided between secondary (n=1427) and tertiary (n=1484) pieces. There are only 303 primary flakes indicating that most of the cortex had been removed at quarries or in areas of the city other than the sacred precincts.

A comparison of flake stages from rooms in summit pyramid Structure IIA and palace Structure III (***Table 47***) shows that the low frequency of primary flakes remains constant in the two palaces. It is very interesting, however, that the secondary flakes dominate in summit pyramid Structure IIA while the tertiary flakes are more prominent in palace Structure III. This tends to support our hypothesis (Domínguez Carrasco et al. 1998) that lithic manufacture was more a function of the sacred sector than the secular sector if that distinction was being made in the Terminal Classic.

**Table 47. Percentages of Primary, Secondary, and Tertiary Flakes in Summit Pyramid Structure IIA and Palace Structure III (n=2107).**

| Structure | Primary | Secondary | Tertiary |
|---|---|---|---|
| Palace III | 10 | 36 | 54 |
| Pyramid IIA | 10 | 55 | 35 |

## Tool Kits: Qualitative and Quantitative Perspectives

The underlying assumption of the analysis of stone tools was that associations of tool types would reveal functions or combinations of functions in rooms. The means to affect such a simple assumption proved to be quite complex. Ordinarily one turns immediately to numerical analysis of quantitative data to obtain repeated associations of tool types and the inference is made that numbers imply association. Of course, life and its analysis are never that simple. Perhaps the preeminent problem is that amidst the wreckage of centuries, carefully controlled, strict quantitative analysis becomes increasingly problematic with the passage of time. As a result every opportunity has to be taken just to obtain inspirations as to what the parameters of the activities undertaken were by devising methods of peering through the accumulated confusion. With some tool types this is easy. The extremely characteristic barkbeaters (macerators) are still used today by the Maya of the peninsula and anyone can tell from firsthand experience what they mean. On the other hand, the use of stone points and scrapers was lost in remote time and with it the subtle innuendos of morphology and applications to materials except for what has been obtained from the Lacandon.

To smooth over some of the problematics of quantitative data, three qualitative techniques were used. As noted above, one was to interview field supervisors about the character of associations. Some particularly poignant observations emerged out of field notes. Hammer stones were found with piles of flakes and a point was observed in a niche. As always happens during excavations, excavators are struck by tool combinations and make notes about the apparent association between tools.

Another technique that proved fruitful was to lay the stone tools out on tables by room provenience. Out of this exercise arose notable combinations such as point tips and obsidian blades. As discussed below, even the subtle character of the point tips varied from one part of the site to another, variations that would have been very hard to detect by purely quantitative methods because of the rarity of the associations and the subtle variations in material type and design of even broken points.

The third somewhat-qualitative technique was to use presence-or-absence data to represent the associations of tool types without reference to their numbers in rooms. This is equivalent to looking into a live room and observing that, yes, such-and-such activity was going on there, some women preparing food in one, some men preparing implements to go in another to go hunting or waring, and in yet another some scribes preparing paper and writing in codices. But one does not try to penetrate the deeper implications of going into the rooms and counting the number of metates, spear points, or books.

## Patterns of Formal Tool Subtypes

Before proceeding to other categories of lithics, it would be helpful to pause and examine covarying patterns distribution of formal lithic tool subtypes among rooms. From the analyses above, a data set of 35 subtypes from 113 rooms was compiled (see Appendix 3). The 113 "rooms" are the situations in which at least two types are present in some sort of restrained space, most of them rooms, but some principal staircase/zone proveniences and some limited to a palace but not confined to a room in the palace. The number of formal tool subtypes present across these rooms ranges from two to 80 (see "N rooms w/ type' in **Table 48**). Hammer stones are the most frequent lithic tool type (N=80). A factor analysis was run on this presence or absence data to find the co-occurring patterns of tools.

Factor 1 General Presence: High (red, tool kit 1 in ***Figure 41***) presence of tools such as axes (N=63) and scrappers (N=60) appear on this factor because they are general purpose tools that appear in many rooms, usually more than 40 rooms. Rarer tools such as Straight Based Points (N=24, less than 40) are probably legitimately associated with the more ubiquitous tools.

Factor 2 Points vs Cores: In this factor functions separate out in combinations. It is a bipolar factor with both plus and minus values indicating tool sets occurring in different rooms. Scrappers and Pointed Based Points (blue, 2b), for example, occur in different rooms from Notched and Broad Stemmed Points (red, 2a). Cores and Flakes (blue) also occur with the Scrapers.

Factor 3 Barkbeaters vs Obsidian: Again functions are reasonably implied by Obsidian and Broad Stemmed Points (red 3a) in some rooms, and Barkbeaters and Manos (blue, 3b) in other rooms.

Factor 4 Lanceolates: Lanceolates (red, 4) appear with Straight Stemmed Points, Denticulates and Chisels. Notice that the room Ns are getting low, all below about 30.

Factor 5 Bipoints vs Small Stemmed Points: Bipointed Points and Polishers (red, 5) separate out into separate rooms from Small Stemmed Points (blue).

**Table 48. Factors for Presence of Tools in Rooms to Obtain Tool Kits**

| | | N rooms w/ type | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Com-munality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Points | POINTED | 15 | 0.4 | -0.4 | 0.2 | 0.0 | 0.2 | -0.1 | 0.4 | 0.0 | -0.1 | 0.70 |
| | TIPS | 58 | 0.5 | -0.1 | -0.1 | 0.0 | -0.1 | -0.1 | 0.3 | 0.3 | -0.2 | 0.55 |
| | SMALL S | 7 | 0.2 | 0.2 | -0.1 | 0.2 | -0.5 | 0.4 | 0.2 | 0.2 | 0.2 | 0.71 |
| | BIPOINT | 7 | 0.1 | 0.0 | 0.2 | 0.2 | 0.5 | 0.3 | 0.2 | -0.2 | 0.2 | 0.66 |
| | LANCEOL | 15 | 0.3 | 0.3 | -0.1 | 0.5 | 0.2 | -0.2 | 0.1 | 0.0 | 0.3 | 0.68 |
| | STRAIGH | 24 | 0.5 | 0.2 | 0.2 | 0.4 | -0.2 | -0.2 | -0.2 | 0.1 | 0.0 | 0.62 |
| | CONTRACT | 20 | 0.3 | -0.1 | 0.2 | 0.0 | -0.2 | 0.0 | 0.6 | 0.2 | 0.0 | 0.75 |
| | NOTCHED | 16 | 0.4 | 0.4 | 0.2 | -0.1 | -0.3 | -0.3 | -0.1 | 0.0 | -0.1 | 0.59 |
| | BROAD S | 18 | 0.3 | 0.4 | 0.4 | 0.0 | 0.3 | 0.0 | 0.1 | 0.2 | -0.2 | 0.63 |
| | SPATULA | 4 | 0.3 | 0.3 | 0.3 | 0.1 | -0.1 | 0.4 | -0.3 | 0.1 | -0.2 | 0.73 |
| Tools | RASPADOR | 60 | 0.5 | -0.4 | 0.2 | -0.1 | 0.1 | 0.1 | -0.2 | 0.1 | -0.3 | 0.67 |
| | HACHA | 63 | 0.6 | -0.2 | 0.0 | -0.2 | 0.0 | 0.4 | 0.1 | -0.1 | 0.0 | 0.71 |
| | LASCA ÚT | 58 | 0.6 | -0.1 | 0.1 | 0.0 | -0.1 | -0.2 | -0.1 | -0.1 | 0.3 | 0.61 |
| | PERFERAD | 24 | 0.4 | 0.1 | -0.2 | -0.3 | 0.2 | -0.3 | 0.2 | -0.1 | -0.3 | 0.60 |
| | CELTA | 18 | 0.4 | -0.1 | -0.1 | -0.1 | -0.3 | 0.1 | -0.2 | 0.2 | 0.2 | 0.57 |
| | AZUELA | 36 | 0.6 | 0.1 | 0.0 | 0.1 | 0.0 | 0.5 | 0.2 | -0.1 | 0.2 | 0.68 |
| | DENTICU | 32 | 0.3 | -0.2 | 0.0 | 0.5 | -0.2 | 0.0 | -0.1 | -0.3 | -0.3 | 0.66 |
| | BIFACE | 20 | 0.4 | 0.1 | -0.2 | -0.1 | -0.1 | -0.2 | 0.1 | -0.5 | 0.2 | 0.71 |
| | OBSIDIA | 50 | 0.4 | 0.1 | 0.6 | 0.0 | 0.0 | -0.1 | 0.1 | 0.1 | 0.2 | 0.64 |
| Domestic | PERCUTO | 80 | 0.5 | -0.2 | -0.2 | 0.1 | 0.0 | 0.2 | -0.1 | 0.0 | 0.0 | 0.59 |
| | MACERAD | 9 | 0.1 | 0.0 | -0.6 | 0.0 | 0.0 | 0.0 | 0.1 | 0.4 | -0.1 | 0.68 |
| | POLIDOR | 21 | 0.4 | 0.2 | -0.1 | 0.2 | 0.5 | 0.1 | -0.2 | 0.1 | -0.1 | 0.63 |
| | CINCEL | 4 | 0.2 | -0.2 | -0.3 | 0.5 | 0.1 | -0.3 | 0.0 | 0.0 | 0.0 | 0.56 |
| | MANO | 61 | 0.6 | 0.1 | -0.4 | -0.3 | 0.2 | 0.0 | -0.1 | 0.1 | 0.1 | 0.67 |
| | METATE | 45 | 0.5 | 0.3 | -0.2 | -0.2 | 0.2 | 0.1 | -0.2 | 0.2 | 0.1 | 0.67 |
| | MORTERO | 14 | 0.5 | 0.2 | 0.1 | -0.3 | 0.0 | -0.1 | 0.0 | -0.3 | 0.0 | 0.53 |
| | DESVAST | 17 | 0.5 | 0.2 | 0.0 | 0.0 | -0.3 | -0.1 | 0.0 | -0.1 | -0.2 | 0.54 |
| Materials | PREFORM | 45 | 0.7 | -0.1 | -0.1 | -0.1 | -0.2 | -0.1 | 0.1 | -0.1 | 0.0 | 0.61 |
| | NÚCLEO | 54 | 0.6 | -0.4 | 0.0 | 0.1 | 0.0 | 0.0 | -0.3 | -0.1 | 0.0 | 0.67 |
| | NAVAJA | 14 | 0.1 | -0.4 | 0.3 | -0.2 | 0.0 | -0.1 | -0.2 | 0.3 | 0.5 | 0.69 |
| | CHUNK | 61 | 0.5 | -0.2 | 0.1 | 0.2 | 0.2 | -0.1 | -0.2 | 0.1 | 0.0 | 0.52 |
| | Percent Variance | 80 | 19.1 | 6.0 | 5.8 | 5.3 | 5.0 | 4.2 | 4.1 | 3.9 | 3.9 | 57.2 |

Extraction Method: Principal Component Analysis.

Factors 6, 7, 8, 9 Uniques: The remaining four factors pick up the tendency of Adzes (red), Contracting Stemmed Points (red), Bifaces (blue), and Flakes (red) respectively to occur in no particular patterns relative to the other tools. They are also in the less than 40 frequency range.

## Tool Kit Descriptions

A factor analysis of room inventories, and subsequent crosstabulation evaluation of relationships, support the following suite of eight tool kits (from the acropolis precinct at Calakmul.

1. Manos and Metates. Factor 1 represents a number of types of apparent mixed functions (point tips, utilized flakes, metates, mortars, preforms, celts, tortoise shell scrapers, chunks, and pics). Although some of this functional ambiguity is attributable to number sizes in the data matrix, some of it seems to represent a complex group of tools. Some of the tools are associated with food preparation such as manos and metates. Others probably represent tools that have a wide range of uses and therefore tend to occur unsystematically with other tools among the rooms.

2a. Notch-Broad Stems. The positive aspect of factor 2 points to an alliance between notch stem points, probably used for cutting, and broad stem points. The broad stems appear to be a multipurpose tool with needle sharp tips and heavily resharpened beveled blade edges. The combined features of the two types suggests a cutting and punching activity, perhaps the sewing of hides or bark.
2b. Scraper-Point. The negative aspect of factor 2 contains scrapers and pointed stem points. Cores are also present. This would seem to suggest the locations of weapons manufacture, probably that of atlatls judging by the size and morphology of the pointed stemmed points. The scrapers could have been used for preparing shafts.
3a. Obsidian. Obsidian appears in lone opposition to the other types on factor 3. The complementarity of the distribution implies use in non-related functions. For example, if obsidian was used for cutting hair, the isolation of obsidian would mean that hair cutting was not performed in the same premises as atlatl manufacture.
3b. Macerator-Mano. Manos and macerators appear as a combination of tools occurring in the same space. The macerator must have been used in bark cloth preparation, while manos normally imply the grinding of corn or other seeds. However, the so-called manos are highly varied in morphology and often show evidence of end damage resulting from hammering. They could have been used ***Figure 41***as part of a bark cloth production kit as well, perhaps rolling to smooth the products.
4. Chisels-Denticulates-Straight Stems. The straight stem points appear to amalgamate with the lanceolate in this context. Also present are robust denticulate scrapers and chisels. The combination suggests some sort of incising tool kit. It could have been used for quarrying, working wood, or perhaps engraving stelae.
5. Bipoint-Polisher. The bipoints and polishers together suggest some sort of very special craft. The snapped points found widely distributed through the site and associated with obsidian blades in a near one-on-one relationship could be manufactured by snapping bipoints in two. Although the sample sizes are small, small stems are found in a complementary distribution to this tool kit.
6. Adzes-Small Stems. Small stem points and adzes suggest a woodworking kit of some specialized form. Axes are also present in this association.

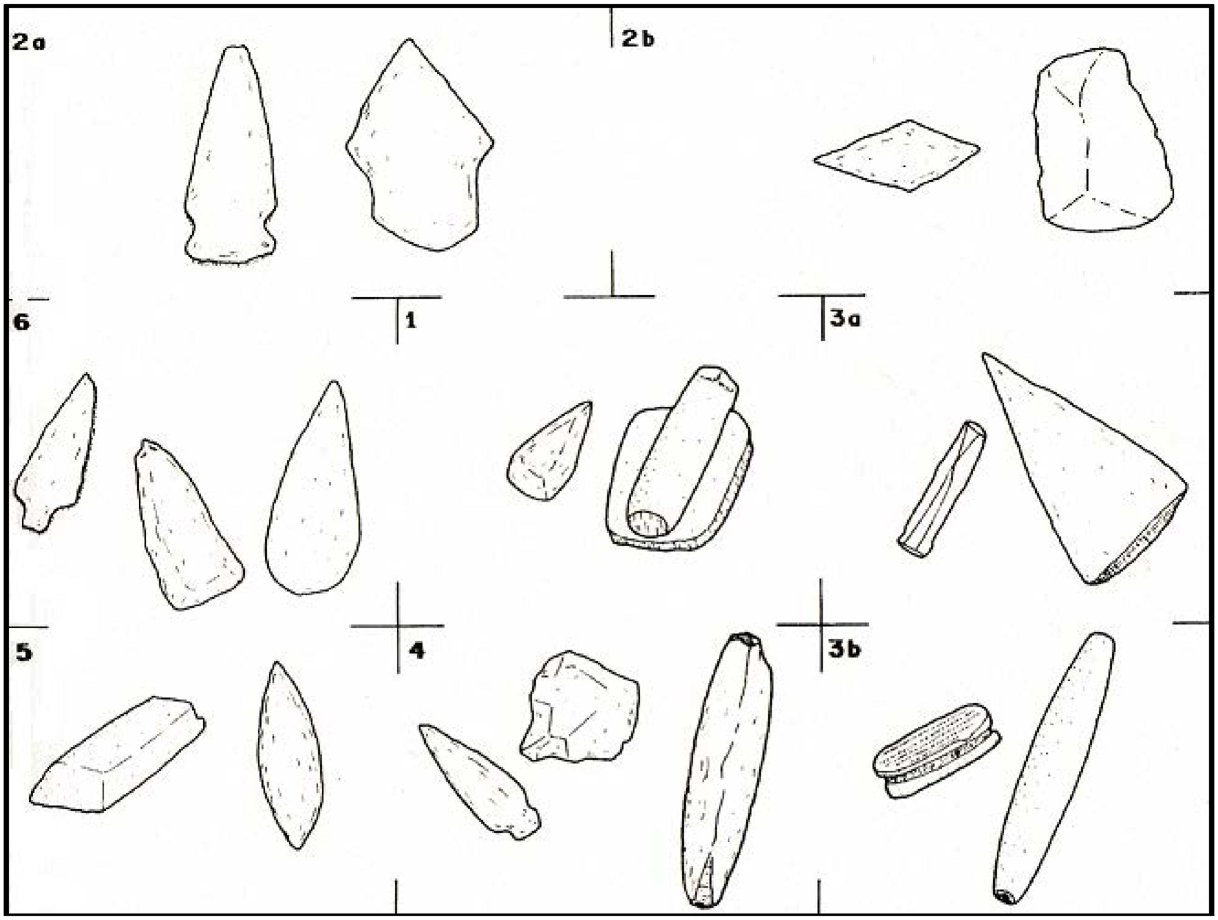


**Figure 41. Tool Kits Obtained by Factor Analysis of Tool Types by Rooms as Presence or Absence Data.**

## Internal Lithic Distribution of Temple Structure II

Analyzing patterns of artifact distribution among the rooms is marked by what appear to be distinctive suites of tools between the structures. To clarify the characteristics of these differences the assemblage from pyramid Structure II with temples and palaces on the summit and rooms on the zones, and palace Structure III were first examined separately and then together. Factor analysis of presence-or-absence of artifact types was used to provide a non-linear examination of the patterns of tool suites.

Pyramid Structure II is one of the largest constructions in Mesoamerica. It is, in design and scale, comparable to El Tigre pyramid in El Mirador 37 km to the south. Thirty rooms on the Structure II zones provided assemblages of lithic artifacts (***Figure 42***). Large collections of ceramics (Dominguez Carrasco 1994) were also gathered.

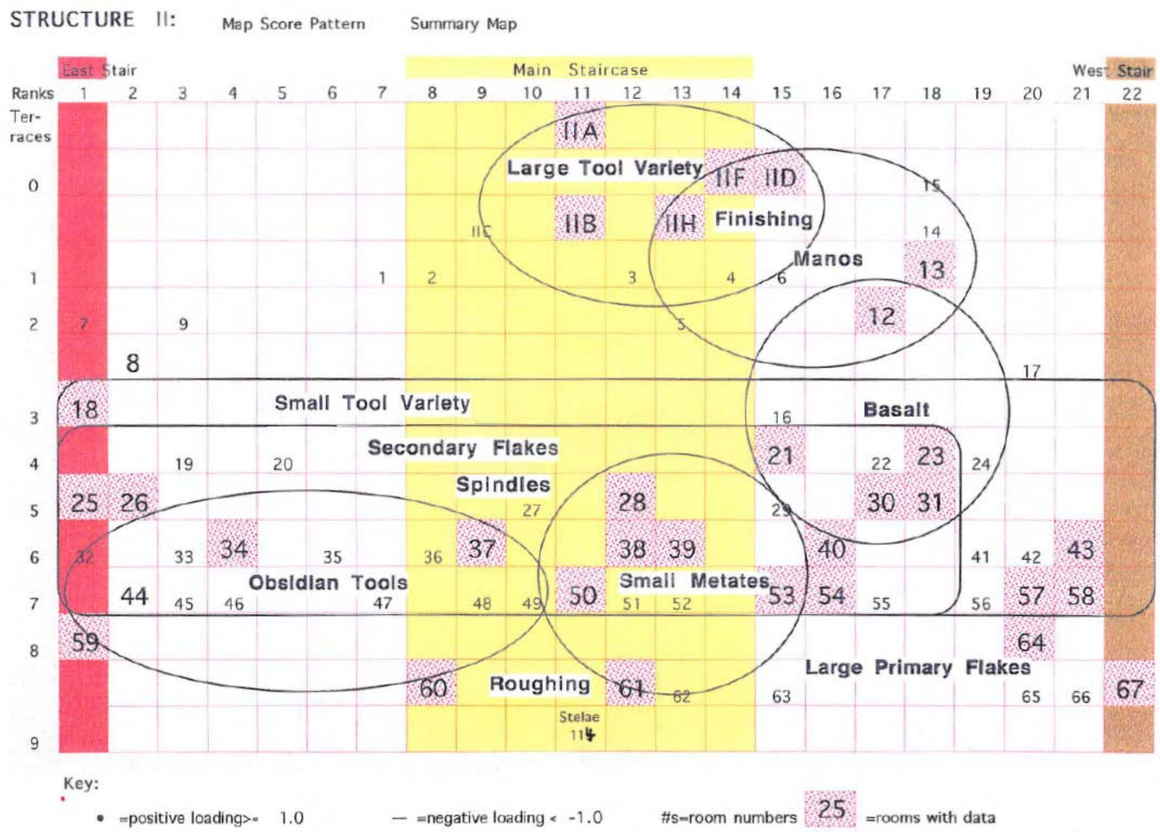


**Figure 42. Room Map of pyramid Structure II Summit IIA, IIB, … and zones 1, 2, … 9 Showing Tool Kit Vicinities.**

Some of the zones rooms were raised on the main staircase. The arrangement suggests that the construction of rooms on the pyramid followed sometime after its Preclassic initial phase of construction and use. This may have been during a more secularized Terminal Classic. Evidence is accumulating that sites were generally fortified or "encastellated" during the Terminal Classic (Marken and Arnauld 2018). Building residential structures on the zones of pyramid Structure II might well have been a handy means of fortification in the Calakmul context.

There is much about the arrangement of artifacts in the rooms, i.e., one chocolate brown point per room, one obsidian blade per room, that suggests orderliness, and suddenness and definitiveness of its abandonment. The age of the assemblage probably represents a moment toward the end of the Late Classic or sometime during the Terminal Classic. Most rooms do not contain large numbers of lithics. Presumably the rooms were kept reasonably clean of tools not relevant to their specialized purpose, and the last-look scenario pertains to the last few weeks, months or years of utilization.

To analyze the distributions and correlations of tool types in the rooms, the raw count data were converted to the presence-or-absence of a tool type per room. Reducing the data to the presence of types in a room provides a first approximation look at the distributions of tool types without involving the more complex issues of frequency and reuse of rooms. Presence-or-absence also dispenses with the frequency dimension leaving a principle components analysis in a non-linear mode in which tools types are free to interact irrespective of their numbers.

Chert was not included in any analysis because it is ubiquitous, and therefore invariant from room-to-room. It must, however, be kept in mind that it is one of the qualitative features of all rooms included in the analyses.

In pyramid Structure II, eight factors (not shown, they are much like **Table 48**) manifest reasonable artifact associations from the analysis of artifacts with good room provenance. The first five of these will be discussed here to examine the most important suites of tools. The five factors account for 53 percent of the total variance in the presence or absence matrix. We presume that the tools associated in these factors represent tools typically used together in some sort of task. The tasks were performed for the most part in separate specialized rooms. Tools of a type may be found in other rooms, but they are not in systematic, correlated association with other tools. For example, an association of manos with bifacial tools is implied by factor 4+ (see below). As can be seen in ***Table 15***, there are manos in many rooms on the face and summit of the pyramid Structure II. It is only in the rooms toward the upper west side and top that they appear in systematic relationships with bifaces.

The factor analyses are taken to represent interesting hypotheses. The relationships are unsure relative to statistical significance and should be regarded as hypotheses of relationships. In subsequent sections some of these hypotheses will be tested using cross tabulated statistical tests. It has to be kept in mind, however, that because it is a highly complex ecological and social environment, a positive statistical result is more frequently than not a surprise, and a negative statistical test does not disprove a relationship: it only shows that in the presence of complexity a positive test outcome is not readily apparent. For these reasons the relationships implied by the factor analysis are more likely regardless of statistical test outcomes because it does take into account at least some of the inherent complexities of the life situation of the room occupants. The point of interest is to determine what the occupants of the rooms were using in terms of artifact types and materials and what their relative wealth and quality of life statuses were. Including room area in the study provides information that the differences in quality of life are technologically associated. All factor analyses are principal components without rotation of the factors.

In the immediately following paragraphs, the five factors will be discussed (***Table 49***). Then a summary discussion and map of the tool complexes with be presented.

1. +High Wealth/Large-Small Variety (23%). Most of the import of factor 1 is that large rooms have more varied artifact types. Though a truism, it is statistically important. The factor captures the variance generated by this simple fact and removes it from consideration in subsequent factors. That shear room size is important in the pattern is flagged by the loading of room size (Area). There are two negative loadings on the pattern; one is the east-west polarization of the face of the pyramid. This negative relationship indicates that the greater variety of artifacts appears on the east side of the pyramid and lesser variety on the west. A negative relationship with elevation indicates that greater variety of artifacts were found near the top zones and summit palace structures on Structure II than toward the bottom of pyramid Structure II.

**Table 49. Tool Suites Associated with pyramid Structure II Factors. +/- indicates the polarity of the variables on the factors.**

| | |
|---|---|
| Factor 1 | +Large Variety, Large Rooms (high wealth), East, Up: Large Variety<br>------------------------------------------------------------------------------------------<br>-Small Variety, Small Rooms (low wealth), West, Down: Small Variety |
| Factor 2 | +Basalt Manos, Bifacing Flakes: Basalt?<br>------------------------------------------------------------------------------------------<br>-Obsidian, Small Heat-Treated Flakes, Scrapers, Small Rooms (low wealth): Fine cutting & scrapping |
| Factor 3 | +Adzes, Scrapers, Large Flakes, Polishers: Roughing<br>------------------------------------------------------------------------------------------<br>-Perforators, Denticulates, and Crude Points: Finishing |
| Factor 4 | +Basalt, on Floor (Context+): beating & cutting<br>------------------------------------------------------------------------------------------<br>-Limestone, Large Primary Flakes, in Rubble (Context-), Low elevations: Beating & cutting |
| Factor 5 | +Metates: Grinding<br>------------------------------------------------------------------------------------------<br>-Spindles, Secondary Flakes: Spinning and Cutting |

Factor 1 can also be interpreted as indicating which artifacts are most ubiquitous. Flakes and materials of most types are widely present in the 78 rooms. Perhaps more interesting are types not represented on this index of ubiquity. For example, as we shall see in the next factor, in some small rooms, chalcedony and obsidian are found in a pattern distinctive from basalt and limestone. Similarly, there are utility items that do not appear as part of the general scatter such as adzes, celts, sharpeners, and heat treating (Fuego). These and other tools that will be discussed in the following patterns appear to be discretely distributed in special purpose areas rather than being a part of the general scatter.

Factor scores were calculated to identify the room locations of tool suites. The factor 1 scores (***Figure 43***) show that, with the single exception of room 59, a large room at the east lower corner of the pyramid face, all of the positive relationships are atop the structure. We know apart from this analysis that rooms 60 and 61 on the same terrace with 59 also have large numbers of artifacts (see discussion of rooms 60-61 above). Rooms on the summit of the pyramid have many types of artifacts. The rooms with small variety of artifact types (-) are aligned along the middle and west portion of the pyramid Structure II zones. Thus, large varieties of artifacts are at the top and on the east side of pyramid Structure II. In the QOL paradigm, this suggest that people who are better off because they have more network connections are located in the upper, east rooms.

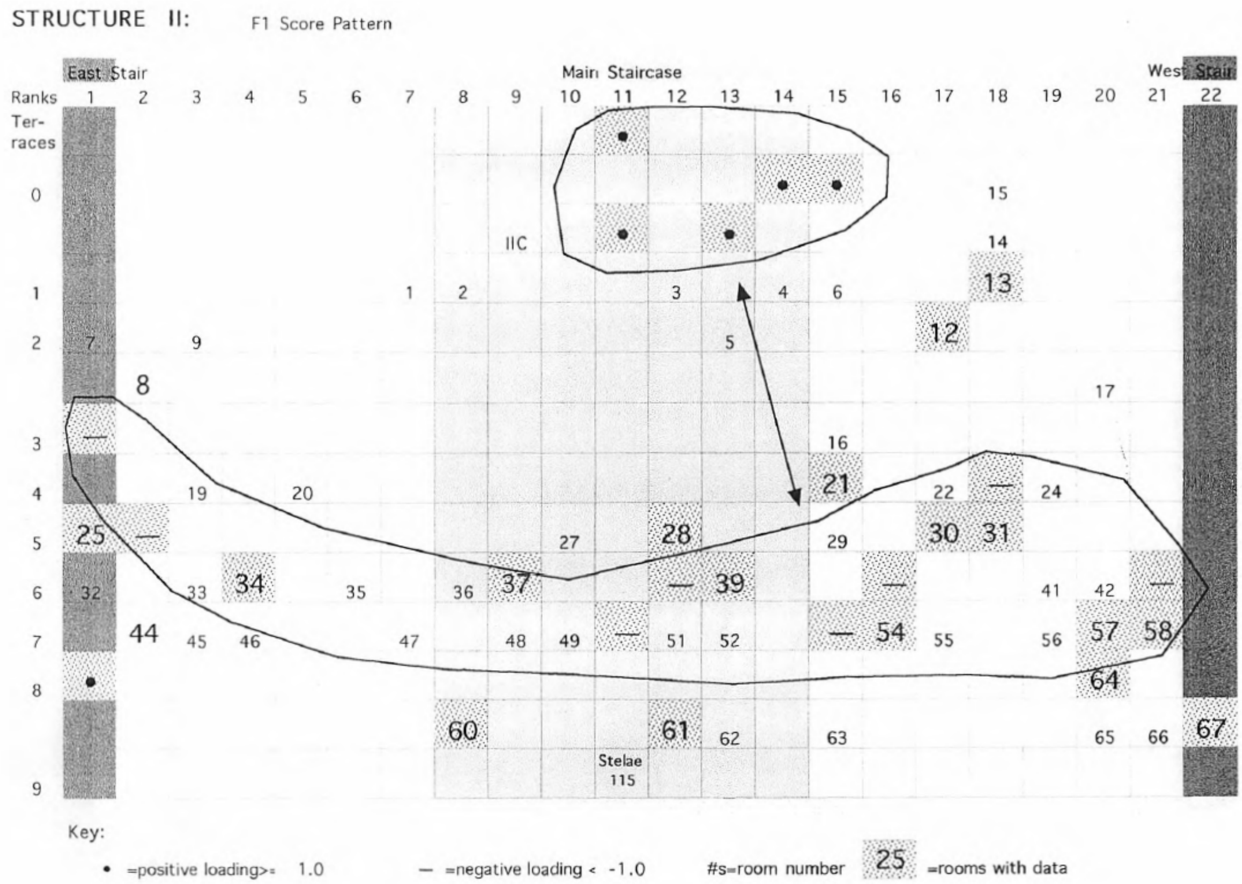


**Figure 43. Room Map of Factor Scores for Factor 1, Large Room-Small Room.**

Perhaps the lesson to be drawn from this pattern is that large rooms at Calakmul are materially busy rooms. Does this imply that small rooms involve rituals, non-material, private matters? They could be market stalls or for other similar functions (see Folan and Dominguez Carrasco 2017).

2. +Basalt-Obsidian (10%). Pattern 2 is primarily a matter of luxury imports. Small (1-3 cm) obsidian blades and heat treated, tertiary flakes constitute the negative node. Scrapers also appear with this pattern. The obsidian blades are obviously luxury goods as they occur in relatively low frequency and were obtained from the most distant material sources in the Guatemalan and Mexican highlands. Both obsidian blades and small, tertiary heat-treated flakes suggest refined cutting functions. This is joined to scrapers for a combined fine cutting and scrapping function.

At the positive node are basalt manos (this can be checked in the artifact-oriented phase of the analysis) and bifacing flakes. Basalt is also a non-local material with lavish labor input for manufacture. The use of basalt manos must have been enriching to make it worthy of the expense of importing such heavy materials. Additional functional interpretations await the next phase of the analysis which is oriented toward single artifacts.

The pattern 2 scores (***Figure 44***) show a concentration of the fine cutting and scrapping pattern at the lower extremity of the east side of the pyramid. The basalt pattern appears to the west of the main staircase and on the summit of pyramid Structure II in Structure D, Structure F, and Structure H.

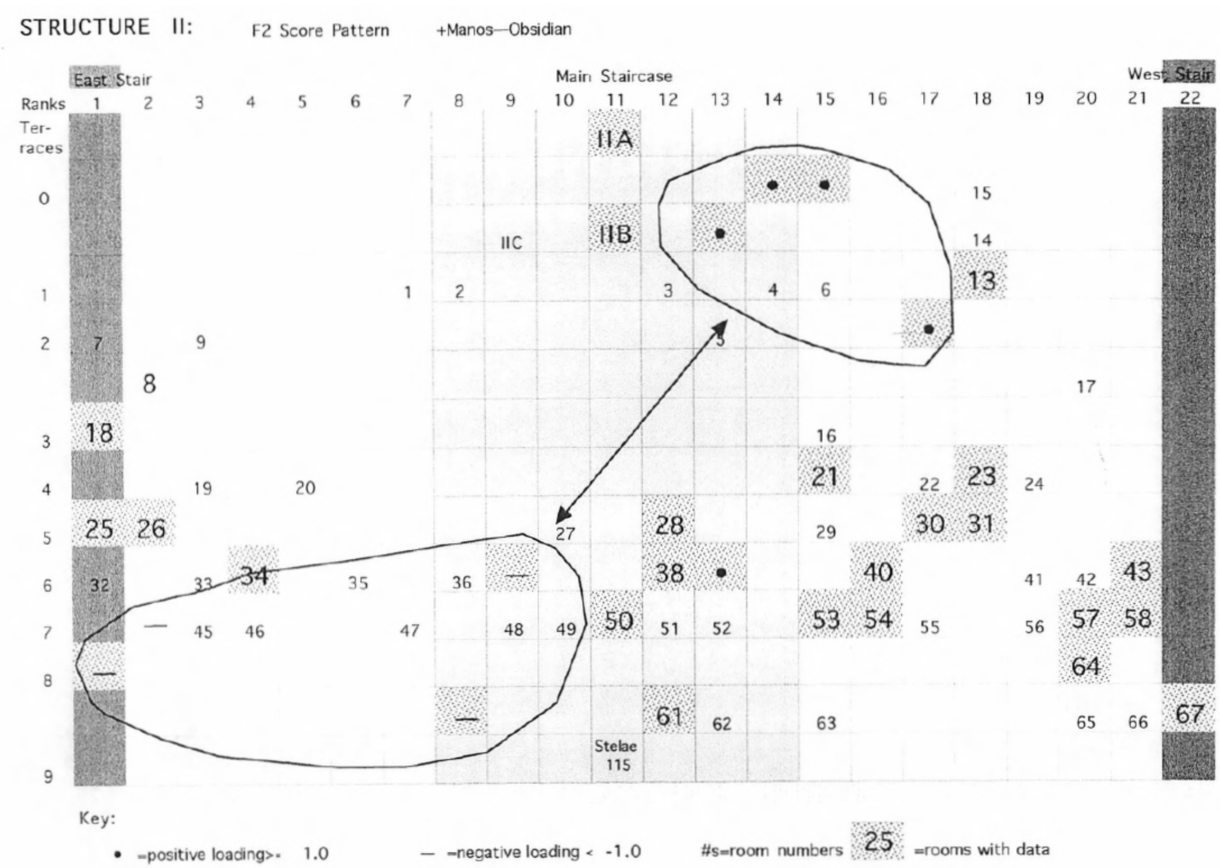


**Figure 44. Room Map of Factor Scores for Factor 2, Basalt Manos (+)-Obsidian Blades (-).**

3. <u>+Adzes-Perforators</u> (8.0%). The pattern consists of formal tools. Adzes, scrapers, large flakes, and polishers appear on the positive node. The adzes and large flakes suggest a roughing out of wood function. Scrappers can be used to debark much as a fine adz. Adzes imply heavier work.

Opposed to the roughing function on the negative node are perforators, denticulates, and crude points (Puntas sin muesca). Perforators and denticulates could furnish a finishing shop. In either case, the distinctions are enlightening as to the covariation of tools. Adzes as opposed to perforators could easily be guessed to be involved with diverse roughing and finishing functions. The association of adzes and scrapers, on the one hand, and perforators and denticulates on the other implies functions that vary from usual functional interpretations. The standard functional interpretation of denticulates is rough sawing such as during the processing of coarse materials such as roots for food. The association with perforators, however, calls this assumption into question in this context. However, the many sharp points on a denticulate could easily function as fine engravers or other refining functions. This is a question that needs to be addressed by wear analysis. Coarse points could also serve as knives in association with this tool kit. Pyramid Structure II, palace Structure B contained only a set of these tools: perforator, point, and denticulate.

The pattern 3 scores (***Figure 45***) reveal that the positive adz rooms are distributed across the bottom of the pyramid. The negative perforator suite is at the top of the pyramid and on the main and east staircases. The adz—perforator contrast suggests roughing at the bottom of the pyramid and refining at the top. It creates an image of the pyramid, like a tornado, drawing raw material in at the base and refining it up pyramid. After following this sacred trail, it is passed on to the palaces as discussed below.

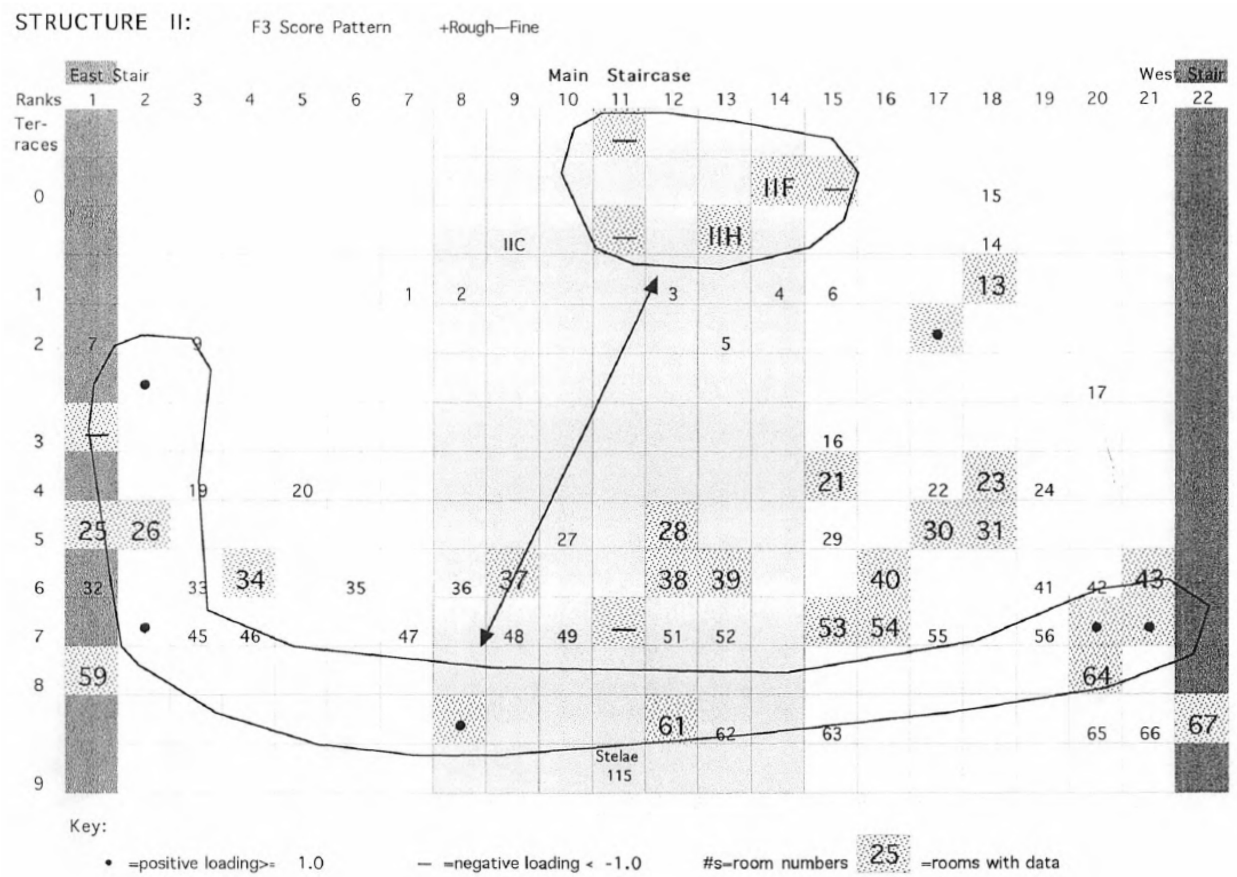


Figure 45. Room Map of Factor Scores for Factor 3, Rough-Fine.

Figure 46. Basalt Manos, Metates, Axes, Adzes, Hammer Stones from Structure II.

4. +<u>Basalt-Large Flakes</u> (6%). This is the only pattern with an association between stratigraphy (floors and rubble) and artifacts. Basalt and limestone appear within this pattern in opposite contexts. Basalt is located on the floors and limestone in the rubble above it. Maseradores, manos, and hammerstones are the artifacts commonly made of limestone, although none of these tool types display an apparent affinity to the pattern. It is interesting that they all function in beating-hammering roles. The location of the limestone implements in the rubble could indicate that they were stored in more elevated locations such as nooks, while basalt typically resides on the floor. At Dzibilchaltún, metates were found in a long reception area of the household (Folan 1969:442).

Basalt was used for a few manos (see Factor 2). The basalt manos are well polished and quite handsome (***Figure 46***). They could also have served other purposes. They may have been weapons, for example. They are perfectly round which makes one suspicious of their use for grinding; unless used very carefully, grinding would have flattened sides. A bivariate analysis discussed below suggests they may have been used in the paper/cloth making process.

Basalt appears alone on the positive node. There may be a slight association with axes. On the negative node with limestone are large primary flakes. Would large primary flakes be useful for cutting bark cloth?

The pattern 4 scores (***Figure 47***) detect this basalt pattern in the central portion of the pyramid west of the main staircase. The limestone—large flakes suite are found along the bottom, concentrating toward the external staircases

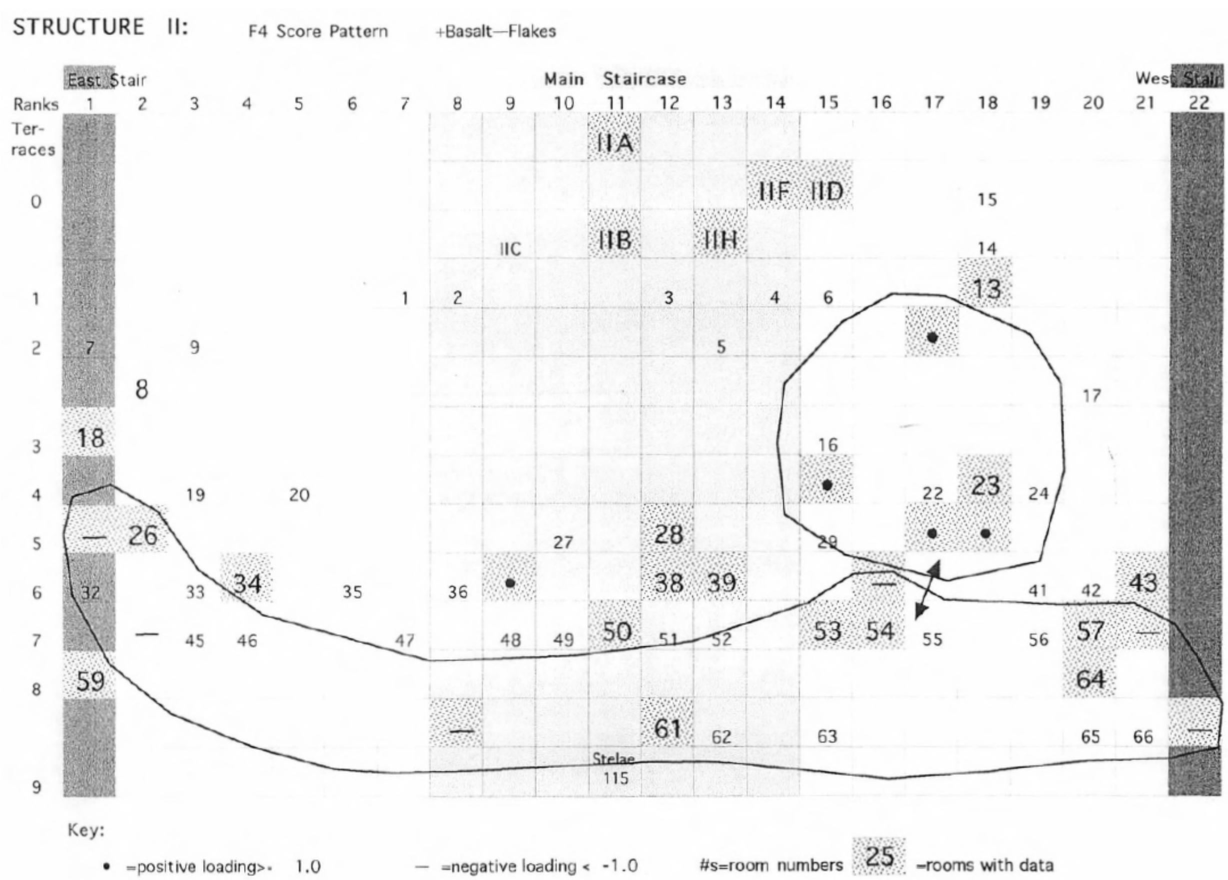


**Figure 47. Room Map of Factor Scores for Factor 4. Basalt (+)-Flakes (-).**

5. <u>+Metates-Spindles</u> (6%). The negative node of pattern 5 reveals an association between spindles and secondary flakes. This could imply tailoring activities requiring string-thread manufacture including spinning and cutting of thread. At Dzibilchaltún, a spindle whorl was found in a crypt (Folan 1969:447).

Its interior location indicates a person of some status. This suggests some amount of reverence for the object and an elevated status for fabrics, a common export from the peninsula as viewed by Columbus on his fourth voyage (Bergreen 2011). The northwest part of the peninsula around Halacho, Yucatan, remains an area of textile manufacture to the present.

The positive pole is confined to small metates. The metates exhibit grooves that could catch dye pigments or spices once ground fine.

The pattern 5 scores (***Figure 48***) indicate that the metate function is on the lower west side of the main staircase just below the basalt function in pattern 4. The spindle-flake function is dispersed in a long linear pattern across zones 4-7. This is similarly parallel to the limestone-flake distribution in pattern 4. One is left with the impression of some sort of subtle interaction between the two patterns. The areal distribution is the same/similar, but the room distribution differs. Perhaps the manufacture of textiles of thread and bark cloth, and their dying while using basalt manos and metates in the fabrication and design. That two possibly related functions appear on separate factors suggests that all tasks of the sequential processes were not performed in the same rooms, but in adjacent rooms.

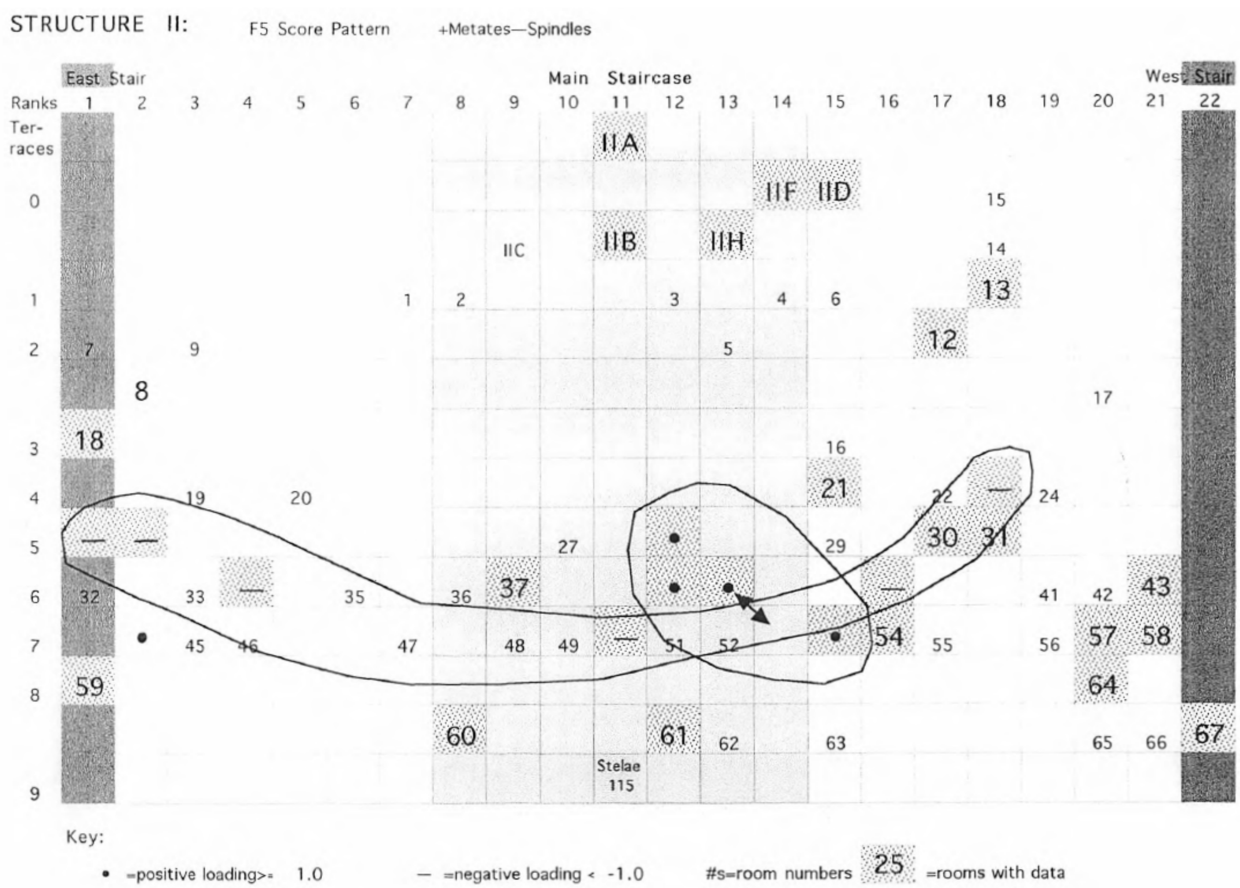


**Figure 48. Room Map of Factor Scores for Factor 5, Metates-Spindles.**

There are four more patterns (factors 6-9) involving two or three tool types. They may or may not be important. That they account for very small portions of variance suggests a minimal quantitative role for these patterns. Pattern 7 is interesting in that it suggests flint, macerators, and polishers are associated with smaller rooms.

From the first five patterns, we can draw a picture of interrelated tasks that were practiced in differing room locations (see ***Figure 42***). Under the mask of room size, which larger room size automatically allows for a wider variety of activity as area increases, there are numerous underlying patterns. Removing the room-size mask, we find that some of these patterns tend to concentrate in clusters on the zones of the pyramid. These concentrations include the metate/grinding (5+) function at the lower reach of the main staircase. The basalt "manos" (4+) function is at the upper west area of the structure. Refining activities (3-) with perforators, points, and denticulates are in the rooms atop the pyramid. However, obsidian blades (2-), which must have been used for some sort of refined cutting, appear with small, heat-treated flakes and scrapers are at the lower east side. Other functions are distributed in linear patterns across the structure such as the large primary flakes (4-), the adz roughing function (3+), and the spindle whorls and secondary flake function spinning and cutting (5-).

In broadest outline, the patterns suggest a mosaic of functions (Folan 1969; Barba and Manzanilla 1989; Fedick 1996). There is an overall tendency for raw material transformation (primary flakes, adzes) in the lower reaches of the structure, to give way to more refined functions toward the top involving perforators, basalt "manos", denticulates, and crude bifaces.

Contrary to this trend, obsidian blades, secondary flakes, and metates are found in the presence of spindles toward the bottom and to the east. In accord with these same patterns, it would seem that the western side of the principal staircase of pyramid Structure II was associated with elite, ritual-related functions perhaps of a military character based on the presence of a pattern including chocolate colored points with black dots and other objects constructed out of exotic and luxury materials.

One might speculate that the manufacture of textiles (spindles) and bark cloth (maseradores) was being practiced on the lower front of the structure. The association of basalt "manos" with the area west of the main staircase where the qualitative pattern of chocolate brown black spotted snapped points were found suggests that the area west of the main staircase was given to some sort of regimented elite function, perhaps ritual or military in character, that was supported by exotic/expensive stone objects. This is an hypothesis that may be supported by analysis of other materials such as ceramics, and by the artifact-by-artifact analysis that will require additional research.

Structure III and Temple VII, again based on the different sequential stages of lithic production, support our hypothesis of the movement of lithic materials from temples (II-A and VII-F) toward palaces (II-B and III). In pyramid Structure VII there is a large presence of primary and secondary flakes. In palace Structure III there is a high concentration of secondary and tertiary flakes. These include numerous flints and minor frequencies of prismatic blades of obsidian (in sub operations III-A, III-E, III-Room 1Q and III Room 12R). This pattern may be relevant to a Classic-Period sacred status of lithic production. Bruce (1976) reports that the Lacandon of the past fabricated lithic materials in the God House but later, after the arrival of the missionaries, made them in the kitchen (Clark 1991; Clark and Esponda 1993; Nations and Clark 1983).

## Bivariate Analysis: Rooting around in the Details

To test the relationships suggested by the factor analysis, the artifact distributions were treated with crosstabulation tests. This treatment is not exhaustive but there are enough determinations to provide an understanding of what the most important tool kits are and what their level of statistical significance is; which is to say, that the sample sizes are large enough that they are unlikely to have occurred by chance. Because it is a multidimensional technique, factor analysis performs many tasks simultaneously such as exposing collinearity, unmasking variables, correcting for autocorrelation and curvilinearity, and others. As such it far outstrips the ability of crosstabulation to sort out complex relationships. However, the statistics associated with crosstabulation tables, Fischer’s Exact Probability Test in this case, are reassuring in that they show that some of the less involved relations pass the statistical test. Crosstabulation sometimes reveals serendipitous insights that would otherwise be missed in the more global perspective of factor analysis. However, an insignificant crosstabulation relationship only means that a simple relationship does not exist, not that no relationship, especially a multifaceted relationship, exists.

Unlike the factor analysis above, the crosstabulations calculated the frequencies of tools rather than their presence or absence in rooms.

Factor 3 suggests that barkbeaters (macerators) are associated with manos. To test the statistical significance of this association a 2x2 crosstabulation table was created and Fischer's exact test calculated

(***Table 50***). The results show that the relationship is real with all but one (8) of the macerators falling within the same rooms as manos. The co-occurrence of manos and macerados (n=8) is twice what would be expected by chance (n=3.8). This implies that the manufacture of bark cloth was performed in the same space as the use of manos. Perhaps the manos were used in the bark cloth production process for smoothing, flattening, or otherwise finishing the paper and/or cloth.

**Table 50. Crosstabulation of Manos and Maceradors (barkbeaters).**

| | | | MACERADOR | | Total |
|---|---|---|---|---|---|
| MANO | | | 0 | 1 | |
| | 0 | Count | 82 | 1 | 83 |
| | | Expected Count | 77.8 | 5.2 | |
| | 1 | Count | 53 | **8** | 61 |
| | | Expected Count | 57.2 | **3.8** | |
| Total | | Count | 135 | 9 | 144 |
| | | Fischer's Exact Probability = | 0.005 | | |

Factor 3 also contains obsidian artifacts on the opposite aspect from the mano-bark beater tool kit. This implies that obsidian tools were being used in other spaces than those used for making bark products. The association produced no expected values of unexpected quantity in the crosstabulation context. Whatever the obsidian relationship is that appears in Factor 3, it is too complex to be understood in terms of a crosstabulation or does not exist.

Factor 2 on its negative aspect contains an association between pointed (contracting) stem points, and scrapers (raspadors). Since the pointed stems appear to be designed as dart points (see above), the combination suggests a hunting and scraping kit. The scrapers probably being used to prepare shafts and other components of the weapons system. The relationship generated a highly significant p<.001 (***Table 51***). Also associated with this tool kit are cores that might be the source material for manufacturing stone components of the weapons system and scrapers.

**Table 51. POINTED stem * RASPADOR Crosstabulation.**

| | | | RASPADORE | | Total |
|---|---|---|---|---|---|
| POINTED | stem | | 0 | 1 | |
| | 0 | Count | 82 | 47 | 129 |
| | | Expected Count | 75.3 | 53.8 | |
| | 1 | Count | 2 | 13 | 15 |
| | | Expected Count | 8.8 | **6.3** | |
| Total | | Count | 84 | 60 | 144 |
| | | Fischer's Exact Probability = | <.001 | | |

The positive aspect of Factor 2 is a co-relationship between **notched** and **broad stem** points. This association also produces a statistically significant probability (***Table 52***). The association of a point designed for drawing (see notches above) and the robust broad stems, most of which have carefully prepared, needle-sharp points, and heavily resharpened and beveled blade edges, signals a multipurpose tool. The combination implies a punching and cutting combination. Such a tool kit might be used for cutting and punching leather to make garments and garment support accouterments such as belts and straps. Deer skin was used in the manufacture of parchment for Maya codices; whether these tools could have been used in the process needs to be studied.

**Table 52. BROAD Stem * NOTCHED Crosstabulation.**

| | | NOTCHED | | Total |
|---|---|---|---|---|
| BROAD Stem | | 0 | 1 | |
| 0 | Count | 116 | 10 | 126 |
| | Expected Count | 112.0 | 14.0 | |
| 1 | Count | 12 | **6** | 18 |
| | Expected Count | 16.0 | **2.0** | |
| Total | Count | 128 | 16 | 144 |
| | Fischer's Exact Probability = | 0.006 | | |

Factor 4 contains four tool types, **straight** stem and **lanceolate** points, **denticulates**, and **chisels**. The straight stem and lanceolate points exhibit a significant relationship (***Table 53***). Because of sample size, denticulates and straight stems also have a significant association (p=.004). there are about three times as many co-occurrences (7) as expected (2.5). The other relationships are not significant because of small sample size, but the proportions of expected and observed values are approximately equal and therefore unexciting.

**Table 53. LANCEOLate * STRAIGHt stem Crosstabulation.**

| | | STRAIGHt stem | | Total |
|---|---|---|---|---|
| | LANCEAOLate | 0 | 1 | |
| 0 | Count | 112 | 17 | 129 |
| | Expected Count | 107.5 | 21.5 | |
| 1 | Count | 8 | **7** | 15 |
| | Expected Count | 12.5 | **2.5** | |
| Total | Count | 120 | 24 | 144 |
| | Fischer's Exact Probability = .004 | | | |

The **lanceolates** are the near-morphological equivalents of the **straight stems** because a straight stem is in many varieties a lanceolate with a little bit of a shoulder. Thus, the overlap between straight stems and lanceolates is not surprising. A great deal of variety exists in the straight stems that does not appear in the lanceolates, but there is no particular problem in viewing the lanceolate as a variety of the straight stem.

The association of the **straight stem** varieties with denticulates and chisels suggest a rather robust undertaking that required modification of hard or strong materials. Hansen (personal communication) found bifaces that resemble some of the lanceolate and straight stems hafted on handles and used to quarry limestone. The straight stem tool kit could be for a similar purpose.

The **small stem points** are issues in both factors 5 and 6. They are an interesting type. They have a diminutive stem that is usually offset from the axis; this suggests a haft designed to get the hand of the user out of alignment with the action, probably a draw knife. This perspective is supported by edge treatment that generally involves serration opposite the offset haft and dulling of the edge on the handle side, something like a modern steak knife.

Factor 6 contains small stem points along with axes and adzes. The axes and adzes have a very strong association of p=.001 (***Table 54***), but the small stem points have a weak one (p=.01). The association of heavy equipment such as axes and adzes is not surprising. The small stems are so few in number that their constituency to the tool kit remains marginal.

### Table 54. HACHA * AZUELA Crosstabulation

| | | | AZUELA | | Total |
|---|---|---|---|---|---|
| HACHA | | | 0 | 1 | |
| | 0 Count | | 76 | 5 | 81 |
| | | Expected Count | 60.8 | 20.3 | |
| | 1 Count | | 32 | 31 | 63 |
| | | Expected Count | 47.3 | 15.8 | |
| Total | Count | | 108 | 36 | 144 |
| | | Fischer's Exact Probability = <.001 | | | |

The presence of axes and adzes implies a woodworking tool kit. The presence of wooden lintels and perishable structures atop pyramids, and probably furniture of wood would have required heavy tools. If the small stems are associated with this tool kit, it might have performed as a woodsman's knife for cutting binding materials. Cutting sisal, inner bark or similar materials binding planks would explain the need for an offset handle on a relatively gracile implement.

Factor 5 picks up **bipoints** and **polishers** (polidor). The statistical relationship is not particularly strong (***Table 55***, p=.06), but a greater than expected number of locations of bipoints (n=21) correspond to the locations of polishers (3). The bipoints are always well made and generally relatively thin. They may have been manufactured, at least in one use, to be snapped in two to make the symmetrical bipoints. The meaning of the bipoint-polisher association is not clear. However, the so-called polishers might have been used to carefully snap the bipoints in two.

### Table 55. PULIDOR * BIPOINT Crosstabulation

| | | | BIPOINT | | Total |
|---|---|---|---|---|---|
| PULIDOR | | | 0 | 1 | |
| | 0 | Count | 119 | 4 | 123 |
| | | Expected Count | 117.0 | 6.0 | |
| | 1 | Count | 18 | 3 | 21 |
| | | Expected Count | 20.0 | 1.0 | |
| Total | | Count | 137 | 7 | 144 |
| | | Fischer's Exact Probability = | 0.06 | | |

**Small stem** points appear on Factor 5 in its negative aspect. The disjunction between small stems and **bipoints** is very real. No bipoint appears in the same space as a small stem. There are only seven specimens in each type in the analysis, so there is plenty of room for the disjunction, but the relationship does imply some sort of complementary function of the two types. Their associations, small stems with heavy equipment, and bipoints with more refined material, also implies varying functions.

The remaining factors 7-9 contain only one tool type or two types on negative aspects of one factor. These tools, **contracting stems**, **bifaces**, and **prismatic blades**, hold no regular pattern of distribution to the other tool types that can be detected by factor analysis in the context of a presence-or-absence analysis. Since they are tools that can be assumed to be important, their lack of systematic association probably implies that they were used indiscriminately in many different functions and were therefore unsystematically associated with many different tool types.

Factor 1 contains a large number of types (n=19). Of these, nine appear only on factor 1. Factor 1 as a general rule picks up variance that has to do with extraneous influences such as the sizes of numbers. In this analysis the wide disparity in sample sizes of types might be an issue. In the factor analysis the sizes of the factor loadings on factor 1 correspond in some detail to the number of presence values in the rooms. Regressing the Ns against the loadings indicates that a significant relationship exists between the sizes of the loadings and the Ns (F-value = 35.7, p<.001). The R-squared is 0.55 indicating that 55 percent of the loadings in the first factor can be accounted for by the size of Ns. However, this means that 45 percent of the variance in factor 1 is a function of other influences. Since many of the tools appear only on factor 1, some of the strong loadings in the first factor must be related to the inter-correlation of tool types, otherwise they would appear.

The nine types that appear only on factor 1 are shown in ***Table 56***. Some of them such as utilized flakes would have undoubtedly been used as general-purpose tools and would have occurred everywhere with other tool types. Others such as the devastadors and pics would probably had specialized uses and locations and are found as they are because of low Ns.

**Table 56. Tool Types Appearing only in Factor 1.**

| |
|---|
| Point tips |
| Utilized Flakes |
| Metate |
| Mortero |
| Preforms |
| Celts |
| Devastador |
| Chunk |
| Pic |

Some of the other tool types share variance between factor 1 and the other factors discussed above. The combination of tools includes devastadors, performs, celts, all heavy implements. The mortars tend to be small fancy vessels with legs, perhaps for grinding cosmetics or spices. The association with metates leads to visions of some sort of general food preparation assemblage.

## Internal Lithic Distribution of Palace Structure III

Five patterns emerged from an analysis of presence or absence room data from palace Structure III. The first two patterns relate to the size of rooms while the remainder pertain to associations of artifacts without respect to room configuration.

1. Room Size (32%). The first patterns is unambiguously associated with room area. The larger the room, the larger the variety of artifacts in the room. All materials appear except flint and jasper implying that they are distributed by some other principle than simply the size of the rooms. Flint (blue) and jasper (yellow), especially, are part of the Mayan color cosmology, and will be regarded as potentially significant in that domain. Flint and jasper also appear in patterns 2 and 3 (see below).

Large primary flakes, along with cores and bifaces, increase with room size, but secondary and tertiary flakes do not. This suggests that lithic manufacture was on-going in the large rooms.

The likelihood of potlidding, and presumably inadvertent heating of lithics, increases with room size. This could suggest something like the larger rooms were utilized for functions involving fire, perhaps kitchens or collective gathering quarters.

All tool types increase with room size except sharpeners, metates, and perforators. One would expect that metates and perhaps sharpeners were related to food preparation. Perforators, however would be used in some other function involving piercing of wood, hide, and other materials for constructive purposes. Metates appear on pattern 4 and sharpeners on patterns 4 and 5 (see below). Perforators are on pattern 2.

2. Perforators-Pics (7%). Room size appears again on this pattern and it is a bipolar factor implying

two suites of tool occurring in mutually exclusive room sets. This indicates that there are different functions proceeding in both large and small rooms that are mutually exclusive.

The positive aspect of the pattern 2 indicates that in the small rooms heat treated secondary and tertiary small flakes are associated with cores. Flint and chalcedony are commonly present. The flint and chalcedony are rare and possibly exotic in the site as a whole. Their use suggests special functions or elite consumption. Utilized flakes indicate cutting/ scraping functions while perforators perform associated piercing. Perhaps the perforators indicate a finishing quality to the task. This may replicate the roughing-finishing functions detected at the lower side of pyramid Structure II (see above).

The large rooms are on the negative aspect of pattern 2. They are associated with basalt. Basalt is predominately a feature of pyramid Structure II in the combined Structures II/ III analysis (see below). Basalt appears to be a social thing appearing in the large and presumably more social rooms of palace Structure III and in the apparently regimented sectors on the west of Structure II, and more toward the top of Structure II. All of this suggests some sort of social aura about basalt. Since Caracol was Calakmul's persistent ally, and it was from a basalt supplying area of the lowlands, there may have been an effort to use it in socially significant contexts.

The tool associations of the larger rooms include picks, scrapers, and preforms (or possibly bifacial tools). The picks presumably suggest some sort of roughing function, but scrapers and preforms, possibly bifacial cores, suggest finishing functions.

The implications of the paired patterns of factor 2 are that rooms of different size served several functions. Perhaps it suggests that small rooms are like sewing rooms (perforators) and the larger rooms more like kitchens (picks, scrapers) and social rooms.

3. <u>Mortars-Axes (10%)</u>. No structural or fire related features appear in bipolar pattern 3.

The positive aspect of pattern 3 is involved with small secondary and tertiary flakes and mortars. The small three-legged mortars appear to suggest textile or food preparation in other contexts (see structure II above). The association here with small, refined flakes suggests cutting functions, perhaps cutting of food (spices?) or dye stuffs for grinding.

The negative aspect of pattern 3 is associated with flint and jasper materials. Axes and preforms appear, distinctly larger cutting implements. The axes imply a roughing function, perhaps chopping for foodstuffs. It does not seem like a proper environment for chopping of wood although there is no way to discount it without wear analysis. Axes are said to be ubiquitous and versatile, perhaps the ancient equivalent of machetes. This would be equivalent to having machetes in the kitchen.

4. <u>Sharpeners-Axes (8%)</u>. This pattern is uniquely associated with stratigraphic context. It suggests that only sharpeners are found on or under the floors. Adzes, hammerstones, axes, and mortars tend to be toward the rubble. They are larger tools and so may have been retrieved more frequently in the higher stratigraphy. Alternatively, the axes and adzes could have been stored more frequently in wall niches resulting in their being incorporated into the rubble as the structure disintegrated.

5. <u>Sharpeners-Adzes (7%)</u>. Sharpeners and crude points are associated with limestone material on the positive aspect of pattern 5.

The opposite aspect of the pattern is adzes and axes. The forms suggest fine work in some rooms and coarse in others.

In summary, as in Structure II, palace Structure III shows functional differentiation on room size. Though tool types are replicated in both structures, their associations and context suggest varying emphases and functions. There is no record of spindles in Palace III. There is only one barkbeater in the Structure II Temple A (see ***Table 13*** 2A). These industrial functions appear to be largely confined to the zones of Structure II.

## Inter-structural Lithic Distributions Between Structures II and III

A factor analysis of all rooms (n=58) with good provenance from both structures revealed four patterns of distribution. The first two patterns involved differences between the two structures and the second two show patterns of artifact type associations irrespective of structure.

1. Palace Finishing (24%). Pattern 1 captures the sample size aspect of the assemblage and contains a large proportion of the observed types. Since the structure number is involved, the pattern implies that assemblages are larger in palace Structure III and that the greater variety of artifacts is in palace Structure III. Room area is present indicating that a determining influence in assemblage size is the room size and that rooms tend to be larger in palace Structure III. All of the variables measuring flake technology types, flake reduction state, and flake size appear on this pattern. The large rooms in palace Structure III with large assemblages are simply far more broadly based in variety of characteristics. Of the material types, only basalt is not associated with palace Structure III, but rather finds a home in pyramid Structure II.

Potlidding is taken to represent inadvertent burning of lithic materials, usually flints and cherts. In contrast, discoloration (FUEGO) is thought to imply intentional preparation of cherts by heat treating. Inadvertent burning appears to be widespread in palace Structure III but not in pyramid Structure II.

Tool types indicate that obsidian pieces are more a feature of palace Structure III than pyramid Structure II. Many of the tools are small work implements such as obsidian blades, utilized flakes, denticulates, perforators, preforms, and points. The larger tools such as adzes, axes, celts, hammerstones, devastadores, manos, and metates do not appear. This suggests finishing as opposed to roughing orientation of the palace assemblage.

2. Pyramid Roughing (11%). The presence of the structure number variable on this factor clearly implicates pyramid Structure II as a part of this pattern. Structural influences are further refined by elevational differences in room location (ELEVA) on the temple face. The context of artifacts is important.

None of the flake attributes are important on pattern 2. As is apparent above, we obtained a better sense of flake character within structures when we examine the structures separately. Among material types, basalt and quartzite are marked as characterizing pyramid Structure II.

The tools associated with pyramid Structure II are distinctly of the roughing types. Included are adzes, axes, manos, and metates. Points are also an important feature of pyramid Structure II rooms. Hammerstone are common in pyramid Structure II. At least one of their functions appears to have been stone tool manufacture.

3. Points/Blades or Manos/Bifaces (7%). Patterns 3 and 4 have no particular affinity to either structure, elevation, room area, or context. Pattern 3 is bipolar and thus represents two distinct tool associations that occur in different sets of rooms in both structures. Since no structure variables are involved, the room tool sets crosscut structures.

Small tertiary flakes of chalcedony and obsidian blades appear on the negative aspect of the factor (pattern 2–) along with points. They would be rooms with special point/obsidian blade functions. That they appear in both structures implies that the tools association's function was not limited by structure. Whatever social functions divided those inhabiting Pyramid II and Structure III, those activities did not include the combined use of obsidian blades and points, but rather they shared their use. This pattern includes the notable chocolate brown snapped points and snapped points of related materials.

The positive aspect of pattern 3 implies a cofunction for manos and bifaces of all kinds. This includes all types of manos and all materials and sizes and all types of bifaces including points, preforms, and crude bifaces. The categories are general and indicate general rather than specific functions of the two tool classes.

4. Flakes or Picks (7%). Secondary, heat treated flakes appear on the positive aspect of pattern 4.

The presence of flat platforms implies a relatively early reduction stage. The secondary flakes may represent reduction waste but are more likely suggestive of the uses to which such flakes were put.

The negative aspect of pattern 4, is an association of denticulates and picks. Obsidian material also appears. Denticulates and picks both are associated in theory with penetrating and cutting/scraping coarse materials such as roots.

The remainder of the patterns either contain singular variables or small variable associations that appear to be trivial.

## Summaries: Inter-structural lithics flows

In an earlier section we examined the distribution of material types from a globalist point of view using factoring. In this section we will try to narrow the scope to localist conditions to see where the networks of exotic goods and functions are linking into the social structure as indicated by room locations. To material types we add, reduction stage, and termination to sensitize the analysis to manufacturing stages to see if there are origin and termination points for lithics among the rooms. Types of material vary in accessibility and tend to be graded according to their utilitarian value and perhaps in some varieties as sacred symbols due to color or place of origin. Naturally materials that are acquired by trade from long distances are of greater symbolic and/or utilitarian value than local, generally available materials. In Smith's (2019) vocabulary they signal a higher standard of living: in this there is no conflict between the quality of life paradigm and the social hierarchy paradigm. For example, some of the rare obsidian artifacts at Calakmul were ground into bloodletting spines indicating extremely prominent symbolic value in the validation of royal status. Brown cherts, on the other hand, were ubiquitous forming 83 percent of the total. It apparently ranked high in utilitarian value; there are some indications that it also was highly regarded in certain rare forms as ritual material; chocolate brown chert with black spots occurs as point tips on the right-hand face of pyramid Structure II as singular specimens in rooms. Whatever it was used for, it was regarded as important for personages of priestly or military association to have one, and perhaps only one.

Examination of materials and technology attribute distributions was implemented through crosstabulations of attributes with two structural variables, structures and elevations. The structures variable represented pyramid Structure II as 2 and palace Structure III (Lundell's Palace) as 3. Nine types of lithic materials are represented by the numbers 1 to 9 and are named in the following tables; the full cross tabulations with frequencies can be seen in the spreadsheet Tables 57-60. In ***Table 57***, the distribution between structures are shown as percent deviation from the mean for the structure to eliminate the influence of structures sample sizes. There are over 1,000 more lithics recovered from pyramid Structure II (n=5,385) as from palace Structure III (n=4,251). The difference from the mean percentages reduce these differences to readily interpretable proportions of the total assemblage from the structures. The means are acting as expected frequencies.

**Table 57. Proportional Presence of Material Types in Structures. (Full crosstabulation results are in the supplemental materials spreadsheet Table 57-60.)**

Key: Highest above mean (red); Lowest below mean (light blue)

| Material Types | Structures 1 | 2 | 3 | 7 | Total |
|---|---|---|---|---|---|
| Flint | 0.1% | 29.0% | -28.3% | -0.7% | |
| Chert | 0.2% | -2.7% | 2.1% | 0.4% | |
| Chalcedony | 1.3% | 7.4% | -6.7% | -2.1% | |
| Quartzite | -1.2% | 19.7% | -16.2% | -2.3% | |
| Obsidian | -0.8% | 0.6% | 2.8% | -2.5% | |
| Limestone | -1.7% | -3.1% | 7.3% | -2.5% | |
| Basalt | -1.7% | 28.9% | -24.7% | -2.5% | |
| Jasper | 0.6% | 20.9% | -20.2% | -1.3% | |
| Serpentine | -1.7% | 30.5% | -26.3% | -2.5% | |
| Jade | -1.7% | 16.5% | -12.3% | -2.5% | |
| Count | 173 | 5385 | 4251 | 252 | 10061 |
| % within Material Type | 1.7% | 53.5% | 42.3% | 2.5% | 100.0% |

Differences in distribution can be observed by considering the structure that possesses the greatest differences from the total structure mean (Dif Expected Values, red). For example, of the 57 flint artifacts, their presence in pyramid Structure II (29.0% red) far exceeds that in palace Structure III (028.3% blue). The flints are of exotic origin and of suggestive colors, particularly blue, green and red. Yellow also is found in comparably small numbers (jasper=20.9%) largely from Structure II. Basalt and serpentine are also largely confined to Structure II. Quartzite, though not as rare as the other exotics (n=552), is also largely (+19.7%) found in the Structure II. Since quartzite is a sedimentary material, it could have been acquired in the vicinity of Calakmul. The same can be said as well for flint and jasper, although the location of these rarer siliceous rocks is not known at present; it is not in the immediate vicinity of the city by present knowledge. Lithics were collected along the Conhuas to Calakmul survey but have not been processed yet. Certainly basalt and serpentine are from far to the south among the volcanic and metamorphic mountainous areas. *Palace Structure III possesses only token numbers of all of the exotics as differences from the mean suggesting minimally that the denizens of pyramid Structure II controlled and used most of the flow of exotic lithic materials. Their external networks bear the mark of community wealth through networks.

*Two material types that palace Structure III holds in superior differences from the structure means is the locally available and ubiquitous brown chert (+2.1%) and the exotic obsidian (+2.8%). This superiority of obsidian in the assemblages may imply commerce between Temple II and Structure III factions in the material of obsidian. Given the royal association of obsidian discussed above, it would seem likely that *though controlled by the pyramid faction, obsidian was integral to palace operations as well and perhaps a bit more important than in/on pyramid Structure II as a functional entity. It could also mean that the palace faction had alternate obsidian networks. ***Table 21*** shows that the obsidian from Guatemala is dominantly in pyramid Structure II and that from the Mexican highlands in Structure III. The differences in numbers, however, are not large.

Limestone artifacts are also found in greater proportions in palace Structure III (7.3%). Recall that limestone that is tough enough to be made into tools, silicified limestone, comes from the eastern part of the peninsula. It raises the question of what was being prepared or manufactured in the Palace that require a preponderance of fancy artifacts made of limestone? The distinction between fancy and mundane needs to be made because hundreds of large manos and metates of limestone are not included in this analysis.

An effort was made to further break out faction/class distinctions by stratifying the artifact material types in palaces and on the elevations of Structure II zones. The results of this analysis appear in ***Table 58***. The 0 code is for the palaces and the percents are differences from the mean for the elevation. The Structure II façade assemblage is divided into nine zones (1-9).

**Table 58. Proportional Presence of Material Types by Zones and Places.**

Key: Highest above mean; Lowest below mean

| | Palaces | Zones | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Material Types | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Total |
| Flint | -20.1% | -0.1% | 3.4% | -0.5% | -0.5% | 2.4% | 6.4% | 0.2% | 10.9% | -1.9% | |
| Chert | 2.0% | 0.0% | -0.2% | 0.0% | -0.1% | -0.2% | -0.5% | -0.4% | -0.3% | -0.1% | |
| Chalcedony | 1.7% | -0.1% | -1.7% | 0.4% | 1.3% | 0.5% | 0.7% | -1.7% | -0.4% | -0.5% | |
| Quartzite | -14.7% | -0.1% | 0.9% | 0.5% | 0.5% | 1.4% | 0.7% | 4.0% | 2.8% | 4.0% | |
| Obsidian | -10.4% | -0.1% | 2.5% | -0.5% | 0.4% | -0.9% | 3.1% | 3.4% | 3.6% | -1.0% | |
| Limestone | 4.5% | 0.7% | -1.4% | 1.0% | -0.5% | -1.3% | 0.1% | -0.5% | -2.0% | -0.4% | |
| Basalt | -20.8% | 0.4% | 2.7% | 0.6% | 0.6% | 4.7% | 10.3% | 3.6% | -1.4% | -0.8% | |
| Jasper | -16.3% | -0.1% | 5.6% | 0.8% | 0.8% | 0.0% | 3.6% | 3.0% | -0.6% | 3.3% | |
| Serpentine | -23.3% | -0.1% | -2.2% | -0.5% | -0.5% | -1.3% | 2.4% | 7.0% | 20.5% | -1.9% | |
| Jade | -21.2% | -0.1% | -2.2% | -0.5% | -0.5% | -1.3% | 17.1% | 6.5% | 4.2% | -1.9% | |
| Count | 7393 | 6 | 199 | 48 | 47 | 120 | 267 | 322 | 529 | 176 | 9107 |
| % within Material Type | 81.2% | 0.1% | 2.2% | 0.5% | 0.5% | 1.3% | 2.9% | 3.5% | 5.8% | 1.9% | 100.0% |

Examining the highest proportions of materials, the presence of chert, though ubiquitous, falls at 2.0% above the mean in the palaces and in the zones is consistently well below 1 percent on the zones. *This implies that the occupants of the palaces were not linked to external networks for their utility materials, or that the larger rooms of the palaces were being used for community workshops. On the other hand, chalcedony (1.7%) is the only exotic material that is notably concentrated in the summit structures. This rather suggests a possible special use by a status that preferred chalcedony's clear, glassy appearance. Limestone (+4.5%), possibly imported, also possess a possible special use.

Obsidian is found in highest proportions on three lower zones of the pyramid Structure II but is in relative deficit (-10.4%) in the palaces. Though in absolute numbers, obsidian occurs frequently at the top of the pyramid, it is clearly, proportionally focused on the bottom zones of Structure II. *This suggests a route of commerce that took it to the knapping shops at the bottom of the pyramid and then to the palaces with some diversions to pyramid IIA. The obsidian numbers are insignificant in the upper and mid sections of the pyramid zones.

Basalt and serpentine are concentrated on the lower zones of the pyramid, especially in zones 5-8. Given its exotic origin and the labor expense and skill required to work it into usable artifacts, this suggests the presence of *skilled crafts persons on the lower zones of Structure II, or perhaps the artifacts were imported in finished condition.

Quartzite is found in its highest concentration at the foot of the pyramid Structure II around the altar. It decreases up the pyramid and falls to its lowest proportion in the palaces. It is also consistently present in modest but significant numbers in all elevations except zone 1. *This intriguing distribution suggests that a simple down the line diminution of frequencies as it is imported at the base of the pyramid and utilized in some important function throughout the complex. It suggests a utilitarian function, probably one that takes advantage of its extremely hard character.

The **reduction sequence** of flakes and the termination characteristics suggest the origins and functions to which knapped lithics were being subjected. Primary and secondary flakes are indicative of the earlier stages of reducing cores to useful flakes. They therefor represent the locations to which preformed cores are being imported and prepared for final distribution. Crosstabulation of reduction sequence against the elevation/class variable indicates the highest proportion of cores (5.0%) at the bottom of the pyramid Structure II (***Table 59***). Their relative number decline up pyramid and into the palaces. Primary flakes are found on an upper and lower zone, largely in the palaces. Secondary flakes are pretty much dominant in the palaces. Tertiary flakes are notable for being pretty much as would be expected from the overall numbers: the largest deviation is little more than 1.0%. *The overall picture would seem to be that once cores were prepared toward the lower zone of the pyramid, later stages of reduction, especially stage 3 was performed irrespective of room location. Either all classes performed tertiary flake manufacture, or it was undertaken by servants in their company.

**Table 59. Proportional Presence of Flake Reduction Sequence in Zones and Places.**

Key: Highest above mean (red); Lowest below mean (light blue)

| Reduction Seq | Palaces 0 | Zones 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 Absent | -5.4% | 0.1% | 1.1% | 0.6% | 0.3% | 1.5% | -0.4% | 0.7% | -0.1% | 1.6% | 1953 |
| 1 Core/Bif | -1.8% | -0.1% | -0.9% | -0.1% | -0.5% | -1.3% | 1.6% | -0.8% | 5.0% | -1.0% | 223 |
| 2 Primary | 3.2% | -0.1% | 0.5% | -0.3% | -0.5% | -1.0% | -0.2% | 0.1% | 0.3% | -1.9% | 589 |
| 3 Secondar | 2.8% | 0.0% | -0.8% | -0.2% | -0.2% | -0.2% | -1.0% | -1.2% | 0.6% | 0.5% | 2868 |
| 4 Terciary | 0.3% | -0.1% | -0.1% | -0.1% | 0.2% | -0.4% | 1.2% | 0.8% | -0.8% | -0.9% | 3375 |
| Count | 7395 | 6 | 198 | 48 | 47 | 120 | 267 | 322 | 529 | 176 | 9108 |
| % within Reduction | 81.2% | 0.1% | 2.2% | 0.5% | 0.5% | 1.3% | 2.9% | 3.5% | 5.8% | 1.9% | 100.0% |

**Terminations** can suggest variable functions to which flakes are subjected (***Table 60***). The codes were designed to detect normal terminations, i.e., terminations that tapered as would be expected from manufacture indicating skilled craftspersonships, hinged terminations, terminations that fail because too little force was applied by a less skilled knapper, snaps with flat ends indicating intentional modification of length, and snaps with overhangs (top and bottom overhangs) implying shear forces on flakes as they broke during use. The later shear forces are probably the result of breaking during use.

**Table 60. Proportional Presence of Flake Terminations in Zones and Places.**

Key: Highest above mean; Lowest below mean

| Terminations | Palaces 0 | Zones 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Normal | -2.5% | 0.0% | 0.3% | 0.1% | 0.1% | 0.3% | 0.6% | 0.7% | 0.0% | 0.5% | 6368 |
| Top | 7.2% | -0.1% | -0.6% | -0.2% | -0.2% | -0.7% | -1.3% | -1.6% | -1.1% | -1.2% | 2178 |
| Planar | 3.7% | -0.1% | -1.3% | -0.5% | 0.4% | -1.3% | -2.9% | -1.6% | 3.6% | 0.0% | 106 |
| Bottom | 2.3% | -0.1% | -1.8% | -0.5% | -0.5% | -0.9% | -0.4% | -1.9% | 2.8% | 1.0% | 243 |
| Retouched | -2.1% | 0.4% | 0.9% | 0.0% | -0.5% | -0.3% | -0.8% | -0.9% | 5.2% | -1.9% | 191 |
| Hinge Frac | -31.2% | -0.1% | -2.2% | -0.5% | -0.5% | -1.3% | -2.9% | 34.0% | 6.7% | -1.9% | 8 |
| Unclassifi | -3.4% | -0.1% | -2.2% | -0.5% | -0.5% | -1.3% | -2.9% | -3.5% | 16.4% | -1.9% | 18 |
| Count | 7398 | 6 | 199 | 48 | 47 | 120 | 267 | 322 | 529 | 176 | 9112 |
| % within Terminaci¢n | 81.2% | 0.1% | 2.2% | 0.5% | 0.5% | 1.3% | 2.9% | 3.5% | 5.8% | 1.9% | 100.0% |

Only eight hinge fractures were identified in the assemblage. Four were on zones 7 and 8, and four were in palace IIB. *This indicates a very skilled knapping population. There are no hinge fractures in the palace Structure III.

Converse to the non-existence of hinge fractures, normal terminations were abundant (n=6,358) starting with hundreds toward the lower zones and decreasing to 10s in the upper zones. 78.7% were in the palaces (n=5,010). The proportion of normal terminations shows that the trend actually continues into the palaces with the palace normal terminations appearing below the mean (-2.5%). The highest proportion of bottom shear fractures is on the lower zones but the highest top shears are in the palaces. *This has a ring of intentionality about it and needs to be investigated. Plane snaps appear in significant numbers in zone 8 and the palaces. It can be suggested that these non-shear snaps are intentional during manufacture. *Such snaps may have been created during sizing and hafting of flakes into tools pointing compound tool making in the low zone and palaces.

The complex of traits taken together might support the supposition of importation and manufacture of stone tools at the bottom of the pyramid Structure II zones (***Figure 49***). Subsequently, products fan out toward the summit of the pyramid Structure II and toward the palace Structure III. Obsidian flows dominantly toward the palace Structure III but also to the summit of the pyramid. Hard quartzite fans out to all parts of the pyramid Structure II and to palace Structure III. Its proportions decline as the flow of lithics reaches the pyramid top and palace Structure III. It was used for treating tougher primary materials; snapped flakes further down line were used to modify finished materials (Montet-White 1973). *As cores move away from the lower zones of pyramid Structure II, they are reduced by skilled craftspersons, especially in the palace Structure III where no hinge fractures were observed, normal terminations formed the greater part of the assemblage. Plane fractures dominated in the manufacturing area while shear fractures have a significant roll up pyramid Structure II implying a use area.

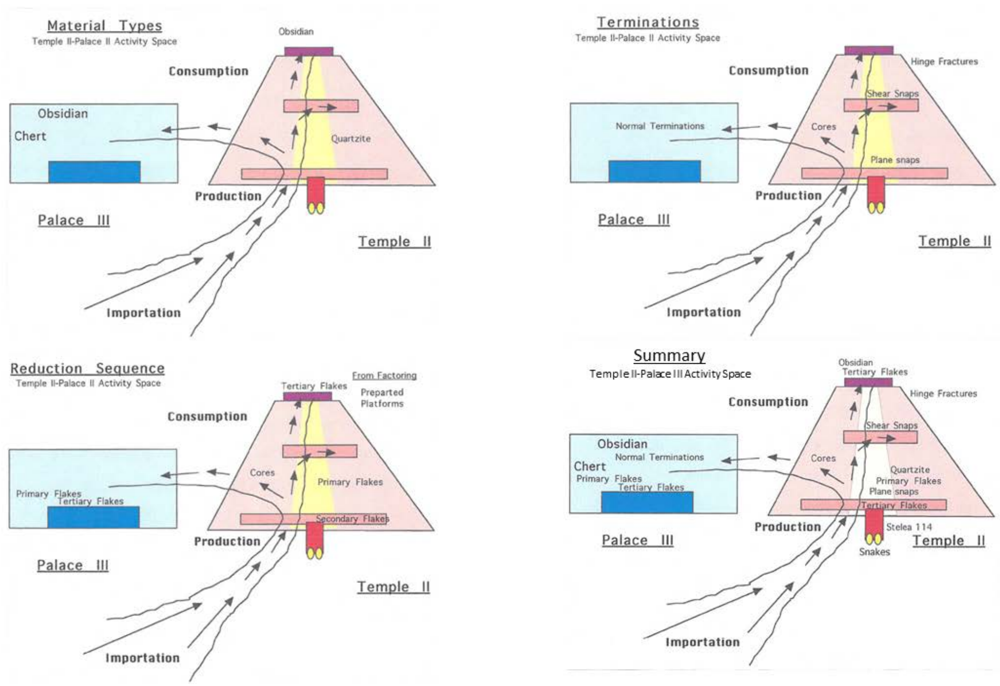


**Figure 49. Lithic Flows through the Pyramid Structure II and Palace Structure III Environ.**

# PART III: ARTIFACT DIVERSITY (TYPES): MIXING STONES WITH OTHER ARTIFACT TECHNOLOGIES

With these understandings of distributions of lithic artifacts, we now turn to relations between lithics and other categories of artifacts. These relationships are especially interesting when the functions of the non-lithic categories are understood and therefore lend understanding of the uses of less well-defined lithic categories. Figurines, for example, are clearly ritual in functions. Also, as analyzed by Dominguez C. 1994 and Ruiz G. (1998), they have gender and species implications.

## Points and Figurines

### Points

A distribution of the frequencies of point types (see ***Table 43***) and figurines by class provides an overview of the distribution of point categories. The greatest number of point types are in the Structure IIA(2A) rooms and rooms of palace Structure III(3), and toward the middle to low elevation of Structure II zones. Several patterns of note can be observed

- The **pointed stemmed points** are found exclusively on the summit of pyramid Structure II in temple IIA and in palace Structure III. Their pointed bases are a reasonable candidate for projectiles and their distribution could suggest that they were used by **guards** of elite activities and residences.
- **Small stems and lanceolates** are exclusively located in pyramid Structure II. Both could be knives, especially the small stems (see discussion above), suggesting some sort of preparation of materials or **food**.
- The **larger stemmed points** (contracting, straight, and notched) are **more evenly distributed** across the full venue, but also tend to be **more frequently located in Structure II**.

### Figurines

Figurine classes (Ruiz Guzman 1998) were most frequently found in pyramid summit Structure II temple A (***Table 61***) (Database 2). They are notably absent from most of the rooms of palace Structure

III, perhaps reflecting the essentially secular nature of the building. The greatest concentration of figurines appears on the lower zones of pyramid Structure II. Feminine figurines seem to be concentrated, but not exclusively so, on the lower zones of pyramid Structure II.

**Table 61. Frequencies of Figurine Classes by Operations.**

| Prov Suboperation | Fig101 Feminine | Fig102 Masculine | Fig103 Zoological | Total |
|---|---|---|---|---|
| 2 | 4 | 11 | 5 | 20 |
| 2A | 6 | 23 | 9 | 38 |
| 2B | 1 | 13 | 4 | 18 |
| 2D | 1 | 4 | 1 | 6 |
| 2F | 1 | 3 | | 4 |
| 2H | 1 | 11 | 3 | 15 |
| 2N1 | 2 | 6 | | 8 |
| 2N2 | 2 | 5 | 4 | 11 |
| 2N3 | | 5 | 3 | 8 |
| 2N4 | | | | 0 |
| 2N5 | 5 | 9 | 2 | 16 |
| 2N6 | 4 | 19 | 7 | 30 |
| 2N7 | 4 | 28 | 24 | 56 |
| 2N8 | 7 | 29 | 13 | 49 |
| 2N9 | 17 | 33 | 16 | 66 |
| 3 | | | 1 | 1 |
| 3A | 7 | 19 | 11 | 37 |
| 3B | 2 | 2 | 4 | 8 |
| 3D | 3 | 4 | 7 | 14 |
| 3E | | 1 | | 1 |
| 3G | | | | 0 |
| 3H | | | | 0 |
| 3J | | | | 0 |
| 3L | | | | 0 |
| 3P | | | | 0 |
| 3Q | | 2 | | 2 |
| 3R | 2 | 14 | 4 | 20 |
| Total | 69 | 241 | 118 | 428 |

Especially in the case of the points, the distribution of specimens is sparse. However, if the points and figurines are taken to represent the type of work or activity performed in a room rather than a quantity of artifacts, this need not be a liability. The points were factored along with the class (masculine, feminine, zoological) to provide a perspective on possible gender-specific distributions in the space relative to specialized bifaces.

Since the distributions of points and figurines are somewhat complementary in nature, a factoring of them should reveal differing dimensions. In fact, this is largely true (***Table 62***). Only factor 3 shows an overlap between points and figurines (factor 1 only makes sense as something related to the size of the numbers).

**Factor 2** implies that, where figurines are found, the robust spatulate and broad stemmed (i.e., expended spatulates) tend not to be found, and visa-versa. Since this factor also reflects the strongest relationship to figurines of all categories, why are the spatulates separate? The spatulates might be female gendered implements. The broadly excurvate edges resemble the ulus commonly held to be female implements in many ethnographic cultures; they could have been hafted to complete this design. This implies that whatever ceremonies the figurines pertain to, they were performed in circumstances other than woman's work. It looks suspiciously like men keeping secrets from women as among the Australian aborigines.

In **Factor 3**, which contains the pointed stemmed and contracting stemmed points, possible functional homologs as they are only separated by size and the pointiness of the base. With them the broad stems also appear. As mentioned above, the pointed stems appear only in quarters on the top of Structure II and in palace Structure III, and the type appears to be a projectile. That they have a related distribution to the robust broad stems suggests a projectile-knife tool kit, a handy combination in either war or the chase. Were both men and women using ulus in this culture?

**Table 62. Quantitatively Factoring of Point Types and Figurines in Structure II(2) and III(3) (n=542).**

| | Factors | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | Commonality |
| | Size | Broads & Figurines | Pointed vs. Small | Small & Spatulate vs Lanceolate | |
| Pointed St. | -0.08 | -0.36 | **0.76** | 0.08 | 0.72 |
| Small St | 0.39 | 0.16 | **-0.56** | **0.54** | 0.78 |
| Lanceolate | **0.74** | 0.01 | -0.12 | **-0.48** | 0.79 |
| Straight St. | **0.74** | 0.23 | -0.29 | -0.17 | 0.71 |
| Contracting St. | **0.56** | -0.08 | 0.39 | **0.50** | 0.73 |
| Notched St. | **0.73** | 0.34 | 0.24 | -0.39 | 0.85 |
| Broad St. | **0.53** | **0.55** | **0.40** | -0.11 | 0.76 |
| Spatulate | **0.50** | **0.69** | 0.14 | **0.45** | 0.95 |
| Feminine | **0.67** | **-0.50** | 0.02 | 0.25 | 0.75 |
| Masculine | **0.86** | **-0.44** | 0.02 | -0.02 | 0.93 |
| Zoological | **0.82** | **-0.49** | -0.16 | -0.05 | 0.93 |
| Percent cumulative variance | 41 | 57 | 70 | 81 | |

Extraction Method Principal Components Analysis

**Factor 4** shows that in another pattern of distribution among the rooms, the small stems, contracting stems, and spatulates appear together. They too are distinctly found elsewhere from the lanceolates. The small/contracting stem-spatulate combination could form a tool kit that finds a complimentary distribution to the lanceolates function.

## Ceramics

In this section we will expand our horizons to encompass lithics, figurines and ceramics. Ceramics add important understandings of data, functions and diversity of artifacts to room assemblages as well an understanding of trade networks with which the inhabitants were involved. Utilizing nuclear radiation, Dominguez Carrasco's (1994) found that much of the utility ceramics were locally made. However, some of the wares were traded in from the northern lowlands. Reents-Budet and Bishop (2011) using similar techniques traced the highest status ceramics of the Kaan dynasty to Nakbe from where the Kaans appear to have drawn traditional sources for polychrome drinking vessels (Gunn et al. 2017).

The typed ceramics were compiled into a file mutually formatted with the lithics and figurines so they could be analyzed together. Database 3 contains of 1,670 ceramic proveniences counted 121,101 sherds. From this Dataset 4 was extracted that was compatible with the room model of analysis used with the lithics and figurines, securely provenienced sherds were cataloged into a data set with 319 proveniences representing 34,780 sherds.

## Lithics, Ceramics and Figurines (LFC) Together

Experimenting with the mix of ceramics, figurines and lithics types as counts per room showed that the data on the three technologies were extremely divergent in frequencies. As a result, each technology sorted out to separate factors but did not mix across technologies to any significant degree. Closer inspection on the frequencies data showed that this was because sherds were nearly everywhere in great numbers while figurines and lithics were relatively rare.  The total of the technologies and structures gives some insight into the problem: Lithics=1,858, Figurines=407, Ceramics=121,038; Str I=3,029, Str IIA=38,761, Str II Zones=75,220, Str III=5,025, Str VII=723.

Once again converting the counts to presence or absence helped correct these disparities in numbers.  The presence or absence matrix contains 184 proveniences that are secure across all technologies (Dataset 4).  There are 71 artifact subtypes and varieties. The effects of disparity, however, remained evident in the factor matrix, though less evident than with the counts. Many of the ceramic types only correlated with other ceramic types. In the components matrix displayed here (**Table 63**), these single correlation ceramic types were removed to focus on the types that were interactive across technologies systems. This reduced the number of subtypes to 37. A location variable, 0PYR1PAL, was included that distinguishes pyramid Structure II (0) from palace Structure III (1).

**Table 63. Factoring of Lithics, Figurines, and Ceramics (LFC) Together. Unshared types were removed from this display; see Appendix 5 for full factor matrix.**

| | Component | | Key Types | | | | | | #Shared | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type# | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Communality | | Type Name | Function | Freq o |
| P3.1 | 0.13 | 0.48 | 0.05 | 0.36 | 0.06 | -0.35 | -0.03 | 0.50 | 3 | Point Pointed stem | Projectile | 12 |
| P3.4 | 0.34 | 0.47 | 0.26 | -0.07 | 0.08 | 0.32 | -0.12 | 0.53 | 2 | Point Lanceolate | Projectile | 21 |
| P3.5 | 0.39 | 0.48 | 0.01 | 0.11 | 0.15 | -0.08 | -0.06 | 0.42 | 2 | Point Straight stem | Projectile | 31 |
| P3.7 | 0.19 | 0.36 | -0.01 | 0.28 | -0.05 | 0.39 | -0.06 | 0.40 | 3 | Point Side notched | Cutting | 21 |
| P4.1 | 0.38 | 0.57 | 0.13 | -0.02 | -0.22 | -0.12 | 0.09 | 0.56 | 2 | Ax fragment | Chopping | 38 |
| P6.3 | 0.38 | 0.57 | 0.14 | 0.04 | -0.10 | 0.04 | 0.17 | 0.54 | 2 | Mano small | Grinding | 29 |
| P6.4 | 0.47 | 0.46 | -0.28 | 0.10 | -0.02 | 0.05 | -0.01 | 0.52 | 2 | Mano medium | Grinding | 51 |
| P6.5 | 0.43 | 0.47 | 0.00 | 0.01 | -0.13 | -0.18 | -0.13 | 0.48 | 2 | Mano large | Grinding | 21 |
| P10.2 | 0.27 | 0.53 | -0.08 | -0.01 | 0.35 | 0.28 | -0.12 | 0.57 | 2 | Preform very very small | Flake source | 15 |
| P10.3 | 0.47 | 0.60 | -0.08 | 0.19 | 0.18 | -0.10 | -0.05 | 0.67 | 2 | Preform very small | Flake source | 21 |
| P10.4 | 0.33 | 0.50 | 0.08 | -0.09 | 0.51 | 0.11 | -0.10 | 0.65 | 2 | Preform small | Flake source | 13 |
| P10.6 | 0.20 | 0.37 | 0.07 | 0.03 | -0.06 | 0.06 | -0.43 | 0.38 | 2 | Preform very large | Flake source | 5 |
| P11.1 | 0.45 | 0.40 | 0.06 | -0.30 | -0.03 | -0.12 | 0.39 | 0.62 | 3 | Celt fragment | Chopping | 12 |
| P11.3 | 0.22 | 0.09 | -0.17 | 0.21 | 0.04 | 0.45 | -0.46 | 0.54 | 2 | Celt large | Chopping | 5 |
| P12.3 | 0.42 | 0.45 | 0.13 | -0.19 | -0.17 | 0.12 | 0.03 | 0.48 | 2 | Adz large | Smoothing | 21 |
| P17.1 | 0.49 | 0.45 | -0.06 | -0.05 | 0.43 | -0.02 | -0.07 | 0.64 | 3 | Biface fragment | Cutting | 17 |
| P17.2 | 0.18 | 0.40 | 0.15 | 0.08 | 0.28 | 0.27 | 0.33 | 0.48 | 2 | Biface very very small | Cutting | 10 |
| P17.3 | 0.25 | 0.37 | -0.06 | -0.22 | 0.17 | 0.18 | 0.43 | 0.50 | 2 | Biface very small | Cutting | 4 |
| P17.4 | 0.06 | 0.33 | -0.21 | -0.08 | 0.29 | 0.38 | 0.46 | 0.61 | 2 | Biface small | Cutting | 1 |
| P21.1 | 0.35 | 0.50 | -0.13 | 0.13 | -0.10 | -0.12 | 0.01 | 0.43 | 2 | Hammerstone small | Hammer | 63 |
| P21.2 | 0.41 | 0.50 | -0.08 | 0.09 | 0.37 | -0.14 | -0.05 | 0.59 | 3 | Hammerstone large | Hammer | 19 |
| P22.0 | 0.11 | 0.16 | -0.21 | -0.08 | 0.01 | 0.55 | 0.24 | 0.46 | 1 | Barkbeater | Paper | 10 |
| P30.12 | 0.32 | 0.40 | 0.24 | 0.07 | -0.27 | 0.02 | -0.20 | 0.44 | 1 | Obsidian prismatic blade | Cutting | 43 |
| P101 | 0.11 | 0.64 | -0.34 | 0.28 | -0.26 | -0.17 | 0.04 | 0.72 | 2 | Figurine Feminine | Ritual female | 16 |
| P102 | 0.10 | 0.71 | -0.35 | 0.28 | -0.14 | -0.20 | -0.01 | 0.77 | 2 | Figurine Masculine | Ritual male | 19 |
| P103 | 0.10 | 0.65 | -0.33 | 0.20 | -0.24 | -0.19 | 0.01 | 0.67 | 2 | Figurine Zoomorphic | Ritual animal | 15 |
| P318.1 | 0.44 | 0.09 | 0.22 | -0.24 | 0.36 | -0.29 | 0.05 | 0.52 | 2 | Pelota Mod. v Pelota | Food ceremony Tar* | 5 |
| P310 | 0.51 | 0.08 | 0.43 | -0.42 | -0.12 | 0.06 | -0.10 | 0.66 | 3 | Chaquiste Imp v No Especi | Food ceremony Tar | 8 |
| P311.1 | 0.84 | -0.35 | -0.11 | 0.03 | -0.02 | -0.05 | 0.00 | 0.84 | 2 | Chim.Cre.Pol. v Chimbote | Food ceremony Tar | 46 |
| P308.1 | 0.55 | -0.02 | 0.13 | -0.14 | 0.16 | 0.08 | -0.37 | 0.51 | 2 | Carro Mod. v Carro | Food ceremony Ter | 13 |
| P307.1 | 0.75 | -0.41 | -0.11 | -0.02 | -0.08 | -0.04 | 0.14 | 0.77 | 2 | Carmelita Inc v Carmelita | Food domestic Tar | 47 |
| P313.1 | -0.02 | -0.01 | 0.55 | 0.40 | 0.03 | -0.05 | 0.13 | 0.48 | 2 | Encanto Est. v Encanto | Liquid domestic Tar | 101 |
| P315.1 | 0.79 | -0.35 | -0.20 | 0.11 | -0.08 | 0.09 | 0.01 | 0.81 | 2 | Maquina Caf. v Maquina | Liquid domestic Ter | 62 |
| P325.2 | 0.35 | -0.19 | 0.42 | 0.43 | 0.08 | 0.05 | 0.12 | 0.54 | 3 | Tinaja Rojo v Tinaja | Liquid domestic Ter | 131 |
| P314.1 | 0.47 | -0.37 | 0.32 | 0.42 | 0.00 | 0.17 | 0.16 | 0.68 | 3 | Infierno Neg. v Infierno | Liquid mortuary Tar | 105 |
| P303.1 | -0.13 | 0.11 | 0.52 | 0.49 | -0.05 | 0.06 | 0.09 | 0.55 | 2 | Balanza Neg. v Balanza | Liquid mortuary Tem | 28 |
| 0PYR1PAL | -0.36 | 0.11 | 0.50 | 0.32 | 0.19 | -0.13 | -0.09 | 0.56 | 2 | Pyramid (0) or Palace (1) | | |
| %Variance | 23.3 | 13.6 | 4.2 | 3.8 | 3.2 | 3.1 | 2.8 | | | | | |

Frequencies of Presences (1s) in 184 proveniences

NOTE: Eigenvalues, % Variance and Cummulated % Variance are for the components before self correlated types were removed.
Extraction Method: Principal Component Analysis. 7 components extracted.
* Tar=Late Classic, Ter=Terminal Classic, Tem=Early Classic

Seven components accounted for 54.02% of the variance in the lithic-figurine-ceramic data. In the factor matrix (see **Table 63**) key types (orange) have been selected to represent the group of highly correlated types: in Factor 2, for example, very small preforms (0.60) can be used to represent the other 19 types that frequently appear in rooms with the very small preforms because they all go together as a highly correlated group.

Factor 1: The first component (1) is most powerfully influenced by ceramics with Chimbote (0.84) and Maquina asserting most of the influence. They occur exclusively in pyramid Structure II rooms (OPYR1PAL=-0.36), the other structures not at all (see Appendix 5 green). They are thinly scattered on the zones, Maquina is most prevalent in numbers (n=13,244) compared to Chimbote (n=643). There are many rooms in Structure IIA that have none of either type. Chimbote is for food while Maquina is thought to be associated with liquids. They occur in similar numbers of rooms (n=62, 46). Maquina was a feature of the Terminal Classic while Chimbote is from the adjacent and possibly overlapping Late Classic. Medium sized manos (0.47) along with hammerstones, preforms, celt and biface fragments are associated with the ceramics but figurines not at all. It looks as an ensemble like rooms that are combination food preparation and consumption spaces along with making and using stone tools and/or storage. *They might be the remains of a still fairly large resident population at the transition from Late Classic to early Terminal Classic. *The absence of Chimbote/Maquina and small manos from pyramid Structure I might indicate that it was still the most sacred structure to this population.

Factor 2: The second component is somewhat the reverse of the first with more focus on lithics and representing most of the figurines. The strongest ceramic presence is Carmelita (-0.41), a Late Classic food preparation ware. Carmelita is also absent from pyramid Structure I perhaps reflecting the activities of a transitional population (Appendix 4 yellow). All of the ceramics are negatively related to all lithics meaning there are two sets of rooms, one of which contains Carmelita and related wares, and the other contains most of the lithics and figurines. All of the lithics are associated with this set except large celts, small bifaces, and barkbeaters. All three types have low Ns ranging from 1 to 10: they may have been separated out by their infrequency: they appear together on factor 6 with side notched points for cutting. Apart from these three lithic types, all of the lithic types are in agreement that there are certain rooms that are for lithics rather than ceramics. The strongest relationship is with small preforms which we suggest were used as sources of utilizable flakes, a likely representation for lithic activity rooms.

The distribution of Factor 2 has the richest mix of lithics, figurines and ceramics. It can serve as a proof of concept for the multi-technology associations of artifacts; obviously much else could be done with the other factors and deeper analysis of the total dataset. Enough information is presented in **Table 64** to experiment with the other factors.

As can be seen in **Table 64**, Factor 2 also has the richest array of rooms on the two poles of its mutually exclusive rooms. In the **Figure *50*** map the small preforms and related lithics and figurines on the positive pole are located in or near Structure IIA and Structure III. This appears to suggest that areas near and in the palace and temple were diverse in activity with figurine-related rituals and lithic use activities. The presence of celt and biface fragments implies use and discard of both tool functions.

The Carmelita and related ceramics on the negative pole are located along the lower zones of pyramid Structure II. The Carmelita type-variety is a Late Classic ware for food and domestic use. Carmelita is modestly numerous (N=1,177, present in 47 of 183 proveniences). Its exclusive presence in Structure II explains much of its powerful association with negative Factor 2. Additional information on Carmelita suggests it is primarily a domestic food preparation ware (see Table 63).

Factor 3: Factor 3 focuses on four types of ceramics and the figurines that occur in other rooms exclusive of them. The figurines are more frequent in palace Structure III (Appendix 4 light green). The ceramics are Encanto, Tinaja, Chaquiste and Balanza black. They are from the Early, Late and Terminal Classic and span functions from food (Chaquiste), liquid (Encanto and Tinaja) and mortuary vessels (Balanza black). The set is notable for disparity of sample sizes with Encanto and Tinaja logging in at over 20,000 each while Chaquiste and Balanza only 18 and 36 respectively. The great numbers of Encanto and Tinaja suggest a high utility storage, perhaps of water and food. The mortuary function of Balanza and mix of times and functions might suggest repurposed vessels from looted tombs. The frequencies are highly replicated in structures IIA and IID and also occur in similar number in Structure I and Structure VII.

Factor 4. With the possible exception of pointed stemmed points (0.36), Factor 4 is all ceramics. All pointed stems are in Pyramid I and Pyramid II but not on the zones, perhaps an upper-class indicator. There are two sets of ceramics rooms represented, one with Infierno black (0.42) along with Tinaja red, Encanto, and Balanza. This set largely replicates in another set of Factor 3 rooms but with Infierno black added. This raises the question of what influence the Infierno black has. It is classified as a mortuary vessel, which defines the difference from Factor 3. It only occurs in Pyramid I and Pyramid II and is numerous like Encanto (n=20,677) and follows the same widespread pattern of room distributions though half as many (n=10,347). Encanto also appears in structures III and VII. This suggests that Infierno black is more likely to be a domestic vessel like Encanto, which is also Late Classic. Its widespread use would seem to contradict its value as a mortuary vessel. Chaquiste (-0.42, note the negative/opposite value) on the other hand, is in a second room set exclusive of those in the first set. They are all (n=18) on the zones except for two in temple Structure IIA and one in palace Structure IIB. Most (n=9) are on the principle staircase. The Chaquiste types is used in food preparation. *The rare and scattered Late Classic remains

**Table 64. High +/- Factor Scores for Lithics, Figurines and Ceramics. The gray factor scores are beyond +/- one standard deviation.**

| Room | PC1 | Room | PC2 | Room | PC3 | Room | PC4 | Room | PC5 |
|---|---|---|---|---|---|---|---|---|---|
| 2--EP | 3.94 | 2-N08- | 4.13 | 2--- | 3.78 | 2F-- | 3.61 | 3E-- | 3.25 |
| 2--- | 3.90 | 3A-- | 4.00 | 2--EP | 3.59 | 2D-- | 3.41 | 2-N08- | 2.93 |
| 2A-- | 3.60 | 2-N06- | 3.58 | 2-N04EP | 2.67 | 2H-- | 3.14 | 2-N09EP | 2.72 |
| 2B-- | 3.01 | 3E-- | 2.82 | 2A04- | 2.23 | 2A-- | 2.60 | 2BH-- | 2.17 |
| 2A-PE | 2.98 | 3D-- | 2.31 | 2-N07EP | 2.10 | 2A05- | 2.60 | 3--- | 2.13 |
| 2-N04EP | 2.60 | 3B-- | 2.23 | 2A06- | 2.05 | 2A06- | 2.09 | 2A07- | 2.11 |
| 2-N09EP | 2.34 | 2B-- | 2.06 | 2A05- | 1.90 | 2A04- | 1.92 | 3Q-- | 1.94 |
| 2-N08C59 | 2.18 | 3--- | 1.98 | 2A07- | 1.84 | 2B-- | 1.87 | 2--- | 1.89 |
| 2-N07EP | 2.11 | 2--- | 1.98 | 2BN02- | 1.61 | 1A04- | 1.82 | 2F-- | 1.59 |
| 2H-- | 2.09 | 2--EP | 1.95 | 2A-- | 1.53 | 1--- | 1.63 | 3P-- | 1.49 |
| 2-N05C31 | 2.04 | 2A-- | 1.72 | 1A04- | 1.49 | 2D08- | 1.60 | 1A04- | 1.44 |
| 2-N02C12 | 1.84 | 3Q-- | 1.66 | 2A-PE | 1.44 | 1A02- | 1.55 | 2A-PE | 1.27 |
| 2BN02- | 1.70 | 2-N07- | 1.65 | 2D08- | 1.43 | 2A07- | 1.48 | 1A07- | 1.21 |
| 2-N07C58 | 1.57 | 3R-- | 1.63 | 1--- | 1.31 | 1D05- | 1.28 | 2-N07C58 | 1.21 |
| 2-N08C61 | 1.49 | 2D-- | 1.62 | 1A02- | 1.25 | 2-N06C37 | 1.21 | 2A02- | 1.16 |
| 2-N06EP | 1.48 | 3P-- | 1.43 | 3P-- | 1.25 | 2A03- | 1.20 | 2-N05C25 | 1.06 |
| 2-N07C57 | 1.42 | 2F-- | 1.35 | 2-N05C31 | 1.20 | 2-N06C34 | 1.15 | 1A09- | 1.03 |
| 2-N05EP | 1.39 | 2-N09- | 1.32 | 1D05- | 1.13 | 2-N05C30 | 1.15 | 1D05- | 1.03 |
| 2-N08C64 | 1.37 | 2-N03- | 1.30 | 7E-- | 1.08 | 2A08- | 1.11 | 2-N08C61 | 0.88 |
| 2-N08EP | 1.36 | 2-N02- | 1.25 | 2D07- | 1.02 | 2A09- | 1.11 | 1C02- | 0.85 |
| 2ABTR- | 1.35 | 2A05- | 1.07 | 2A08- | 1.00 | 2D02- | 1.11 | 1C07- | 0.85 |
| 2-N07C50 | 1.27 | 2A04- | 1.03 | 2A09- | 1.00 | 2D09- | 1.11 | 2-N05EP | 0.82 |
| 2-N08C60 | 1.23 | 2-N02C08 | 0.97 | 2D02- | 1.00 | 2A02- | 1.07 | 1--- | 0.74 |
| 2-N03EP | 1.15 | 2A06- | 0.96 | 2D09- | 1.00 | 3R-- | 0.99 | 1A03- | 0.73 |
| 2F-- | 1.06 | 2A07- | 0.95 | 3--- | 0.97 | 2D07- | 0.89 | 2BN03- | 0.73 |
| 2B-Nicho | 1.06 | 2H-- | 0.91 | 1A10- | 0.95 | 1C02- | 0.89 | 2-N02C12 | 0.71 |
| 2-N09Est | 1.04 | 2-N07C52 | 0.81 | 1C02- | 0.89 | 1C07- | 0.89 | 1A08- | 0.70 |
| 2-N08C67 | 1.02 | 2BNICHO- | 0.79 | 1C07- | 0.89 | 2-N08C61 | 0.88 | 1C04- | 0.70 |
| 3A-- | 1.01 | Outside | 0.72 | 2A12- | 0.88 | 1A10- | 0.87 | 2-N07C57 | 0.69 |
| 2-N04C44 | -0.76 | 2-N06C40 | -1.03 | 2ABTR- | -0.96 | 2BN05- | -0.92 | 2H-- | -0.69 |
| 2A12- | -0.76 | 2-N02C16 | -1.07 | 2-N07C53 | -0.96 | 2BN01C01 | -0.93 | 3I-- | -0.69 |
| 2A15- | -0.76 | 2-N07EP | -1.07 | 2AESC.- | -0.97 | 2BN01C02 | -0.93 | 3M-- | -0.70 |
| 2-N07C65 | -0.76 | 2BN02- | -1.14 | 3B-- | -1.04 | 2--PE | -0.93 | 2-N07C44 | -0.78 |
| 7D-- | -0.76 | 2BN03C17 | -1.15 | 2BN03- | -1.05 | 2-N04- | -0.93 | 2BN01C01 | -0.80 |
| 2-N06C31 | -0.76 | 2-N08C67 | -1.16 | 2-N08C60 | -1.12 | 2-N06C36 | -0.93 | 2BN01C02 | -0.80 |
| 2-N06C36 | -0.76 | 2AESC.- | -1.16 | 3D-- | -1.14 | 3M-- | -0.95 | 2-N06EP | -0.81 |
| 2BN02C25 | -0.77 | 2BN02C23 | -1.17 | 2AF-- | -1.17 | 2-N04ALT | -0.97 | 2--PE | -0.90 |
| 1E06- | -0.77 | 2-N05C28 | -1.17 | 2BN03C17 | -1.19 | 7H-- | -0.98 | 2-N04- | -0.90 |
| 2BN09- | -0.79 | 2-N05C25 | -1.19 | 2-N06C43 | -1.20 | 2-N02C23 | -0.99 | 2-N02C08 | -0.94 |
| 2-N07C56 | -0.79 | 2-N02C09 | -1.22 | 2D-- | -1.23 | 2-N02C8 | -0.99 | 2-N07C45 | -0.98 |
| 2--PE | -0.80 | 2-N02C14 | -1.24 | 2-N05C25 | -1.26 | 2-N08C58 | -1.01 | 2A06- | -1.00 |
| 2-N04- | -0.80 | 2-N06C43 | -1.25 | 2-N08C61 | -1.29 | 2--NICHO | -1.03 | 2-N03- | -1.04 |
| 2-N05C36 | -0.80 | 2-N02EP | -1.30 | 2-N07C58 | -1.31 | 2BN02C25 | -1.06 | 3L-- | -1.15 |
| 2BN02C17 | -0.80 | 2-N08C64 | -1.30 | 2-N05C28 | -1.33 | 2-N07C65 | -1.07 | 3D-- | -1.18 |
| 2-N04ALT | -0.80 | 2-N03C18 | -1.31 | 2-N04C21 | -1.37 | 2-N07C56 | -1.07 | 2-N01- | -1.20 |
| 2--NICHO | -0.80 | 2AF-- | -1.35 | 2-N06- | -1.45 | 3O-- | -1.08 | 2BNICHO- | -1.21 |
| 2BN01C01 | -0.80 | 2-N07C48 | -1.37 | 2B-- | -1.47 | Outside | -1.08 | 7E-- | -1.25 |
| 2BN01C02 | -0.80 | 2BN03- | -1.41 | 2-N08C67 | -1.48 | 2BN09- | -1.13 | 2-N05- | -1.35 |
| 1E01- | -0.80 | 2-N04C24 | -1.46 | 2-N01- | -1.51 | 2-N04C44 | -1.13 | 2-N02- | -1.36 |
| 2BN02C12 | -0.81 | 2BN02C08 | -1.49 | 2F-- | -1.56 | 2A-PE | -1.15 | 2-N07C52 | -1.37 |
| 2D03- | -0.81 | 2-N07C50 | -1.55 | 2-N09- | -1.63 | 2-N02C12 | -1.16 | 7H-- | -1.55 |
| 3K-- | -0.81 | 2ABTR- | -1.63 | 2-N07C57 | -1.72 | 3--- | -1.29 | 2-N05C31 | -1.55 |
| 2-N03C16 | -0.81 | 2-N08C65 | -1.65 | 3Q-- | -1.73 | 2-N04C23 | -1.45 | 2-N06- | -1.67 |
| 2AI- | -0.81 | 2-N09Est | -1.68 | 2-N05- | -1.84 | 3Q-- | -1.58 | 2-N07- | -1.69 |
| 7C-- | -0.82 | 2-N03EP | -1.71 | 2-N02- | -2.25 | 2-N08C59 | -1.87 | 2BN02- | -1.79 |
| 2-N02C23 | -0.82 | 2B-Nicho | -1.75 | 2-N07- | -2.27 | 2-N09EP | -2.10 | 2-N09- | -2.65 |
| 2-N02C8 | -0.82 | 2-N05EP | -1.81 | 2H-- | -2.47 | 2-N08- | -2.14 | 2-N07EP | -3.15 |
| 2FD- | -0.85 | 2-N08EP | -1.87 | 2-N08- | -2.47 | 2--- | -2.21 | 2A-- | -4.22 |
| 2FH- | -0.85 | 2-N06EP | -1.93 | 3R-- | -2.59 | 2--EP | -4.08 | 2-N04EP | -4.41 |

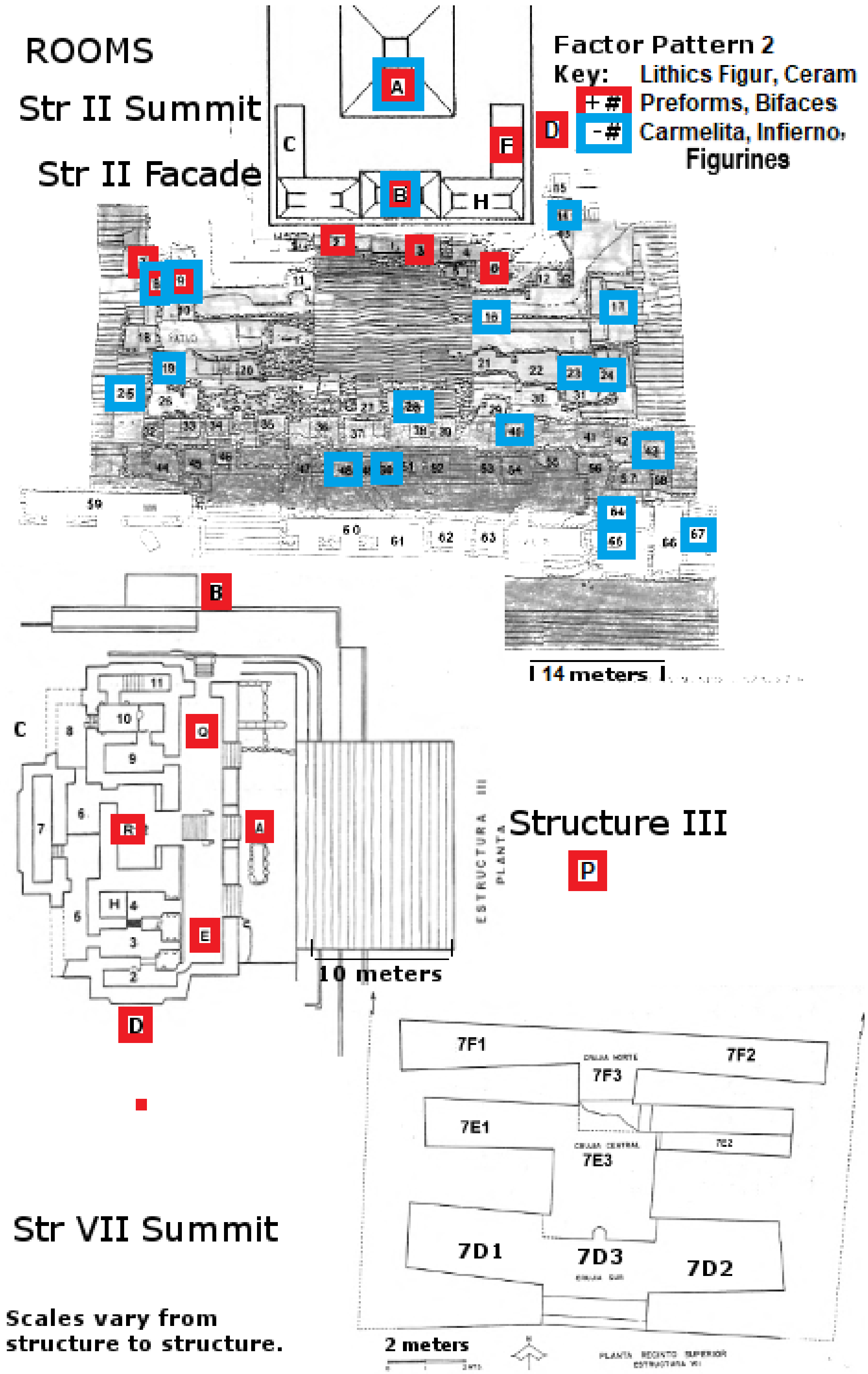


Figure 50. Room map of LFC Factor Scores +/- for Factor 2.

might indicate that as the structure was abandoned, the Chaquiste pots were taken away in the migration. What does this mean for the function of Chaquiste?

Factor 5. Factor 5 is largely of lithics, large hammer stones and preforms being the key types and everything else also related to flake production. They occur in Structure II and Structure III. The only associated ceramic type is Pelota, a Late Classic food vessel.

Factor 6. This factor is lithic founded and includes barkbeaters as the key element. Associated are small bifaces, large celts and side notched points. It might be a paper making tool kit. (See tool kit 3a in tool kit section)

Factor 7. Factor 7 is composed of lithics except for Carro ceramics. The lithics are bifaces of all sizes and celt fragments: probably not a flake production inventory because there are no hammerstones.

## Conclusions

About 15,000 stone artifacts have been recovered from 93 rooms in palace Structure III and pyramids I, II, and VII at Calakmul. Some of the tools provide unambivalent functional information such as barkbeaters, drills, and adzes. Other lithics, such as utilized flakes and axes, thought to have been the ancient equivalent of modern multipurpose machetes, provide potentially informative but ambivalent functional information. Using rooms as a unit of analysis, tool kits are inferred by combined analysis of the unambivalent and ambivalent tool forms. These tool kits, combined with various qualitative clues, indicate functional, and in some cases social structuring of activities in the key precinct of the city organized from Preclassic times around a plaza flanked by, among others, Pyramids I, II, and VII and palace Structure III,. In the decade from 1984 to 1994 excavations were undertaken in and on these structures.

The term "key precinct" is used advisedly. In his work on quality of life understandings of past cultures, Smith (2019) develops an alternative to viewing past societies as hierarchical status social organizations, which terms such "elite precinct" inherently imply. Rather he advocates looking at societies from the point of view of households and communities. It is at the level of households and communities that continuity and sustainability have to be achieved by solving the fundamental, day-to-day problems that societies must face. As we have seen from several points of view in this report, the perceptions of key and elite precinct are not in all cases incompatible. For a time, in the sixth and seventh centuries the Kaan household managed to solve the complex problems of commercial networks, family continuity, food production and transportation, and social projects including massive elaboration of the existing ritual and household infrastructure of the key precinct. The outcome of this effort was that the Kaan household and its support structure was especially enduring, a dynasty. This is especially evident in the reign of Yuknoom the Great (636-686 CE), when they were the most networked social structure in the southern Maya Lowlands (Marin and Grube 2008).

Subsequent to the Kaan (Snake) dynasty at Calakmul, a new social organization established itself in the key precinct. It brought with it an entirely new understanding of the utility of the key precinct, perhaps one in which the pyramids became fortifications and/or markets and palaces, both on and by Structure II. The household structure of this social organization is not clear. It may have been another dynasty, the Bat household, or it may have been a more egalitarian, immigrant community. In either case, new rooms were built on the zones of pyramid Structure II and IIA and it became a residential and/or commercial district rather than sacred and hierarchical architecture. For our concerns, using rooms as units of study, our focus is necessarily on the latter household, whatever their structure and relationship to the rest of Calakmul society and that of the central Maya Lowlands.

Smith's (2019:495-497) formula for understanding the household and community support structure is to look at artifacts as byproducts of household wealth and capabilities. <u>Wealth</u> is income that can be estimated by room sizes and numbers of artifact types. <u>Capabilities</u> consist of a range of choices that households are able to make that contribute to their continuity. Important in this mix are networks that supply external necessities such as materials for tools, dietary necessities such as salt and ocean fish, and locally earned goods that can serve in payment for necessities. The number of networks can be quantified from archaeological assemblages by enumerating the number of external networks represented in room artifact inventories.

By analyzing room sizes with material types, we were able to identify areas, especially those on the lower zone of pyramid Structure II with external networks that involved long distance trading in probably chalcedony, probably high-quality brown chert, and certainly obsidian, basalt and serpentine. These items point to external networks and they appear frequently in elevated and palatial circumstances.

The presence of chalcedony and high-quality chert and tool grade limestone in the larger and higher (wealthier) rooms of palace structures on pyramid Structure II and palace Structure III appears to suggest they are linked to other networks, especially in the case of palace Structure II to the obsidian network from the Mexican highlands. That suggests that both the Classic, the Terminal Classic populations had wealth discrepancies and shared values.

The lithic technology of Calakmul is a biface-based approach to making stone tools, the only exception observed being obsidian punch blade technology (Braswell et al. 2004). Materials used were largely cherts and probably of local origin. For some purposes materials were imported such as basalt and granite for grinding implements. These materials might reflect trading relationships with Maya mountain-based Caracol, Calakmul's alliance partner (Martin and Grube 2008) along the cross peninsular Royal Road (Canuto et al. 2012). Fine brown cherts may have been imported from Belize (Rovner and Lewenstein 1997) and sometimes are paired with obsidian blades in peculiar circumstances such as wall niches. The overall lithic inventory looks more like Becan (Andrieu 2013) than Tikal. The fancy grinding tools might be relicts from the Kaan period (7th century) while the more general lithic tool inventory reflects the habits of northern immigrants during the Terminal Classic (9th/10th century). The huge variety in point types could also mark further use of relic tools.

Thanks to the widths of the pyramid Structure II zones it seems likely that distinguishing between artifacts on the floors and in the rubble on the floors adds a three-dimensional perspective to the study. Tools on the floor were probably used and stored on the floor. Tools in the rubble were stored on or in walls, hanging from the ceilings and perhaps came down from roof top workspaces.

In the arsenal of capabilities measurements, Smith (2019:486) regards that quality of life indicators point to households and prosperity indicators to communities. In the ruins of Calakmul's last centuries community and household have a peculiar crossing of paths. The Late Classic architecture was obviously designed for sumptuous reasons (Reents-Budet et al. 2011), apparently to impress the leaderships of communities in the orbit of the Kaan household during their peak years of the 7th century, the times of Yuknoom Ch'een II (The Great, 636—686 CE) and his military prince Yuknoom Yich'aak K'ahk' (686-695 CE). The 8th century seems to have been a period of decline with the hegemony of the Kaans south of Tikal disintegrating by the 740s CE (Martin and Grube 2008). At about that time the Kaans seem to have turned their attention toward the west coast ending up in Calkini (Bolles and Folan 2001) amidst the growing influence of the west coast, maritime-oriented cities (Gunn et al. 2017).

Sometime in the 8th or 9th century a new group of inhabitants arrived, possibly from Oxpemul 35 km to the north, and/or other northern refugees from the 9th century droughts. Such a movement was observed recently in the village of Pich on the flanks of the Edzna Valley. In 1939 there was a ravaging drought and locust plague that precipitated among other events a war between the states of Campeche and Yucatan. Don Roberto, a chief informant to Betty Faust's studies in Pich, had one of his fingers shot off as an infant while his mother fled from the state of Yucatan to Pich, Campeche. A section of the village is still today occupied by State of Yucatan immigrants.

In the case of Calakmul the northerly newcomers must have been much less numerous than the previous Kaan-related occupants. They may have been attracted to Calakmul by its reservoirs that would have made it habitable in the dry season though at a much smaller scale than previously because of the droughts. The wet season, such as it was in the droughty 9th century, would have been a time to disperse and grow tropical gardens. During the dry season, the time of trade and war, they needed water and fortification, not sumptuous display. They built humble residences on the zones of temple Structure II and IIA. Similar occurrences have been observed on the zones of El Mirador's temples 37 km to the south and through much of the central Maya lowlands including Tikal. That large metates were carefully upended and stored high on Calakmul Structure II (Folan et al. 1995) suggests that the inhabitants intended to return the following dry season but did not for whatever reasons. Grinding on the platforms of obsidian artifacts in these residences suggest these occupants postdated 800 CE.

This story leads to the conclusion that in the 7th century, the time of the Kaan's, the promontory and key precinct of Calakmul was a matter of a very wealthy household. Its sumptuary palaces were the scenes of chocolate cups and feasts, a part of the Kaan regulation of their hegemonic empire. During the subsequent 9th century, Calakmul's key precinct crossed over from household to community. The whole of it may have been in the defensible perimeter of the Calakmul promontory including its water supply to the east of the key precinct 500 m. The small residential rooms on the zones of Structure II indicate a culture with much less income than the large rooms in the palaces on summit Structure II and palace Structure III. The once grand palaces rooms became stand up supports for stored metates and multifunction workshops harboring several tool kit components.

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# APPENDIX 1: CALAKMUL LITHIC CODING PROTOCOL (May 1999)

**Variable List in Lithics 99.xls File**

1. Structure Number (Operation)
2. Quadrat Number (Suboperación)
3. Lot (Lote)
4. Sublot (Sublote)
5. Subphase (Subfase)
6. Room East Coordinate (Este)
7. Room North Coordinate (Norte)
8. Context (Contexto)
9. Room Elevation (Elevación)
10. Artifact Number (Número de Artifacto)—Duplicate the room-rows in the spreadsheet until they equal the number of artifacts in the room. Enter the artifact sequence numbers after the room elevations.

Artifact Labeling. Label each artifact with a room number (Operation, Suboperation, Lot, Sublot) and an artifact sequence number. Start artifact numbers with 1 for each room and number until the largest number equals the total number of artifacts in the room.

**Codes for the artifact characteristics.**

11. Artifact Weight in grams (Peso de Artifact en gramos)
12. Artifact Platform width in mm (Ancho de la Plataforma del Artefato en mm.)
13. Artifact material type (Tipo de Material del Artifact)
    0. Other
    1. Flint
    2. Chert (Brown, Tan)
    3. Chalcedony
    4. Quartzite
    5. Obsidana
    6. Limestone
    7. Basalt
    8. Jasper
    9. Other
    10. Serpentine
    11. Jade

14. Material Color (Color del Material X.1=light[claro], X.2=medium[medio], X.3=dark[oscuro])
    1. Red (rojo)
    2. Blue (azul)
    3. Gray (XX?)
    4. Brown (café)
    5. Rose (rosa)
    6. Purple (púrpura)
    7. Yellow (amarillo)
    8. Black (negro)
    9. Green (verde)

15. Material Color Consistency (Consistencia del Color del Material)
    1. solid
    2. mottled

16. Visible Edge Damage, not modern (Cortes Visibles no modernos)
    1. no
    2. polish
    3. scaling
    4. step fracture
17. Fire (Fuego)
    1. no
    2. discolored (reddish, dishwatery)
    3. potlidded
    4. fire crazed
18. Artifact Type (Tipo de Artifact)
    1. Flake (lasca)
    2. Scraper (raspador)
        2.1 Scraper fragement
    3. Point unclassified (punta) or unclassifiable fragement
        3.11 fragement
        3.1 Pointed stem
        3.2 Small stem
        3.3 Bipoint
        3.4 Lanceolate
        3.5 Straight stem
        3.6 Contacting stem
        3.7 Notched
        3.8 Broad stem
        3.9 Broad stem spatulates
    4. Ax (hacha)
        4.1. Ax fragment
        4.2. Ax small
        4.3. Ax large
    5. Utilized flake (lasca útil)
    6. Mano
        6.1. Mano fragment
        6.2. Mano very small
        6.3. Mano small
        6.4. Mano medium
        6.5. Mano large
    7. Metate
        7.1. Metate fragment
    8. Mortar (mortero)
    9. Perferator (perferador)
        9.1. Perferator fragment
    10. Preform (crude biface) (see Table XX. Types and Subtypes of Large Bifaces.)
        10.1
        10.2 Preform very very small
        10.3 Preform very small
        10.4 Preform small
        10.5 Preform large
        10.6 Preform very large
        11. Celt (celta, ground stone?)
        11.1 Celt fragment

11.2 Celt small
11.3 Celt large
12. Adz (azuela)
12.1 Adz fragment
12.2 Adz small
12.3 Adz large
13. Push plain (desvastador, bark remover)
-14. Stone (piedra)
15. Core (núcleo, flake or biface)
16. Denticulated scraper (raspador denticulado)
17. Biface
17.1. Biface fragment
17.2. Biface very very small
17.3. Biface very small
17.4. Biface small
18. Prismatic blade (navaja prismática)
18.1. Blade fragment
-19. Fragmento pequeno de piedra (chunk)
20. Shatter (astrilla)
?21. Hammerstone (Percutor)
21.1. Hammerstone small
21.2. Hammerstone small
22. Barkbeater (macerador, machacador, macerator)
23. Other (otros)
24. Polisher (polidor)
25. Curtain anchor (cortinera)
26. Molds for beads (moldes para cuentas)
27. Chisel (cincel)
28. Eccentric (excentrico)
29.
30. Obsidian artifacts types (Braswell's) recorded as hundredths
30.05. flake
30.06. projectile point
30.08. macroblade
30.10. small percussion blade
30.12. prismatic (pressure) blade
30.13. prismatic blade point,
30.14. polyhedral core (for making p. blades)
30.17. chunk
30.18. exhausted polyhedral core
30.22. sculptural eye
30.23. earspool (changed from 99 in Braswell version)

19. Platform (plataforma)
1. Absent
2. Core (núcleo, plana)
3. Bifacial (sharp, punta)
4. Bifacial ground
20. Termination (terminación)
0. Absent
1. Normal

2. Top
3. Plana
4. Bottom
5. Retouched
6. Hinge Fracture (Fractura de bisagra)
7. Unclassified break
8. Symetrical break on basal fragment
9 Assymetrical beak on basal fragment
10. Symetrical on tip
11. Assymetrical on tip
12. fractured tip (lateral or facial)

21. Reducción (reduction sequence)
    0. Absent (ausente)
    1. Core (núcleo), Core or Biface
    2. Primary
    3. Secondary
    4. Terciary

22. Length (largo)

23…, observations on points and obsidian artifacts

## Lithics Artifact Coding Form

**CALAKMUL FORMA CODIGO** ________Iniciales

___numero ___loteSitio = Calakmul **1 LOCATION**
___operacion ___sublote
___suboperacion
___este (m)
___norte(m)
___contexto (1=escombro, 2=sobre piso, 3=bajo piso, 4=sin pro, 5=estrat
___subfase (1=Clasico tardio I, 2=Clasico tardio II...)
___asociado (1=fogones, 2=banquetas, 3=altar, 4= ...)
___ubicacion (1=adentro, 2=afuera, 3=...)
___volumen

___fuego L___ Zona Cuantificar
___exfoliacion L________________________________________

___nucleo L____________________________________ **2 REDUCCION SEQ**
___bifacial L______________________________________
___primario L______________________________________
___secundario L______________________________________
___terciarias L______________________________________

___plano [ L______________________________________ **3 PLATAFORMA**
___punta < L____________________________________ No prismática
___desgaste( L________________________________________

*solo lascas* **4 TAMAÑOS**
___1 cm L______________________________________ [1]
___2 cm L______________________________________ [2][2]
___3 cm L______________________________________ [3][3][3]
___4 cm L______________________________________ [4][4][4][4]
___>5 cm L______________________________________ [5][5][5][5][5]

___obsidiana L______________________________________ **5 MATERIAL**
___basalto/gr L______________________________________
___pedernal L______________________________________
___silex L______________________________________
___calcedonia L______________________________________
___coral L______________________________________
___caliza L______________________________________
___cuarcita L______________________________________
___jaspe L______________________________________

___afilador L__________ **6 HERRAMIENTAS**
___azuela L__________ ___navaja prism L__________
___celta L__________ ___percutor L__________
___desvastar L__________ ___perforador L__________
___hacha L__________ ___pico L__________
___lasca util L__________ ___preforma L__________
___mano L__________ ___punta s/m L__________
___metate L__________ ___punta L__________
___mortero L__________ ___raspador L__________

## Recoding for Linear Analyses

The nominal variables were scaled so that they meet linear assumptions.

13. Artifact material type (Tipo de Material del Artifact) was scaled from fine to coarse texture: obsidian, chalcedony, flint, jasper, chert, serpentine, basalt, quartzite, limestone. The variable could have been scaled on hardness with a different and possibly important result.

Of the 2484 flakes 2329 were brown chert. This is not surprising as brown chert was available from the nearby bajo. Also, some of the fine brown chert (Rovner 1981a&b) could have been imported from Belize. Of the remaining specimens, 14 were flint, 77 chalcedony, 6 quartzite, 22 obsidian, 5 basalt, 20 jasper, and 1 serpentine.

14. Material Color (color del material) was scaled from ... to ...
15. Material Color Consistency (consistencia del color del maerial) was scaled from ... to ...
16. Visible Edge Damage, not modern (cortes visibles no modernos) was scaled from small and refined to large and coarse.
17. Fire (fuego) was scaled from slightly burned to seriously burned and damaged by it. Intentional heat treating or slight accidental exposure to fire would have caused this condition. The greatest amount of damage would be cause by accidental exposure to fire such as building a fire on an artifact or throwing the artifact into a fire.
19. Platform (plataforma)
20. Termination (terminación)
21. Reduction sequence (reducción)
22. Largo. Length of the artifact in cm mano, metates,

**Factor Analysis of all Flakes**

**All of the flakes are from Structure II.**

One of the objectives of the study was to use the geography of pyramid Structure II, i.e. elevation, to discover if there were differences in elite and vernacular use of materials and tool forms. A presumed sacred class variable was created by transforming room numbers into an elevation scheme. Class 1 (=1) was the rooms on the summit of the pyramid. Class 2 (2-29) was rooms near the top of the pyramid on the zones; these might be residences. Class 3 (<29) was rooms near the bottom of the zones, possibly shops. When tabulated against material there were no conspicuous differences between the usages of material types up and down the structure. Differences were suggested, however, by factor analyses.

**Data Modifications during Analysis**

1. Two cases of color 1 changed to 1.1
2. Two cases of color blue changed to 2

# APPENDIX 2: Dataset Material and Technology by Rooms Presence or Absence

| Room | Structure | SIIEW | Elev | SIIYsNo | Contex | Volumen | Fuego | PlPlano | PlPunta | Desgast | Nucleo | Bifaci | Primar | Second | Terciar | w1cm | w2cm | w3cm | w4cm | w5cm | Obsidia | Basalto | Peder | Silex | Calced | Caliza | Cuarcit | Jaspe | Exfol | Afilad | Azuela | Celta | Maserad | LascaUt | Denticu | Mano | Percut | Metate | NavajaP | Perfor | Piedra | Preform | Pulidor | Puntasm | Punta | Raspad | Hacha | Mortero | Spindle | Pico | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| r11C | 1 | 0 | 10 | 1 | 5 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| r13C | 1 | 0 | 10 | 1 | 5 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| r1A | 1 | 0 | 10 | 1 | 1 | 9 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 29 |
| r1C | 1 | 0 | 10 | 1 | 1 | 9 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| r1E | 1 | 0 | 10 | 1 | 1 | 9 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| r2- | 2 | 0 | 9 | 2 | 4 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 33 |
| r2- | 2 | 0 | 11 | 1 | 4 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 37 |
| r2A | 2 | 2 | 0 | 2 | 2 | 7 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 32 |
| r2A | 2 | 2 | 0 | 2 | 1 | 6 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 24 |
| r2A | 2 | 2 | 0 | 2 | 1 | 6 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 35 |
| r2B | 2 | 2 | 1 | 2 | 1 | 5 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 34 |
| r2BH | 2 | 2 | 0 | 2 | 1 | 9 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 23 |
| r2C11 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 9 |
| r2C12 | 2 | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 27 |
| r2C13 | 2 | 3 | 1 | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| r2C18 | 2 | 3 | 3 | 2 | 2 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 9 |
| r2C21 | 2 | 3 | 3 | 2 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 13 |
| r2C23 | 2 | 3 | 3 | 2 | 2 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 8 |
| r2C25 | 2 | 1 | 5 | 2 | 0 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 15 |
| r2C26 | 2 | 1 | 5 | 2 | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 8 |
| r2C28 | 2 | 2 | 5 | 2 | 2 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| r2C30 | 2 | 3 | 5 | 2 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 17 |
| r2C31 | 2 | 3 | 5 | 2 | 2 | 4 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 25 |
| r2C34 | 2 | 1 | 6 | 2 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 23 |
| r2C37 | 2 | 2 | 6 | 2 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 19 |
| r2C38 | 2 | 2 | 6 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| r2C39 | 2 | 2 | 6 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 19 |
| r2C40 | 2 | 3 | 6 | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| r2C43 | 2 | 3 | 6 | 2 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| r2C43 | 2 | 3 | 6 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 10 |
| r2C44 | 2 | 1 | 7 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 27 |
| r2C50 | 2 | 2 | 7 | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 11 |
| r2C53 | 2 | 3 | 7 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| r2C54 | 2 | 3 | 7 | 2 | 0 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| r2C57 | 2 | 3 | 7 | 2 | 2 | 3 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 20 |
| r2C58 | 2 | 3 | 7 | 2 | 2 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 21 |
| r2C59 | 2 | 1 | 8 | 2 | 2 | 14 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 28 |
| r2C60 | 2 | 2 | 8 | 2 | 2 | 8 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 25 |
| r2C61 | 2 | 2 | 8 | 2 | 2 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 24 |
| r2C64 | 2 | 3 | 8 | 2 | 2 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 15 |
| r2C67 | 2 | 3 | 8 | 2 | 2 | 3 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 18 |
| r2C8 | 2 | 1 | 2 | 2 | 2 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 23 |
| r2D | 2 | 2 | 0 | 2 | 2 | 5 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 26 |
| r2E114 | 2 | 2 | 11 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 16 |
| r2EO39 | 2 | 3 | 11 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 10 |
| r2EO42 | 2 | 3 | 11 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 17 |
| r2EO57 | 2 | 3 | 11 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 7 |
| r2EP32 | 2 | 2 | 11 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 8 |
| r2EP33 | 2 | 2 | 11 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 15 |
| r2EP34 | 2 | 2 | 11 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 16 |
| r2EP36 | 2 | 2 | 11 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 25 |
| r2EP37 | 2 | 2 | 11 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 20 |
| r2EP38 | 2 | 2 | 11 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 27 |
| r2EP40 | 2 | 2 | 11 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 26 |
| r2EP41 | 2 | 2 | 11 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 27 |
| r2EP43 | 2 | 2 | 11 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 25 |
| r2EP51 | 2 | 2 | 11 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 34 |
| r2EP59 | 2 | 2 | 11 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 13 |
| r2F | 2 | 2 | 1 | 2 | 1 | 4 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 28 |
| r2H | 2 | 2 | 1 | 2 | 1 | 5 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 26 |
| r3A | 1 | 0 | 10 | 1 | 2 | 15 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 38 |
| r3B | 1 | 0 | 10 | 1 | 3 | 12 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 30 |
| r3C | 1 | 0 | 10 | 1 | 2 | 9 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| r3D | 1 | 0 | 10 | 1 | 2 | 10 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 30 |
| r3E | 1 | 0 | 10 | 1 | 2 | 8 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 29 |
| r3G | 1 | 0 | 10 | 1 | 2 | 5 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| r3H | 1 | 0 | 10 | 1 | 2 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 29 |
| r3I | 1 | 0 | 10 | 1 | 2 | 5 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| r3J | 1 | 0 | 10 | 1 | 2 | 3 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 18 |
| r3K | 1 | 0 | 10 | 1 | 2 | 8 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| r3L | 1 | 0 | 10 | 1 | 2 | 5 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 18 |
| r3M | 1 | 0 | 10 | 1 | 2 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 22 |
| r3N | 1 | 0 | 10 | 1 | 2 | 5 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| r3O | 1 | 0 | 10 | 1 | 2 | 5 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| r3P | 1 | 0 | 10 | 1 | 2 | 5 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 31 |
| r3Q | 1 | 0 | 10 | 1 | 2 | 4 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 27 |
| r3R | 1 | 0 | 10 | 1 | 2 | 4 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 35 |
| r7F | 1 | 0 | 10 | 1 | 3 | 5 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 |
| | | | | | | | 10 | 68 | 42 | 24 | 47 | 43 | 51 | 66 | 58 | 21 | 47 | 50 | 57 | 64 | 25 | 42 | 78 | 11 | 32 | 46 | 50 | 26 | 23 | 5 | 25 | 37 | 11 | 33 | 16 | 53 | 49 | 42 | 23 | 24 | 39 | 31 | 20 | 16 | 52 | 34 | 28 | 12 | 9 | 5 | |

# Appendix 3: Dataset Room by Lithic Subtypes with Diversity and Area

| | ROOM | Structure12 | ZoneRoom | Diversity | Volume | PointedSt | SmallSt | Bip | Lance | ExpSt | ContSt | SideNtch | BrdSt | Spat | AxFrag | AxSml | AxLg | ManVSm | ManSml | ManMed | ManLg | PrefFrag | PrefVVSm | PrefVSm | PrefSm | PrefLg | CeltFrag | CeltSm | CeltLg | AdzFrag | AdzSm | AdzLg | BifFrag | BifVVSm | BifVSm | BifLg | HamSm | HamLg | Barkbeater | ObsPrism |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A10- | | 1 | 10 | 3 | 7.30 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1A2- | | 1 | 10 | 2 | 7.30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1A7- | | 1 | 10 | 3 | 7.30 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1SP-- | | 1 | 10 | 3 | 7.30 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 2-N1C04 | | 2 | 1 | 2 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 2-N2- | | 2 | 2 | 5 | 2.80 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 2-N2C08 | | 2 | 2 | 7 | 2.80 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2-N2C12 | | 2 | 2 | 12 | 2.80 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2-N2EP | | 2 | 2 | 2 | 2.80 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2-N3- | | 2 | 3 | 7 | 2.80 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2-N4C21 | | 2 | 4 | 5 | 2.80 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 2-N4C23 | | 2 | 4 | 3 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2-N4EP | | 2 | 4 | 18 | 2.80 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 2-N5C25 | | 2 | 5 | 3 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 2-N5C26 | | 2 | 5 | 2 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2-N5C27 | | 2 | 5 | 3 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2-N5C28 | | 2 | 5 | 2 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 2-N5C30 | | 2 | 5 | 6 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2-N5C31 | | 2 | 5 | 9 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 2-N6- | | 2 | 6 | 20 | 2.80 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 2-N6C34 | | 2 | 6 | 8 | 2.80 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 2-N6C37 | | 2 | 6 | 8 | 2.80 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2-N6C38 | | 2 | 6 | 3 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2-N6C39 | | 2 | 6 | 4 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 2-N6C40 | | 2 | 6 | 1 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2-N6C43 | | 2 | 6 | 2 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2-N7- | | 2 | 7 | 7 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2-N7C44 | | 2 | 7 | 11 | 2.80 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 2-N7C45 | | 2 | 7 | 1 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2-N7C50 | | 2 | 7 | 2 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2-N7C51 | | 2 | 7 | 4 | 2.80 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2-N7C52 | | 2 | 7 | 6 | 2.80 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2-N7C53 | | 2 | 7 | 5 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 2-N7C57 | | 2 | 7 | 10 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 2-N7C58 | | 2 | 7 | 11 | 2.80 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 2-N7EP | | 2 | 7 | 7 | 2.80 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2-N8- | | 2 | 8 | 22 | 2.80 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 2-N8C59 | | 2 | 8 | 10 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 2-N8C60 | | 2 | 8 | 9 | 2.80 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2-N8C61 | | 2 | 8 | 9 | 2.80 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 2-N8C64 | | 2 | 8 | 4 | 2.80 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2-N8C67 | | 2 | 8 | 4 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2-N9- | | 2 | 9 | 5 | 2.80 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2-N9ALTAR | | 2 | 9 | 2 | 2.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2-N9EP | | 2 | 9 | 12 | 2.80 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 2-SPEP | | 2 | 5 | 6 | 2.80 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2A-- | | 2 | 10 | 23 | 7.27 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 2A2- | | 2 | 10 | 3 | 7.27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 2A4- | | 2 | 10 | 9 | 7.27 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2A5- | | 2 | 10 | 10 | 7.27 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| 2A6- | | 2 | 10 | 9 | 7.27 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 2A7- | | 2 | 10 | 7 | 7.27 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2ABTR.2- | | 2 | 10 | 2 | 7.27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2APE- | | 2 | 10 | 17 | 7.27 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 2B-- | | 2 | 10 | 22 | 7.27 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 2BH-- | | 2 | 10 | 4 | 7.27 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2BN1C01 | | 2 | 10 | 1 | 7.27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2BN1C02 | | 2 | 10 | 1 | 7.27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2BN2- | | 2 | 10 | 5 | 7.27 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2BN2C08 | | 2 | 10 | 1 | 7.27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2BN2C09 | | 2 | 10 | 5 | 7.27 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 2BN3- | | 2 | 10 | 2 | 7.27 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2BNICHO- | | 2 | 10 | 6 | 7.27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2D-- | | 2 | 10 | 9 | 7.27 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 2F -- | | 2 | 10 | 12 | 7.27 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

## Appendix 3: Dataset Room by Subtypes with Diversity and Area (cont'd)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2F-- | 2 | 10 | 5 | 7.27 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2H-- | 2 | 10 | 15 | 7.27 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 2SP-- | 2 | 10 | 3 | 7.30 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3A-- | 3 | 10 | 1 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 3A1- | 3 | 10 | 14 | 7.10 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 3A2- | 3 | 10 | 2 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 3A3- | 3 | 10 | 7 | 7.10 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 3A4- | 3 | 10 | 5 | 7.10 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 3A5- | 3 | 10 | 13 | 7.10 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 3A6- | 3 | 10 | 11 | 7.10 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 3A7- | 3 | 10 | 6 | 7.10 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 3A8- | 3 | 10 | 11 | 7.10 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 3A9- | 3 | 10 | 5 | 7.10 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 3B1- | 3 | 10 | 4 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 3B10- | 3 | 10 | 1 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 3B2- | 3 | 10 | 6 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 3B3- | 3 | 10 | 5 | 7.10 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 3B4- | 3 | 10 | 2 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 3B5- | 3 | 10 | 2 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3B6- | 3 | 10 | 2 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 3C-- | 3 | 10 | 4 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 3D-- | 3 | 10 | 3 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 3D0- | 3 | 10 | 1 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 3D6- | 3 | 10 | 6 | 7.10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 3D7- | 3 | 10 | 7 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 3E-- | 3 | 10 | 14 | 7.10 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 3E0- | 3 | 10 | 1 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 3G-- | 3 | 10 | 2 | 7.10 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 3H-- | 3 | 10 | 4 | 7.10 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 3I0- | 3 | 10 | 1 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 3J-- | 3 | 10 | 3 | 7.10 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 3L-- | 3 | 10 | 2 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3L18- | 3 | 10 | 2 | 7.10 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 3M-- | 3 | 10 | 2 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 3O-- | 3 | 10 | 4 | 7.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 3P-- | 3 | 10 | 10 | 7.10 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3Q-- | 3 | 10 | 8 | 7.10 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 3R-- | 3 | 10 | 7 | 7.10 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 7E2- | 7 | 10 | 1 | 7.90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 7E2d | 7 | 10 | 2 | 7.90 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7F1C | 7 | 10 | 1 | 7.90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 7F1G | 7 | 10 | 1 | 7.90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 7F2- | 7 | 10 | 1 | 7.90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 7F2L | 7 | 10 | 1 | 7.90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 7F2M | 7 | 10 | 1 | 7.90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 7F3D | 7 | 10 | 1 | 7.90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 7F3a | 7 | 10 | 1 | 7.90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 7H-- | 7 | 10 | 2 | 7.90 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

# Appendix 4: Dataset Lithic, Figurine, Ceramics (LFC)

**Dataset 4. Presence or absence**

Lithics | Figurines | Ceramics

| TypeNum | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1— | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 12 |
| 1A01- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 7 |
| 1A02- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 10 |
| 1A03- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 8 |
| 1A04- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 8 |
| 1A05- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 6 |
| 1A06- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 6 |
| 1A07- | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 9 |
| 1A08- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 7 |
| 1A09- | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 8 |
| 1A10- | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 9 |
| 1B01- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 4 |
| 1B02- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 5 |
| 1B04- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 4 |
| 1C01- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 4 |
| 1C02- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 7 |
| 1C03- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 5 |
| 1C04- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 7 |
| 1C06- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 5 |
| 1C07- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 7 |
| 1C08- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 7 |
| 1C09- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 6 |
| 1C10- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 6 |
| 1D01- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 6 |
| 1D03- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 6 |
| 1D04- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 5 |
| 1D05- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 9 |
| 1E01- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 1E05- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 5 |
| 1E06- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 3 |
| 1E07- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 6 |
| 2— | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 56 |
| 2—EP | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 55 |
| 2—N1CHC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2—PE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2—PLAT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 2-N01- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 2-N02- | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 12 |
| 2-N02C08 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| 2-N02C09 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 17 |
| 2-N02C12 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 33 |
| 2-N02C14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 16 |
| 2-N02C15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 2-N02C16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 14 |
| 2-N02C25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 2-N02C8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 2-N02EP | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 22 |
| 2-N03- | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 11 |
| 2-N03C16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2-N03C17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 10 |
| 2-N03C18 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 19 |
| 2-N03EP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 23 |
| 2-N04- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2-N04AL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2-N04C21 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 21 |
| 2-N04C22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 2-N04C23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 2-N04C24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 20 |
| 2-N04C44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 2-N04EP | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 43 |
| 2-N05- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 5 |
| 2-N05C25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 23 |
| 2-N05C26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 9 |
| 2-N05C27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 2-N05C28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 18 |
| 2-N05C30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 15 |
| 2-N05C31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 35 |
| 2-N05C36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2-N05EP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 26 |
| 2-N06- | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 23 |
| 2-N06C31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 2 |
| 2-N06C34 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 17 |
| 2-N06C36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| 2-N06C37 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 22 |
| 2-N06C38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 8 |
| 2-N06C39 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 13 |
| 2-N06C40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 16 |
| 2-N06C45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 21 |
| 2-N06EP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 26 |
| 2-N07- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| 2-N07C44 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 23 |
| 2-N07C45 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 2-N07C48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 18 |
| 2-N07C50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 26 |
| 2-N07C51 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 8 |
| 2-N07C52 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 2-N07C53 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 16 |
| 2-N07C54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 8 |
| 2-N07C56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| 2-N07C37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 28 |
| 2-N07C38 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 30 |
| 2-N07C65 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2-N07EP | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 34 |
| 2-N08- | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26 |
| 2-N08C54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 13 |
| 2-N08C58 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| 2-N08C59 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 35 |
| 2-N08C60 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 27 |
| 2-N08C61 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 30 |
| 2-N08C63 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 8 |
| 2-N08C64 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 27 |
| 2-N08C65 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 22 |
| 2-N08C67 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 24 |
| 2-N08EP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 25 |
| 2-N09- | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| 2-N09AL7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 8 |
| 2-N09EP | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 38 |
| 2-N09Bar | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 23 |
| 2A-- | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 56 |
| 2A-PE | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 45 |
| 2A01- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| 2A02- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 9 |
| 2A03- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 7 |
| 2A04- | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 15 |
| 2A05- | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 16 |
| 2A06- | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 15 |
| 2A07- | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 14 |
| 2A08- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 |
| 2A09- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 |
| 2A10- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| 2A11- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| 2A12- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| 2A14- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| 2A15- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| 2AHTR- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 26 |
| 2AHSC- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 14 |
| 2AP-- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 16 |
| 2AI- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 2AN02- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 3 |
| 2B-- | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 50 |
| 2B-Nicho | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 23 |
| 2B16- | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 23 |
| 2BN01CII | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2BN01CII | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2BN02- | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 30 |
| 2BN02CII | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 21 |
| 2BN02CIP | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 2BN02CI | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| 2BN02CI' | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2BN02CZ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 15 |
| 2BN02CZ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2BN03- | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 23 |
| 2BN03CI' | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 14 |
| 2BN05- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 4 |
| 2BN06C3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 10 |
| 2BN09- | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2BNICHE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 2D-- | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 18 |
| 2D01- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| 2D02- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 |
| 2D03- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| 2D06- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| 2D07- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| 2D08- | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 9 |
| 2D09- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 |
| 2F-- | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 31 |
| 2FD- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2FH- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2H-- | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 41 |
| 2H-C15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| 3-- | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 16 |
| 3A-- | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 29 |
| 3B-- | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 16 |
| 3C-- | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 7 |
| 3D-- | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 17 |
| 3E-- | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 20 |
| 3G-- | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 3H-- | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| 3I-- | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 3J-- | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| 3K-- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| 3L-- | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 8 |
| 3M-- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 3N-- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| 3O-- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| 3P-- | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 12 |
| 3Q-- | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| 3R-- | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 11 |
| 7C-- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 3 |
| 7D-- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 5 |
| 7E-- | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 7 |
| 7F-- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 6 |
| 7H-- | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Outside | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Total | [illegible] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# Las Piedras de Calakmul

Las Piedras de Calakmul explora las relaciones entre las pirámides de piedra y los palacios de Calakmul y las tecnologías que las ocuparon: obsidiana, cuarzo, piedra caliza, cerámica y muchos otros. ¿Cuál era el tejido tecnológico subyacente que unía a los ocupantes del Clásico Tardío y Terminal a la fabulosa arquitectura de la entonces época dorada de Calakmul del siglo VII AD? El Dr. Gunn y sus colegas encuentran que los escalones llenosy los arcos etiquetados de los templos y palacios tienen historias que contar sobre templos convertidos en mercados y fortificaciones, y los misterios permanecen: ¿por qué una gama tan amplia de estilos complejos de punta de proyectil de cuchillo? ¿Las herramientas informan la calidad de vida y el estado de los ocupantes acosados? ¿Por qué los ocupantes esperaban regresar?

The Stones of Calakmul explores the relationships between the stone pyramids and palaces of Calakmul and the technologies that occupied them: obsidian, chert, limestone, ceramics, and many others. What was the underlying technological fabric that bound Late and Terminal Classic occupant to the fabulous architecture of the then-passed Calakmul Golden Age of the seventh century AD? Dr. Gunn and colleagues find that the crowded steps and corbeled arches of temples and palaces have stories to tell about temples turned into markets and fortifications, and mysteries remain: why such a wide range of complex knife-projectile point styles? Do the tools report the quality of life and statuses of the harried occupants? Why did the occupants expect to return?

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