WHEN TRASH BECOMES TREASURE: A POSTCLASSIC MAYA OBSIDIAN CORE CACHE FROM NOJPETEN

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ABSTRACT

This paper examines an obsidian cache offering excavated near the corner of a Postclassic Maya platform structure in Nojpeten, on the island of Flores, Guatemala. The cache consists of approximately 190 obsidian prismatic blade cores and core fragments, but the original number of cores placed in the cache likely fell between 173 and 182, with a best estimate of 177, 178, or 180. The cores were found about 20 cm southwest of the structure in a circular concentration measuring approximately 35 cm north-south by 30 cm east–west and 16 cm deep. The cache is analyzed through a lithic technology framework that focused on three phases: procurement, manufacture, and deposition. Data collection for the procurement phase consisted of sourcing the obsidian using a portable x-ray fluorescence spectrometer and obsidians from three sources in the Guatemalan highlands were found: Ixtepeque, San Martin Jilotepeque, and El Chayal. For the manufacture phase, data collection consisted of documenting core dimensions, degree and type of rejuvenation techniques, and the number and variability of platforms, blade terminations, and blade scars. This information was used to examine the prismatic blade-core technology responsible for creating this assemblage as well as to situate Nojpeten blade-core manufacturing within what is postulated for the greater Petén lakes region during the Postclassic period. To address the deposition phase, this paper examined the archaeological context of the cache by exploring the relationship the cores had with the adjacent structure, and the caching behaviors that resulted in this offering's deposition based on comparison with geographically, temporally, and compositionally similar caches. Analysis of this cache provides information on obsidian source utilization, exchange networks, prismatic blade core manufacturing practices, and caching behavior of the Itza Maya inhabitants of Nojpeten during the Postclassic.

BIOGRAPHICAL SKETCH

Angela B. McArdle earned her Bachelor of Arts Degree in International Comparative Studies and in History, with a certificate in Latin American Studies, from Duke University in 2008. In 2012, she joined the Master of Arts Program in Archaeology (MAPA) at Cornell University, a program affiliated with the Cornell Institute of Archaeology and Material Studies (CIAMS).

Ms. McArdle has been the recipient of numerous awards including the American Association of University Women Career Development Grant, the Cornell Archaeology Program Hirsch Scholarship, Cornell Graduate School Conference Travel and Research Travel Grants, and the U.S. Department of Education's Foreign Language Area Studies (FLAS) Fellowship for Yucatec Mayan.

Ms. McArdle has presented her research at the Society for American Archaeology's Annual Meetings. Her thesis, *When Trash Becomes Treasure: A Postclassic Maya Obsidian Core Cache from Nojpeten*, was supervised by Dr. John S. Henderson.

To Eamon, for encouraging me to fly

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I INTRODUCTION

PROJECT BACKGROUND

Collection Overview and Context

The subject of this thesis is a cache offering of approximately 190 obsidian prismatic blade cores and core fragments (Figure 1) excavated in 1992 as part of a salvage project by the Regional Archaeological Investigation of the North Petén, Guatemala (RAINPEG) Project, directed by Richard Hansen. The cores were found in Nojpeten, the ancient capital city of the Itza Maya, on the island of Flores in the Petén Department of Guatemala (Figures 2, 22-24). Research on this cache is meant to achieve two main objectives: (1) to illustrate how a seemingly modest bit of the archaeological record can produce a substantial amount of information about its cultural context; and (2), to demonstrate that a comprehensive approach that utilizes multiple theoretical and methodological frameworks and incorporates various analytical perspectives yields the most meaningful results. Archaeological discoveries are unique in that they are more than the sum of their parts. As captivating as stand-alone artifacts can be, without an applicable analytical framework they are limited in what information they can provide about the past.

Figure 1. Plan view of Nojpeten obsidian core cache in situ (photo by Hansen 1992).

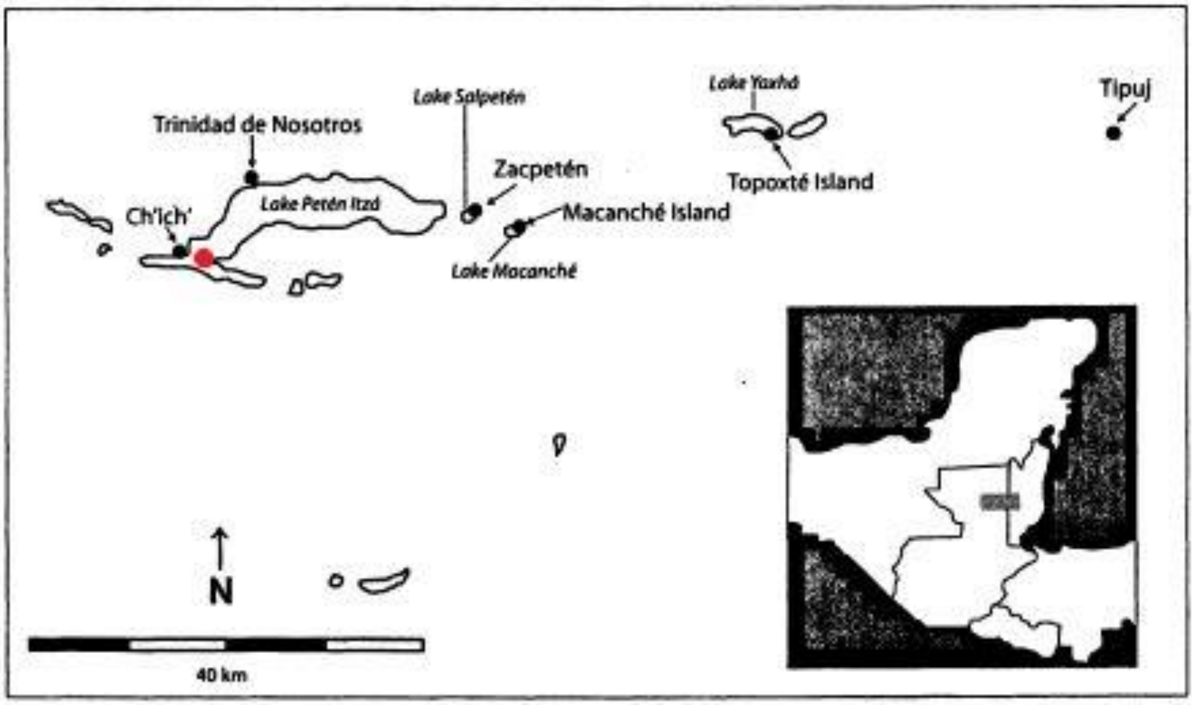


Figure 2. Lake Petén Itza Regional Map; red dot is the island of Flores (Cecil et al. 2007: 508; modified by McArdle 2013).

In this paper, the analysis is structured by a lithic technology framework that is subdivided into three foci: procurement, manufacture, and deposition. Procurement is an origination framework that utilizes x-ray florescence spectrometry to identify the point of origin of the cache contents, locating the geologic obsidian sources. Manufacture is a technological framework that examines the methods and techniques utilized in the production of the cache contents. The deposition framework is a contextual one that examines the cache's archaeological context and compares it with other caches of geographic, temporal, and compositional similarity. Human behaviors are the result of a myriad of influences (e.g. genetic predisposition, expressions of individuality and predilection, societal norms and pressures, environmental constraints, etc.); consequently, the meanings behind the deposition of this cache are almost certainly multidimensional and that examining the cache from multiple angles provides a more robust analysis from which a greater number of conclusions can be drawn. By taking into account the elemental sourcing data that provide geographic origination points for the obsidian present in the cache, the manufacturing technology at work in its creation, and the archaeological context in which it was found, this cache becomes more than just a pile of rocks; rather, it provides an illustrative window into the behavior of the Postclassic Itza Maya of Nojpeten.

The cache further lends itself to a multifaceted approach due to several peculiarities. Its contents are unique in both type and number. Caches with only one type of item are uncommon (Becker 1992: 186; Chase and Chase 1998: 302; Coe 1965: 462; Rodriguez 1997: 2-4); the majority of cache offerings documented for the Maya lowlands consist of various combinations of materials (e.g. ceramic, stone, shell, bone, foodstuff, etc…), whereas this cache consists of only obsidian cores. Additionally, typical Maya caches often include high value, exotic, or ritually significant goods; however, this particular cache consists only of the leftover waste product of a lithic technology that was used to produce blades for utilitarian and/or ritual use. Moreover, while the specific number of individual cores that make up the cache is uncertain (see later discussion on MNI and refitting), the original number likely falls between 173 and 182, with a best estimate of 177, 178, or 180. There is no mention in the reviewed literature of another cache with a similar number of interred items; however, since there is a precedent of the Maya attaching numerological significance to aspects of their built environment (e.g. architectural elements and caches), speculation about the specific numerical choice could prove informative.

Furthermore, the cache's location on the island of Flores adds to its exceptionality. Well-documented archaeological excavations on the island are few, and of those that are available for study, none mentions encountering an intact cache offering, making this the sole example documented for Nojpeten. Obsidian sourcing information is also lacking for Nojpeten, doubtless due to the paucity of archaeological research conducted there. Consequently, this cache is in a unique position to provide insight into many different issues ranging from small-scale questions of local caching behavior and ideology, prismatic blade-core technology, and resource availability, to larger scale questions of Postclassic Maya resource procurement, trade, and cultural exchange patterns in the greater Petén Lakes region. Analyzing this unusual cache from multiple angles offers the best chance for understanding its meaning to the Itza Maya and the behaviors responsible for its deposition.

Legacy Data

As a prelude to a discussion of the three phases of the lithic technology framework, one additional peculiarity of the cache deserves mention. The contents of the cache were excavated in 1992, 22 years prior to the publication of this paper, and only six years after I was born. Clearly, I had no part in the initial excavation or recordation, nor did I have any prior knowledge of its transportation and storage before first encountering the collection in the Foundation for Anthropological Research and Environmental Studies (FARES) laboratory in Guatemala City in the summer of 2013. Consequently, this paper analyzes two different types of data: legacy and primary. The legacy data date to the time of excavation and reflect the methodological decisions made in the field during recovery of the cache contents as well as the concomitant recording of the archaeological context. The primary data are those which I began collecting in the summer of 2013 upon opening two seemingly innocuous boxes labeled “Operation 09-A.” Both the legacy and primary data are subjective rather than objective in nature; accordingly, those subjectivities bear discussion.

Legacy data consist of previously collected pieces of information that have been bequeathed to a future researcher, typically one not associated with their initial collection. These data are generally indicative of a temporal disconnect between their collection and their eventual use, which can be problematic for interpretation. In an article specifically addressing concerns with legacy data, Atici and colleagues (2013) discussed the results of an experiment in which they had several faunal analysts interpret a previously generated zooarchaeological dataset with which they had no prior familiarity. As is to be expected, the experiment demonstrated that a given dataset would be interpreted in different ways depending on the biases (e.g. personal research perspective, questions, and/or analytical decisions) of the analyst (Atici et al. 2013: 670). Despite the different approaches and interpretations, all three analysts participating in the experiment agreed that the nature of the data were problematic due to a lack of contextual and methodological information (Atici et al. 2013: 667, 670), but that what was provided was sufficient for reuse and reexamination. Similarly, the legacy data associated with this cache are problematic, but still useful. It is problematic in that the excavation of the cache occurred in the final days of the field season (a time notorious for waning work ethic and inattention to detail), the accompanying field notes are a hodgepodge compilation of four individuals' notes (Valle et al. 1992) exhibiting an unsurprising degree of inconsistency, and the subsequent report on the excavation of Operation 09-A was not completed until five years after the excavation (Valle 1997), calling into question the accuracy of memory. However, these weaknesses can become strengths. For example, the multitude of varying accounts in the field notes, while at times frustrating in their discrepancies, make for a more reliable account when they match. Ultimately, enough detail is provided in the legacy data to make reasonable assumptions when combined with the primary data later collected.

Like legacy data, primary data are subject to biases and problematic collection, and it is imperative to recognize that the data we collect today will become legacy data for future researchers. For this reason, it is important to promote data sharing in addition to dissemination of interpretations. Atici and colleagues' experiment, conducted from the perspective of the "end users who consume and seek to reuse data" (Atici et al. 2013: 663-664), led them to conclude that researchers should be sharing the primary data they collect provided that the datasets have adequate "documentation and demonstrate sufficient quality." The multiplicity of analytical outcomes, referred to as 'secondary data' (Atici et al. 2013: 665), in the zooarchaeological experiment show the value of data sharing: the more perspectives that are applied the more comprehensive the analyses. It is more valuable to incorporate primary data into "large-scale multidisciplinary studies" than to rely solely on secondary data, or "interpretive publications," which must be taken at face value because primary data are lacking (Atici et al. 2013: 666). Secondary data are difficult to use in comparative analytical studies due to their more qualitative than quantitative nature. Consequently, in the appendices of this paper I have included the data for the technological and sourcing information I collected in the hopes that they substantiate my own claims as well as allow future researchers to explore new directions.

In sum, it is important for the reader to be aware of the unique challenges of the two types of data presented here: legacy and primary, as they undoubtedly affect the resulting analyses and interpretations. The legacy data utilized in this paper meet the criteria Atici and colleagues (2013: 670, 673-674, 678) listed as essential for reuse in that they are accessible, they provide contextual information regarding time and place, they are of sufficient quality for the research questions being asked, and although sometimes muddled, they are relatively intelligible. It is my hope that the newly generated primary data presented here are also of sufficient quality and intelligibility so as to encourage future replication and reevaluation studies. The combination of legacy and primary data lends itself to the application of an analytical framework that is able to incorporate the various dimensions of the data when presented as a whole; as such, the lithic technology framework is a suitable option.

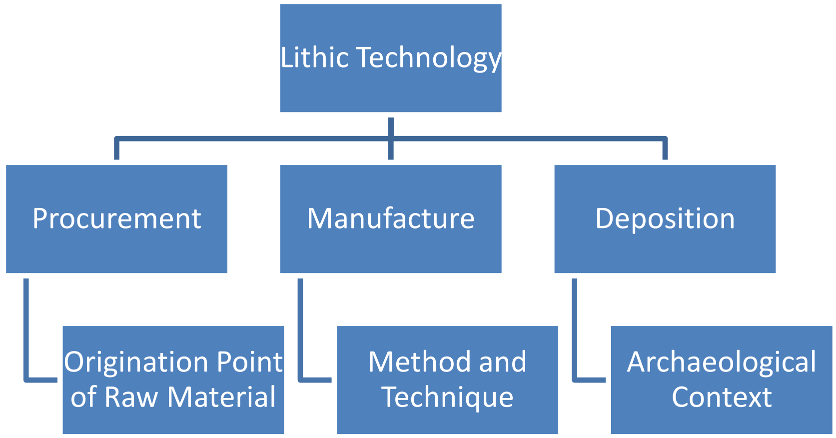
Theoretical and Methodological Frameworks

As a conceptual approach to assessing material culture, a lithic technology framework analyzes the total lifecycle of flaked stone tools, addressing the procurement, manufacture (e.g. production and transformation), use, and discard (what I term "deposition") stages (Inizan et al. 1999:13; Hirth and Flenniken 2002: 121). The end results of the application of lithic technologies are the "culturally determined and temporally specific" stone remnants that archaeologists find scattered across the physical landscape (i.e. the archaeological record); these stone artifacts are vital because they are read as manifestations of past human behavior (Hirth and Flenniken 2002: 121). More broadly then, if technology is regarded as the science of human activities (Haudricourt 1964: 24), lithic technology can be regarded as the science of human behavior as it relates to stone. Nevertheless, this science is not without its pitfalls. Inizan and colleagues (1999: 13) cautioned that a comprehensive lithic technological analysis should acknowledge possible deterministic constraints (e.g. environmental, political, etc…) before assumptions of culturally distinct choices are made. Something more than static stages in the lifecycle of a stone must be employed. Consequently, utilizing a system that mirrors a lithic technology framework, like the *chaîne opératoire,* in one's analytical approach is an effective way to account for the total set of techniques, including deterministic constraints, by addressing processes.

French for “operational sequence,” André Leroi-Gourhan’s (1964) chaîne opératoire is a valuable analytical tool that allows for the successive ordering of data by instituting systematization in the data collection and interpretive process (Insoll 2011: 246). For a lithic assemblage, the chaîne opératoire provides a methodological framework for analyzing each stage of the techniques responsible for the creation of an artifact: from the initial stages involving the procurement of raw source material, through the stone’s manufacture and use, and ending with its discard (Inizan et al. 1999: 14). Its acknowledgement of multiple factors beyond a tool’s function (e.g. accounting for source material, location association, actor agency, knapper skill, use-wear, ritual symbolism, etc.) is instrumental for exploring the role techniques play in relation to one another and within society at large (Insoll 2011: 246). Schlanger (1994: 143) stressed the strength of this approach when he stated that the chaîne opératoire “fosters an explicit concern over the processes, and not merely the states, of material culture. If the becoming of material culture and the succession of material actions can be reconstructed on the basis of static archaeological remains, then the active mind of the past may be within reach.” A concern for the process transforms the “materiality of the technical act (and its outcome)” into something “social, cultural or human,” which essentially means that the “production of matter and the production of meaning are co-incidental” (Schlanger 1994: 144).

In this paper, I use the lithic technology framework with an emphasis on the chaîne opératoire as the main analytical framework because it is able to address the peculiarities of a lithic assemblage too complex to pigeonhole into traditional archaeological categories like ‘utilitarian’ or ‘ceremonial.’ I further break down the lithic technology framework into three foci, highlighting the procurement stage, the manufacturing stage, and the deposition stage (Table 1).

Table 1. Lithic Technology Framework



The procurement framework focuses on the origin point of the raw material. Prior to the development of elemental analysis techniques, sourcing material remains from archaeological contexts relied heavily on macroscopic indicators. Though sometimes useful, these purely visual estimations are subjective and do not provide definitive classification (Moholy-Nagy 1987: 20). X-Ray fluorescence (XRF) technology assists archaeologists in more accurately matching artifacts to their geological sources because this process is able to measure the elemental composition of chemically homogeneous materials like obsidian and compare them to known sources. The section on procurement reviews the mechanics of X-Ray fluorescence, the advantages and disadvantages of handheld/portable XRF spectrometers (PXRF), the technology's applicability to sourcing obsidian artifacts in Mesoamerica, the methodology used with application of the Bruker Tracer III-SD T3S1995 PXRF to the cache contents, previously postulated Postclassic Maya obsidian trade networks, and the results of the obsidian sourcing. It then draws conclusions about networks of exchange based on the results of the sourcing and comparison with other caches.

To initiate a discussion of the manufacture framework, it is first necessary to disambiguate the ways in which the term ‘technology’ is used here and in the greater body of lithic literature. As discussed in previous sections, this paper uses a lithic technology framework. The word ‘technology’ in this broader sense is defined as the means of solving problems posed by physical and social environments (Hirth and Andrews 2002: 2). Lithic technology then, is the manipulation of stone in order to produce tools, weapons, and ritual implements within these same environments; consequently, the lithic technology framework takes into account all the stages and processes outlined above in order to address the different social, cultural, and physical aspects associated with modified stone. Complicating the discussion, ‘technology’ as a term in the lithic literature can also specifically refer to the production methods and techniques utilized in stone tool manufacture. To avoid confusion, for the remainder of the discussion, I will only use ‘technology’ as it refers to the all-encompassing framework, and will use the term ‘manufacture’ in discussions of production methods and techniques.

Because lithics have a much higher survival rate in the archaeological record than less durable items (e.g. organic materials) and because they are an integral part of the adaptive mechanism employed by individuals and societies alike, Collins (1975: 15) claimed they “are one of the most important classes of evidence by which we may view the record of human evolution.” However, at the time that he made that claim, Collins (1975: 15) lamented that archaeologists had not yet developed a comprehensive framework that successfully integrated the technological and typological analytical procedures with the adaptive role lithic manufacture plays in the broader cultural context. Almost 40 years later, the lithic manufacture approach has come a long way from its original focus on only the functional or temporal questions and now often includes an examination of the behavioral and processual issues relating to flaked-stone tool production (Hirth and Andrews 2002:1). This shift in priority to a more inclusive analytical approach gives the lithic manufacture framework a three-fold advantage: (1) it provides a user-friendly heuristic framework for lithic artifact classification; (2) it provides a way for archaeologists to analyze behavioral decisions made by individual artisans during the process of production; and (3) it provides a broader framework for assessing the sources of variability both within and among lithic assemblages, ultimately making comparative studies more fruitful (Hirth and Andrews 2002: 1-2). The section on manufacture provides a background on Mesoamerican prismatic blade-core production technology, reviews the methodology behind the laboratory analysis of the obsidian cores, discusses the specific production factors (i.e. methods and techniques) evident in the cache contents, and draws conclusions about craft specialization, skill, and economic implications using comparisons with other caches documented in the literature.

Concerning the deposition framework, the importance of archaeological context cannot be overstated; it provides a background for artifacts and is the lens through which all subsidiary analyses must operate. It is in this framework where the viability of legacy data is pertinent to the discussion, as I must rely on the observations of others to provide me with these data. Schiffer (1972: 157) claimed that the archaeological context "explains" materials that have been passed through a cultural system; elements entering the system are the objects archaeologists investigate, but the context gives them meaning. Utilizing the archaeological context as a framework requires one to grapple with questions of why an archaeological record exists in the first place, as well as how a cultural system produces archaeological remains, and what variables are responsible for that production (Schiffer 1972: 156). Analysis of the cache through a deposition framework focuses on the archaeological context by examining the depositional environment, in this case, a concentrated cache of obsidian cores arranged in a circular fashion, located between two plaza floors near a structure. This section on deposition provides a background on Nojpeten, reviews the field methodology employed in the excavation known as Operation 09-A, discusses the results of the excavation divisions Lots 1-18, and draws conclusions on the nature of the depositional context by referencing structural associations and caches from other sites.

Together, these three foci situated within a lithic technology framework account for a comprehensive range of activities in which the cache contents participated during their life: what Shiffer (1972: 158) referred to as their systemic context, a collection of five processes including procurement, manufacture, use, maintenance, and deposition. In this paper questions of procurement are addressed through obsidian sourcing provided by x-ray fluorescence spectrometry, questions of manufacture, use, and maintenance of the cores are addressed through the production methods and techniques analyzed by the manufacture framework, and questions of deposition are addressed through examination of the archaeological context. Each chapter - procurement, manufacture, and deposition - is presented as a separate study complete within itself, including discussions of background, method, results, and analysis. However, these three separate studies are brought together in the remainder of this first chapter with an overview of general caching behavior and the Postclassic Maya and again in the final chapter for a more comprehensive analysis that combines the results from all three studies.

GEOGRAPHIC, CULTURAL, AND TEMPORAL CONTEXT

Overview of Mesoamerica as a Geographic and Cultural Region

Mesoamerica is a term used to describe the geographic and cultural area (e.g. a region of similar cultural traits and features) covering parts of modern day Mexico and the countries of northern Central America, which include Guatemala, Belize, Honduras, El Salvador, and small portions of Nicaragua and Costa Rica (Demarest 2004: 8). As a region, Mesoamerica lacks sharply defined boundaries and thus is better conceptualized as an area whose frontier zones were constantly changing: ebbing and flowing as "mosaic groups with contrasting cultural affiliations" (Henderson 1997: 26) negotiated and renegotiated the limits of their spheres of existence, interaction, and influence. Mesoamerica is a region that in the several millennia before European colonization hosted various communities, some with common linguistic and ethnic origins, who interacted through trade, migration, warfare, and more, resulting in a shared set of features that manifested in various ways throughout the region (Demarest 2004: 8; Henderson 1997: 26; Sharer and Traxler 2006: 28). Some shared features included structural similarities like "permanently settled villages, agriculture, and complex societies with urban centers [and] monumental architecture" (Sharer and Traxler 2006: 28-29). Other shared features were based on a common concern with astronomical knowledge; these included similarities in "the recording and worship of the calendric cycles of the sun, the moon, the planet Venus, and the stars" (Demarest 2004: 8), which registered the passage of time and associated astrological omens (Henderson 1997: 26). Shared cosmologies are suggested by the "codex books [found throughout Mesoamerica] made of sheets of bark paper or deerskin coated with stucco and folded like screens" (Demarest 2004: 8) and further indicated by a generally analogous pantheon of deities like "the gods of rain and maize, the death deity, [and] the gods of the sun, moon, and morning star," all of which have various names and titles but share similar mythologies (Henderson 1997: 26). Other indicators of shared cosmologies can be extrapolated from the ritual significance many Mesoamerican communities attached to ballgames, blood offerings, human sacrifices, and the similar conceptions they shared of a multi-tiered universe (e.g. multiple heavens and hells) partitioned into a quadripartite system of color-coded cardinal directions (Demarest 2004: 8; Henderson 1997: 26).

Within this larger Mesoamerican region, the area inhabited by the cultural group known as the Maya is traditionally divided into three parts: the southern Pacific coastal plain, the mountainous highlands, and the lowlands, which can be further divided into the central or southern lowlands (jungle), and the northern lowlands of the Yucatan Peninsula (scrub vegetation) (Sharer and Traxler 2006: 30). The "pre-Columbian" (i.e. prior to European contact) cultural group collectively recognized as the Maya occupied these areas to varying degrees during a period of approximately 3,500 years; this span is subdivided into several smaller periods that began with the Early Preclassic period around 2000/1000 BC and ended with the Postclassic period in the mid-sixteenth century (Sharer and Traxler 2006: 98). The Postclassic Maya are discussed in detail in the following section because it is during this period that the obsidian core cache from Nojpeten was originally deposited.

Overview of Postclassic Maya

Cultural chronologies are characterized by imprecise periods with ever-shifting boundaries, which archaeologists continually refine in order to reflect cultural similarities and changes over time. The period known as the Postclassic is generally defined as beginning around AD 900-1000 (Sharer and Traxler 2006: 589) and extending up through contact with the Spanish in the 1520s (Clark 1985: 9); this approximately 600-year period is further divided into Early Postclassic (AD 900/1000 - 1250) and Late Postclassic (AD 1250 – 1521). The Early Postclassic is preceded by the Terminal Classic period and the Late Postclassic is followed by the Contact or Colonial period.

Archaeologists often describe the Classic period as the apex of Maya civilization due to a surge in monumental architecture, public artwork, and wide distribution of elite and commoditized goods (e.g. polychrome ceramics, fine chert, obsidian, etc.) through complex and stratified societies (Demarest 2004: 162). In contrast, following this period of cultural florescence, the Postclassic period has often been characterized as an era of decline due to a disintegration of polities (e.g. the disappearance of public expressions of Long Count dating) and changing standards of artistic expression and resource consumption (Rice and Rice 2004: 136; Sharer and Traxler 2006: 590). Such a characterization is likely also due to the idea that "Postclassic communities are not well represented in the archaeological record" because they are fewer in number and are more difficult to locate (Henderson 1997: 241).

Despite these disparate characterizations, Henderson (1997: 241) noted that this sharp a contrast between periods is exaggerated, stating that while widespread decline and cultural reorientation are evident in the archaeological record, the Postclassic Maya have definite roots in the Classic period and these continuities are often underemphasized. Rice and Rice (2004: 136) agreed with this assessment, specifically listing "calendrics, cosmovision, shared architectural programs, period-ending rituals, as well as calendrically based political organization based on celebration of k'atun and *may* cycles [13 k'atuns or 256 Gregorian years]"as cultural components that were maintained between the Classic and Postclassic periods. Based on archaeological evidence that indicated a continuity of occupation from the Classic period into the subsequent Postclassic period in all the lake basins thus far investigated, they concluded that the central Petén lakes region was never fully depopulated (Rice and Rice 2004: 130). Smith and Berdan (2000: 284) avoided the term "decline" completely, preferring to describe the Postclassic period as an expression of new spheres of interaction "characterized by larger regional populations, smaller polities, a greater diversity of trade goods, a more highly commercialized economy, new standardized forms of pictorial writing and iconography, and new patterns of macroregional stylistic interaction."

Cultural reorientation is demonstrated by a shift in the Petén lakes region from a rural zone understood as markedly peripheral to large centers during the Classic period, to "an important political and economic force in its own right" (Rice 1984: 192) with a modest resurgence of activity in the Postclassic. This resurgence of activity is marked throughout the Maya world by Postclassic settlement in areas concentrated near bodies of water like rivers, lakes, cenotes, and oceans (Marcus 1995: 24). In the central Petén lakes region in particular, it is reflected by nucleated island communities, historically known as Itza territory (Rice and Puleston 1981: 154). The change in settlement patterns saw a corresponding increase in reliance on coastal resources and long-distance exchange networks and a decrease in the centrality of agriculture to the economic systems of the Postclassic (Henderson 1997: 241; Smith and Berdan 2000: 284).

These dichotomies of continuity and reorientation likely stem from some recovery of surviving Classic period populations (Andrews 1993: 56) and the multiple hypothesized emigrations and immigrations of various communities throughout the region during the Early Postclassic (Cowgill 1963: 4; Henderson 1997: 242-243; Jones 1998: 12-13; Rice and Rice 1984: 48; Rice and Rice 2004: 126-127, 130; Rice and Rice 2009: 43). Rice and Rice (2004: 139) described the Petén lakes region in the early years of the Postclassic as a 'frontier' because it was a liminal space that, while dynamic and socially amenable to the flow of new ideas, was a contested space as evidenced by the change in settlement patterns and construction of new fortifications. It was a landscape shifting back and forth between tradition and innovation, with the intersection of these poles most notably expressed by variations in architectural and ceramic styles (Andrews 1993: 56; Rice and Rice 2004: 139; Sharer and Traxler 2006: 590-591).

Regarding architecture, it is clear that the Postclassic Maya built pyramids, palaces, plazas, temples, and residential structures in much the same way as their Classic Maya predecessors, just at a smaller, cruder, and generally less conspicuous scale (Andrews 1993: 50; Henderson 1997: 241). The architecture of the Postclassic is generally of a "crudely" cut masonry block construction covered by multiple layers of vividly painted stucco (e.g. reds, blues, greens, yellows, creams, and blacks) (Andrews 1993: 50). These crude structures are typically low, square, or rectangular, single-level platforms that formed the bases for superstructures constructed of either masonry or perishable materials (Rice and Rice 2004: 131-132). The facades of these structures were often decorated with moldings and relief sculptures while the inner rooms were either plain or elaborately painted with murals. The roofs of this period were highly variable and included techniques like gabled thatch, flat beam-and-mortar, and vaulting (Andrews 1993: 50).

Like the architecture, the ceramics of the Postclassic exhibit a similar mix of stylistic continuity and adoption of new designs. Traditional widespread prevalence of monochrome utilitarian pottery continued into the Postclassic from the Classic, with a predomination of red wares (especially in the northern lowlands) in addition to vessels of other colors (e.g. tan, cinnamon, brown) (Sharer and Traxler 2006: 590). However, Cecil (2013: 185) noted that when comparing the polychrome pottery in the central Petén lakes region from the Late Classic to Postclassic there was an apparent difference in the "quality of technological and decorative execution such as complexity of designs (motifs and number of colors), fire clouding, and vessel forms." Specific types like Augustine Red, Paxcaman Red, Snail-Inclusion Paste Ware, and

Trapeche were prevalent throughout the Petén lakes region (Cecil 2013: 188; Rice and Rice 2004: 128-129), as were elaborately decorated deity-effigy incensarios and northern lowland ceramics associated with the religious cults of Mayapán (Sharer and Traxler 2006: 590). Changing sociopolitical organization and migrations throughout the region are likely factors in the ceramic variability. However, Cecil (2013: 199) suggested that while some temporal change is evident, similarities in slipping technology, blackened rims, and decorative modes suggest that the social groups and potters who remained in the area continued using traits consistent with regionally specific Late Classic period polychrome manufacture, indicating that traditions local to the Petén lakes region dominated even as styles from the north were incorporated.

As is evident in the architectural and ceramic examples provided above that detail cultural continuities of the southern Maya lowlands colliding with imported northern lowland (i.e. Mexican) styles, the Petén lakes region during the Postclassic can be understood as an area of considerable interaction with populations, goods, and ideas moving about in new ways (Andrews 1993: 52; Rice and Rice 2004: 129). During a 1999 conference entitled "Ideological and Socioeconomic Transformation in Postclassic Mesoamerica," participants examined Postclassic Mesoamerica through the lens of a world-system, which they defined as a "widespread system of interaction that cuts across political boundaries" (Smith and Berdan 2000: 284). World-systems literature, specifically that which utilizes a composition of four spatially distinct interaction networks that examine political/military systems and the exchange of bulk-goods, prestige goods, and information, provides a useful lens through which to understand the Postclassic (Smith and Berdan 2000: 284). This approach encourages consideration of stylistic and cultural factors in addition to economic phenomena, and is cognizant of how "actions and processes in one area affected societies in distant areas" (Smith and Berdan 2000: 284).

Understanding Postclassic Mesoamerica as a world-system contextualizes the patterns of cultural continuity and change evident in the Petén lakes region and bolsters its classification as an interactive sphere. However, like all analytical frameworks, it has drawbacks; these include deterministic tendencies that can minimize heterogeneity and diversity (Isendahl 2006: 511) by ignoring individual actors and "importing modern analyses to ancient settings where they are inappropriate" as well as an excessive focus on economics (Kardulias and Hall 2008: 572). While world-systems theory provides a useful way in which to understand the contexts of this cache, it should be used in conjunction with other frameworks due to its limitations.

Overview of Maya Cache Behavior

Caches are defined in a myriad of ways. In the most literal sense the term 'cache' means a hiding place, but this is more often used in reference to a hiding place where "one or more objects [are] found together…point[ing] to intentional interment as an offering" (Coe 1959: 77, 118). Cache contents vary in number and kind (e.g. stone, ceramic, bone, shell, food and drink, etc.), and can even manifest as empty space if they originally consisted of perishable materials that lacked durability in the archaeological record (Chase and Chase 1998: 302). Some researchers feel that describing cache contents as "offerings" can be problematic (Kunen et al. 2002: 197) because the term does not distinguish between assemblages that "are the material residue of ritual actions that consecrate particular spaces…with cosmological meaning, [and those that are] kratophanous deposits, [which represent] the disposal of worn out ritual objects as ceremonial trash." However, regardless of whether cache contents were offerings or were concentrated depositions of ceremonial trash, they are products of intentional ritual behavior that "serve to establish pathways of sacred space" (Kunen et al. 2002:197).

The intentional nature of the deposit is integral to the definition of a cache (Rodriguez 1997: 2, 84); however, as different kinds of deposits (e.g. caches, hoards, and burials) can all be understood as intentional, this point bears further discussion. Both caches and hoards are defined by the intentional interment of items; but, while hoards function to protect, store, or remove items from circulation with the expectation of future access and/or recovery of these items, there is no evidence to support the intent of future retrieval of items from what we know of caches (Rodriguez 1997: 2-4). There is however, evidence to indicate intentional patterns of caching behavior throughout the Maya lowlands. In a statistical analysis of 505 caches, Rodriguez (1997: 47, 84) found that "interment of items by elites was not haphazard [or] random [and that] patterns can be discerned which show there is a conscious choice of cache assemblages." These patterns may help in distinguishing caches from other types of intentional deposits, but this can prove difficult as the case of caches versus burials demonstrates.

Historically, there has been some disagreement over differentiating between caches and burials in Mesoamerica, as it is common to find skeletal remains as part of seemingly cache-like assemblages (Chase and Chase 1998; Coe 1959). Additionally, the contexts of the contents of caches and burials (e.g. whole, broken, burnt) are often "exceedingly similar" (Chase and Chase 1998: 300, 302). Coe (1959), one of the first to address this challenge in the Maya lowlands, differentiated between the two by saying that a cache usually designated a significant variety of offerings disassociated from human interments, but not necessarily devoid of human skeletal remains. Becker (1993: 47) lamented the standardization of this oversimplification, explaining that in general archaeological practice, when ritual objects were encountered in the field without human bone they were termed caches, but when bones were present they were burials, regardless of their compositional or contextual similarities. He proposed dissolution of these divisions in favor of a single concept of ritual deposition that he termed "earth offerings" (Becker 1992: 186; Becker 1993: 48). These earth offerings are the result of a "conceptual continuum which appears to exist between caches and burials," one that recognizes that caches and burials may be products of similar cognitive meaning relating to the "death-planting-rebirth cycle" that could reflect pervasive Maya cosmological concerns (Becker 1993: 48, 49, 67-68). While informative, this perspective does not account for all possibilities, because not all burials are indicative of ritual and/or ceremonial acts and not all caches necessarily incorporate human remains. Consequently, the concept of "earth offerings" provides an additional perspective on cache behavior, but not an all-encompassing or definitive one. For the purposes of the analysis of the contents of the cache in question from Nojpeten, I use the term cache to denote an intentional, ritualized, interment of objects; these objects may be understood as an offering, or as a concentration of ceremonial "trash," or both things simultaneously; these caches are differentiated from deposits of non-ritualized domestic refuse based on the following characteristics.

Becker (1993) provided a useful list of characteristics to recognize and describe a cache. For cache analysis, Becker (1993: 69) suggested addressing: (1) context: a description of the cache's association with ceremonial or domestic structures; (2) function: classification of the cache (i.e. establishing its type); (3) furniture: a description of associated objects (e.g. containers or offerings) and their arrangement in relation to the cache contents; and (4) dating: the temporal nature of the cache. Chase and Chase (1998: 303) emphasized examining cache-associated structures as both "context" and "furniture" because structures often served a dual purpose as individual containers or repositories for the cache, and as a broader part of the site structure.

Addressing the "context" of a cache accounts for the significance of the cache's association with surrounding constructions and notes the cache's placement, position, and proximity in relation to associated structures and/or negative spaces (i.e. voids). An analysis of context is primarily a preoccupation with location. Architecture serves to define spaces; consequently, ritual offerings like caches placed in and around architecture assist in defining these spaces by altering their nature in different ways (e.g. sanctifying, activating, dedicating, amplifying, enhancing, destroying, etc.) (Chase and Chase 1998: 324; Coe 1959: 119; Rodriguez 1997: 91). Caches are most commonly associated with public architecture; they have been found in temples, palaces, plazas, platforms, and ball-courts and near sculptured monuments like stelae and altars, but it is not uncommon to find them in more residential and less elaborate architectural contexts too (Coe 1959: 78-79, 108; Mock 1998: 6-7; Moholy-Nagy 1997: 302; Ricketson and Ricketson 1937: 139; Rodriguez 1997: 2; Smith 1950: 91-92). When caches are associated with public architecture, it is likely that their interment relates to the elite power dynamics behind the delineation of space (Chase and Chase 1998: 314), as the individuals of this social stratum are probably the ones responsible for commissioning the construction of public architecture (Rodriguez 1997: 2; Schele and Freidel 1990: 88).

Documented caches have been found intentionally intruded into earlier structures, buried within the fill of buildings at the time of construction, outside of but near structures in interstitial locations, and/or in niches (Chase and Chase 1998: 300, 302; Coe 1959: 118; Mock 1998: 6-7). In all of these contexts, caches are frequently found along axial lines (e.g. north-south, east-west, front-rear, primary, transverse, subsidiary, etc.) that orient the cache to important features of the structure (Coe 1959: 118; Coe 1965: 462; Kunen et al. 2002: 199-200; Pendergast 1998: 62). These axes intersect both vertically and horizontally (Kunen et al. 2002: 199-200; Pendergast 1998: 62) and their identification can sometimes lead to the discovery of caches in predictable locations like under stairways, at structural boundaries or openings (like doorways), and at inside and outside corners (Mock 1998: 6-7). Based on iconographic, ethnographic, and architectural evidence (Aveni 2003: 160-161; Aveni and Hartung 1982: 77; Carlson 2005: 105, Rice 2004: 20-21, 71; Taube 1988: 199**),** axes may represent avenues of communication with deities (Kunen et al. 2002: 199-200), transitional pathways of power (Mock 1998: 6-7), or portals to other worlds (Schele and Freidel 1990:438), so caches placed along these axes might have any number of meanings. Rice (2004: 281) wrote that "the founders of Maya settlements had to establish positive relations with cosmic forces and establish a 'ritual *axis mundi*' [cosmic or world axis] by constructing a ceremonial structure;" caches could have served as axis markers that reinforced these relations. Coe (1959: 119; 1965: 462) suggested that the objective of structurally associated caches might have been to relate "to a deity, a personage, an event, a chronological cycle" or to serve as a dedication to and/or sanctification of the structure "or whatever religious or lay objective the structure may have had." Rodriguez (1997: 91) suggested that caches served to animate structures, conducting them through rites of passage that rendered them suitable for use in much the same way as the modern-day practice of christening new ships with a ceremonial breaking of a champagne bottle across the bow.

Addressing the "function" of a cache is an exercise in categorization. Traditionally, several different types of caches have been identified in the literature, but these are not mutually exclusive nor do they serve as an exhaustive list. The categories archaeologists most often use to describe caches are: (1) dedicatory/foundational; (2) terminal; (3) intrusive; (4) offertory/votive; and (5) kratophanous/ritual waste.

A dedicatory or foundation cache is characterized by "an object or set of objects deposited ceremonially at the dedication of a construction site" (Rodriguez 1997: 4). Thus, the timing and location of the cache placement is a primary determinant of categorization as a dedication offering, meaning that when encountered in the archaeological record dedicatory caches "should lie at the basal layer of a construction that subsequently covers the deposit" (Kunen et al. 2002: 198). Dedicatory caches play a role in marking historic moments at Maya sites (Schele and Freidel 1990: 428) because the dedicatory act is understood as a time "to make proper, to bless, to circumambulate, to cense with smoke, to deposit plates full of offerings, and to set something in the ground" (Freidel et al. 1993: 234). These caches often include objects that work together to create a tangible association between cosmological ideas and the physical location of the cache (Kunen et al. 2002: 198), perhaps activating a portal "to the Otherworld, enabling a god or ancestral spirit to be materialized in ritual" (Mock 1998:5) (Freidel et al. 1993: 235). Termination caches are the reverse of dedicatory caches: where dedication caches seem to mark activations and beginnings, termination caches appear to mark deactivations and endings. These caches often include objects that have been defaced, mutilated, broken, burnt, or altered (Mock 1998: 5) and collectively may represent an action that is the cessation of "an obsolete structure on the verge of being buried by a new one" (Coe 1965: 462). When encountered in the archaeological record, termination caches are usually found on the surface of or superficially intruded into an intentionally destroyed construction episode (Kunen et al. 2002: 198). However, intrusive caches are not always indicative of termination rituals, and thus constitute their own cache type for the purpose of this discussion. Their most distinguishing trait is their evident placement "through an existing surface instead of during construction" (Rodriguez 1997:4). In non-dedicatory and non-termination contexts these caches may represent commemorative rituals "interred at [moments] of renovation or renewal" (Rodriguez 1997: 4) that may relate to dates of cosmological, political, or familial significance. Votive or offertory caches are ones with possible religious or sacrificial connotations (Coe 1959: 118) that may have been gifts commemorating events, persons, and/or ideological or cosmological principles (Rodriguez 1997: 4). Kratophanous deposits are not customarily typed as caches, but due to contextual similarities with other cache types and similar ritual aspects, I think they should be. These caches are identifiable by concentrated deposits of "large quantities of material such as obsidian [that] may represent the ritual interment of waste that was produced through the manufacture of cache blades or other sacred objects" (Kunen et al. 2002: 199). Kunen and colleagues (2002: 199) noted that the sacred nature of the pre-depositional behavior associated with caching distinguishes it as ritual deposition instead of refuse discard.

While establishing and utilizing cache typologies may facilitate ascertaining the function of a cache, some scholars (Chase and Chase 1998: 302-303) maintain that reducing ritual activities to a simple functional order is problematic. Relying on historic, ethnohistoric, and ethnographic information, Chase and Chase (1998: 302-303, 214) noted that the offerings made by the sixteenth century Maya were highly variable depending on the specifics of the associated ritual activity and consequently, may have served a variety of functions. It is likely that the offerings of the Postclassic Maya were just as complex as during the subsequent Colonial period. Although it can be instructive to seek out patterns that may clarify diverse functions of different types of caches, the best approach may be to recognize that any given cache may serve multiple functions (e.g. dedicatory, terminal, calendric, definition/delineation of sacred boundaries, veneration, commemoration, etc…), and that these functions are not necessarily static. These functions may change over time even as the contents of the cache remain the same: that is, that any singular cache may serve different functions at different times during its "lifetime" (i.e. the duration of its relevance to the people who are aware of its existence). Moreover, the functions of caching practices may differ through time even while their physical mark in the archaeological record remains the same. In short, similar objects can mean different things to different people.

Addressing the "furniture" of a cache refers to an examination of the repositories and/or associated containers apart from, but in relation to, the contents of the cache. Furniture can be understood as the vehicle or conduit through which the contents of the cache are translated and as such, are as integral to the understanding of a cache as its physical location, structural associations, and the contents themselves. The most common form of cache repositories in the Maya world are ceramic vessels, but cached objects without specialized containers are also common (Chase and Chase 1998: 300; Kunen et al. 2002: 208). Cached objects are found "intruded into floors, buried directly in a building's or platform's fill, or left in a niche" (Chase and Chase 1998: 302) as well as "placed in pits or chultuns" (Moholy-Nagy 1997; Pendergast 1998) without any apparent container-like accoutrements. Caches directly interred in spaces without any accompanying furniture may indicate interment in a place meant to mimic a sacred aspect of the natural environment, like a cave. Kunen and colleagues (2002: 208) noted that caves and natural openings in the earth served as portals or entrances to the center of the universe; their liminal nature allowed them "to transform everyday objects into sacred ones." Therefore, if prepared pits and chultuns were meant to echo these natural spaces, then they too could "infuse ordinary refuse deposited within [them] with sacred significance" (Kunen et al. 2002: 208). Alternately, a lack of apparent furniture does not necessarily mean that none was ever present as part of the cache. Based on narrative scenes depicted in Maya pottery, carved monuments, and the murals of Bonampak, Schele and Freidel (1990: 200-201, 463) presented a vignette in which shamans might have taken cache contents and placed them onto squares of beaten-bark cloth, perhaps amate-fig bark cloth like that found with a cache in Tikal. These cloths were then folded into bundles and bound by a band of woven fibers before being lowered into prepared pits (Schele and Freidel 1990: 201). This scenario illustrates that caches found without furniture may have originally had it, because organic materials like textiles and paper do not survive as well in the archaeological record as objects made of clay and stone.

A preoccupation with establishing the temporality of archaeological materials applies equally to caches. Becker's analytical system accounts for this in his final suggestion for addressing "dating." Techniques for dating a cache vary based on the contents and context, but regardless of how the dates are acquired, once established they can aid in demonstrating variations in cache practices through time. Archaeological evidence indicates that the lowland Maya have been making cache offerings from as early as the Middle Preclassic (1000-700 BC), and these practices continued even after the Spanish arrived in the sixteenth century (Coe 1959: 111; Inomata et al. 2013: 3, 27, 28). Patterns of change in caching behavior are evident throughout the different periods, but the changes most germane to the discussion of the obsidian core cache from Nojpeten are those that occurred between the Late Classic and Postclassic periods. Late Classic caching practices focused on veneration of "honored dead" and sanctifying personal ritual space in a variety of domestic loci, oftentimes incorporating exotic items like eccentric stone objects (Chase and Chase 1998: 327; Coe 1965: 468). The focus shifted in the Late Postclassic from utilizing domestic areas to sanctify personal ritual space to using domestic areas to sanctify ritual space in relation to the larger community; this shift in the focus of cache deposits mirrors the decrease in public monumental architecture that occurred in the Postclassic and suggests changes in societal organization (Chase and Chase 1998: 327).

II. PROCUREMENT

BACKGROUND

The Mechanics of X-Ray Fluorescence

The subjective nature of macroscopic identification (i.e. visual source attribution) of obsidian stems from its dependence on an analyst's ability and experience, which can vary between individuals. Macroscopic identification depends on an analysts' ability to categorize optical characteristics like refracted and reflected color, translucence and opacity, luster and texture of flaked surfaces, the nature and frequency of inclusions within the material, and the color, texture, and thickness of cortex - characteristics that are more qualitative than quantitative (Braswell et al. 2000: 270-271). However, Braswell and colleagues (2000: 271, 273, 274) conducted an experiment where four independent analysts (Aoyama, Braswell, Clark, and McKillop) demonstrated that it is possible to accurately (~96%) identify obsidian sources from visual sourcing techniques alone. Despite their success, they acknowledged that these results were contingent on their extensive experience with artifacts from these sources and that "the visual identification of obsidian from the three important Guatemalan sources is highly accurate, but not quite as reliable as NAA [neutron activation analysis] or XRF [x-ray fluorescence]" (Braswell et al. 2000: 277, 280). One of the advantages of obsidian sourcing with procedures like XRF is that it provides a more objective and reliable assessment than visual sourcing (Moholy-Nagy 2003: 303).

XRF is a process whereby x-rays in the electron orbits of atoms are produced as secondary emissions after bombardment from a higher-energy x-ray. Electrons are arranged in four concentric rings around the nucleus of an atom and each ring has a given name and a maximum number of electrons it can accommodate. When atoms are balanced, meaning they have not been excited by external bombardment and are thus stable, they have a definitive number of electrons that uniquely identifies them as a specific element. XRF analysis takes advantage of this unique identifier by measuring the x-ray emissions an atom releases when bombarded by a higher energy because each element has a distinctive emission signature. When a higher-energy x-ray is emitted from the XRF spectrometer, some of the photons it emits collide with the electrons in the innermost rings of the atoms, dislodging them from their orbits. The vacancies in the innermost rings are immediately filled by the electrons that were originally in the outermost rings, and an x-ray photon is emitted that mirrors the decrease in the atom's energy. This secondary emission is what the XRF spectrometer detects and because the number of the innermost ring x-ray emissions is proportional to the number of atoms of a specific element, it is possible to determine the elemental proportions within a sample (e.g. concentrations of iron or zinc). (Bruker 2010: 31-32)

Advantages and Disadvantages of PXRF Spectrometers

One of the advantages of XRF is that it offers the potential for nondestructive analysis because it requires minimal to no sample preparation, which makes it ideal for testing museum specimens and culturally sensitive materials (Ferguson 2012: 404; Glascock 2002: 612; Nazaroff et al. 2010:885). However, the early instruments manufactured for analyzing the elemental composition of materials were large and expensive machines housed exclusively in laboratories; these instruments required highly specialized operators well versed in physics to read the generated elemental spectra and ensure adequate calibration. Consequently, archaeologists new to the technology were largely uninvolved in the methodology behind XRF and content to allow laboratory staff to provide them the data without understanding, or perhaps even knowing, the operating parameters that produced them (Charlton 2013). As the popularity of XRF became more mainstream, awareness of and accessibility to comparatively inexpensive and user-friendly handheld/portable XRF spectrometers (PXRF) increased; these PXRF came with built-in calibrations providing archaeologists with a viable alternative to the more expensive and time-consuming laboratory analyses.

The most obvious advantages to the PXRF over standard laboratory XRF spectrometers are the savings in cost and time. Due to their small size and portable design, PXRF spectrometers generate fast results with shorter analysis times, allowing archaeologists in the field to conduct more analyses than would otherwise be possible due to complications (e.g. legal limitations, transportation costs, risk of loss or damage) inherent in the transportation of materials to and from laboratories (Charlton 2013; Ferguson 2012; Glascock 2002; Nazaroff 2010). Archaeological research often involves acquiring permits and adhering to bureaucratic regulations regarding exporting and repatriating artifacts (Braswell et al. 2000: 270; Cecil et al. 2007: 506-507), and this can be a confusing and arduous process. PXRF can increase the number of artifacts studied by negating the need for export permits and ameliorating situations where extenuating circumstances (e.g. cultural sensitivities, political complications) make the removal of artifacts from institutions or communities problematic (Nazaroff et al. 2010: 887). As a result, using PXRF can increase efficiency speeding the processes of data collection and publication.

No technology is perfect though, and XRF has its drawbacks. Performing XRF analysis requires a functional knowledge of the underlying physics that govern the process as well as an understanding of igneous petrology and appropriate calibration procedures. Additionally, an effective analyst must be able to design and implement a study with appropriate data collection protocols; this is partly accomplished through testing enough varieties of homogeneous and well-characterized references materials to develop a suitable calibration curve (Charlton 2013; Ferguson 2012: 401).

In addition to the learning curve an effective analyst must surmount, further disadvantages manifest themselves in the limitations of which materials can undergo XRF successfully. Because XRF analysis is a surface technique, errors can arise from the variations in sample size and shape of the material being examined. For example, thinner artifacts measured against thicker calibration standards might show higher traces of elements than their true values (Rice et al. 1985: 593). Ideal materials are flat, homogeneous, and infinitely thick. Such conditions are unusual in archaeological contexts unless destructive sampling takes place (Charlton 2013; Glascock 2002: 612). Fortunately, artifacts of obsidian often meet the ideal conditions for testing and are therefore a suitable material for source attribute testing by XRF.

X-Ray Fluorescence and Obsidian

Obsidian is a naturally occurring volcanic glass, a rhyolitic igneous rock, characterized by a microlithic or vitreous (glass-like) luster and texture, elasticity, and a disordered atomic structure (Crabtree 1972: 5, 98; Inizan et al. 1999: 19). This disordered atomic structure makes obsidian physically amorphous and isotropic, meaning it has the same properties throughout or that it is homogeneous (Crabtree 1972: 5, 70). During the knapping process "the velocities of propagation of elastic waves are independent of direction" (Crabtree 1972: 72), which allows the obsidian to fracture predictably, with consistency, and with extraordinarily sharp edges (e.g. several nanometers thick) due to the absence of planes of weakness (Ferguson 2012: 401-402). Obsidian is essentially a super-cooled liquid due to its formation process; it is "formed when a highly viscous volcanic lava of high silicon and aluminum content cools rapidly, usually at the margins of a lava flow" (Glascock 2002: 611). Usually, this rapid cooling inhibits the mineral crystallization within the obsidian, thus eliminating cleavage planes, inclusions, fissures, molecular imbalances, and other undesirable qualities, allowing for the successful manufacture of effective stone tools (Crabtree 1972: 18). However, some obsidian has phenocrysts, crystals made up of minerals different from but compositionally similar to obsidian, within their matrix, and due to their unpredictable fracturing properties, this obsidian produces lower-quality tools. In general obsidian is compositionally 66-75% SiO_2, 10-15% Al_2O_3, 3-5% Na_2O, 2-5% K_2O, and1-5% Fe_2O_3 + FeO and it most often appears as black or gray (sometimes shades of brown, orange, and green too) in color. Although generally homogeneous in appearance, it is sometimes banded by diaphanous streaks. (Glascock 2002: 611)

As the relatively uniform appearance suggests, most obsidian sources are also chemically homogeneous (Cecil et al. 2007: 14); in fact, the known variations in composition only fluctuate by a few percent or less. Differences in composition stem from the differing compositions of the parent rocks that were melted in the magma chambers of individual volcanoes prior to eruption. (Glascock 2002: 612) Fortunately, for archaeological sourcing, the slight variations in elemental composition are distinct enough to permit identification of the provenience of obsidian artifacts. As long as the variations within sources (intrasource variability) are smaller than the differences between different sources (intersource variability), a necessary condition of the "provenance postulate," the successful sourcing of materials is possible (Ferguson 2012: 401-402; Glascock 2002: 612). Obsidian, which occurs in a relatively limited number of geological contexts, is typically chemically uniform within each volcanic outcrop. Consequently, a tested sample can be matched to its source area with relative ease because each volcanic outcrop has a unique elemental signature, which when compared with other source locations, exceeds the intrasource variability. (Cecil et al. 2007: 507; Ferguson 2012: 401-402)

XRF works well for obsidian provenience studies because unlike other element analytical techniques (e.g. neutron activation analysis), XRF can quantitatively analyze certain elements (i.e. barium (Ba), strontium (Sr), and zirconium (Zr)) with sufficient precision (Ferguson 2012: 404; Nazaroff et al. 2010:885). Six elements (iron (Fe), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb)) are routinely used in obsidian provenience studies, but most calibration procedures for XRF account for more than these six. The current calibration that the University of Missouri Research Reactor (MURR) uses for its obsidian testing measures concentrations for nineteen elements (Na, Al, K, Ba, Ti, Mn, Fe, Co, Ni, Cu, Zn, Ga, Pb, Th, Rb, Sr, Y, Zr, and Nb). MURR recognizes that not all nineteen of these elements are necessarily pertinent to the overall composition of obsidian, but their inclusion provides a wider set of parameters that improves the accuracy of the overall calibration. (Ferguson 2012: 407-408)

Best practices for obsidian testing suggest that the samples selected for XRF should be “infinitely” thick, meaning a sufficient thickness whereby any additional thickness on the sample would not result in additional fluorescent x-rays being emitted during the process (Ferguson 2012: 413). Although this infinite thickness value varies from sample to sample, a thickness of at least 10 millimeters (mm) or 1 centimeter (cm) should produce sufficiently accurate readings (Glascock and Ferguson 2012: 1). Nevertheless, some scholars (Cecil et al. 2007: 14) maintain that the variability in thicknesses of their samples did not produce errors when matching artifacts to their sources, but that each sample should be placed in the sample chamber with the flattest part of the surface facing the x-ray beam because this would help to decrease errors that could occur from insufficient sample thickness. Obsidian samples do not require structural modification prior to XRF testing; however, if there is residual sediment present, it should be washed away prior to testing to avoid detection of extraneous elements (Cecil et al. 2007: 14).

To match the artifact samples to their sources, raw material samples collected from known outcrops and secondary deposits of obsidian are used. The compositional data obtained from the raw source samples become the standard for designating the source localities, which allows the unknown obsidian artifacts to be read against the known compositional profiles of the raw sources (Cecil et al. 2007: 14). Bruker, a manufacturer of scientific instruments for molecular and materials research, based their obsidian calibration on a customized set of forty slab-cut obsidian source samples from the Archaeometry Laboratory at MURR (Speakman 2012: 1-2). These calibration samples were prepared by cutting out a cube, approximately 10 mm (1 cm) thick, of a single sample from each individual source of raw obsidian, then polishing and labeling one surface with the standard number assigned to the source (Glascock and Ferguson 2012: 1). This calibration set provides a matrix-specific standard for calibrating their PXRF spectrometers (Speakman 2012: 1-2).

Admittedly, each data set will have unique calibration adjustments, but Bruker provides basic operating parameters for obsidian testing (Table 2) that assure a general degree of success. The parameters set out in the table below allow x-rays from the XRF spectrometer, ranging between 17 and 40 kilovolts, to penetrate the obsidian sample, which excites all elements on the periodic table between iron (Fe) and molybdenum (Mo) (i.e. numbers 26-42), including key elements that vary between obsidian sources. (Bruker 2010) One adjustment that is relatively easy for a novice operator to manipulate is the data acquisition time. Bruker suggests a 180-second data acquisition, but anywhere between 120 and 200 seconds is the standard in obsidian studies (Speakman 2012). Generally, the longer the analysis the more accurate the results;

however, there is a point of diminishing returns where the additional data acquisition time no longer provides a statistically relevant return on accuracy.

Table 2. Bruker Operating Parameters for the Measurement of Elements (Rb, Sr, Y, Zr, Nb) in Obsidian Samples (information by Bruker 2010, table by McArdle 2013)

Filter	0.006” Cu, .001” Ti, .012 Al Filter (Green Filter)
Kilovolts	40 kV
Micro amps	10 uA or 12uA
Time	120 – 200 seconds
Chamber Specifications	No vacuum
CFZ File	GL1.CFZ
Compton Normalization	19.5 and 22

As with any method reliant on complex instrumentation, there is a concern with stability of readings as the usage duration of the instrument increases. As PXRF is primarily an in-field process due to the spectrometer’s portable nature, it is even more important that data be of high and consistent quality as it is often not possible to reanalyze samples. Instrumental drift as usage increases could introduce analytical errors that would obscure source identifications, invalidating the data. Robert Speakman (2012: 4-5) designed and undertook an experiment to assess the Bruker Tracer Series XRF spectrometer’s stability and determined that instrumental drift was not an issue. Speakman set up the spectrometer to analyze obsidian calibration sample # 8 for 17 continuous hours using 200-second intervals, which resulted in 307 separate analyses. Data collected for elements Fe, Rb, Y, Zr, and Nb exhibited relatively low variation (%RSD), 2% or lower. This %RSD is comparable to the low variation exhibited by most laboratory based XRF spectrometers. Data collected for elements Mn, Zn, and Ga exhibited slightly higher %RSD values of 3-6%, but this variation is typical of these elements (Speakman 2012: 4-5).

Application of XRF for the elemental sourcing of obsidian is decidedly still in its infancy, having only first become a viable archaeometric technique in the 1960s (Braswell et al. 2000: 269). However, despite its novelty, it is a field that appears to be flourishing; there has been a clear and steady upward trend in the number of published studies within the past decade (Freund 2013). Its expansion into the archaeological methodological repertoire does bring with it certain concerns. Most notable among these concerns is the increased accessibility that puts PXRF in the hands of novice operators. Due to the lower cost of PXRF, researchers with insufficient understanding of the physics, calibration methods, and analytical limitations of the technology have easier access to this method of elemental analysis (Ferguson 2012: 418). This unfettered access may facilitate errors resulting from "inaccuracies of the regression model, statistical error of the calibration spectra, [and] inaccuracy of the intensity of the calibration curve and the energy calibration" (Cecil et al. 2007: 14). With its point-and-shoot portability and factory-installed calibrations, the PXRF seems to be a one-stop-shop for chemical sourcing, except that without the requisite knowledge of appropriate calibration techniques and experience with reading the raw data in spectral form, accuracy and efficacy are diminished. Speakman (2012: 1-2) made the valid point that although conclusions regarding compositional sourcing of obsidian in studies of questionable accuracy may still be correct or consistent within themselves (e.g. exhibit high levels of precision), this leads to a situation where results are not replicable or compatible with other data sets and "is not the way that science should be conducted in archaeology or elsewhere." If a standardization of measuring and reporting data and an accepted standard of international reference calibrations were adopted, it would be possible to address cross-compatibility of datasets and discuss the data "in terms of precision, accuracy, and reproducibility—the foundation for valid and reliable science" (Speakman 2012: 1-2).

With these concerns in mind, PXRF still has many advantages (e.g. low costs, rapid data acquisition, ease of access, accuracy (when applied correctly), non-destructive, generation of larger data sets, etc.) as well as the potential for future applications to material studies beyond sourcing. Chemical sourcing provides an excellent opportunity to determine where artifacts originate, adding a chapter to their lifecycles beyond depositional context. This information can help address broader archaeological problems concerning transportation logistics, networks of exchange and trade, social interactions, and community identification, as well as tool production, utilization, modification, and deposition in spatial contexts (Ferguson 2012: 402; Freund 2013). X-Ray fluorescence is a powerful tool that when wielded correctly has the potential to answer questions in a quantitative way that visual techniques cannot.

Mesoamerica and Obsidian

A discussion of a resource and its relation with a geographic and cultural region requires a recognition of the varied ways in which such a discussion can be framed. Within the past 60 years, researchers have grappled with the role of obsidian exchange and trade in Mesoamerica from multiple angles, the most notable of which Clark (2003: 34-38) discussed in his article, A Review of Twentieth-Century Mesoamerican Obsidian Studies; a summary of his review is provided in the table below (Table 3).

The different lines of inquiry outlined in Table 3 demonstrate the many ways in which analysis of a resource like obsidian can aid in answering broad questions about ancient societies like the Postclassic Maya. The discussion in this paper concerning the obsidian core cache from Nojpeten will primarily demonstrate the following aspects of the ideas presented below: that economies are embedded, that trade has spatial signatures, that sources can be determined chemically, that obsidian is well-suited for production and trade analysis, that processed obsidian commodities have unique assemblage signatures, and that trade issues are often issues of garbage.

Table 3. Various angles with which to analyze obsidian exchange throughout Mesoamerica

Supposition	Explanation
Trade has social evolutionary consequences	trade concerns physical resources, human wants and needs, and transactions. Without personal or institutional benefits it makes little sense for traders to trade
Economies are embedded	no clear distinction can be made among economic, social, and political activities
Exchange is ecological	all ecological systems (e.g. human) have a variety of unequally distributed resources and processes involving matter, energy, and information transfers among populations
Trade is political	geological resources unequally dispersed across landscapes have no inherent properties that serve in human ecosystems until implicated in cultural practices and technologies
Trade has spatial signatures	obsidian can be identified to different sources and the relative quantities of each vary as a function of distance across the ancient landscape and different allocation systems
Production organization determines trade impact	the control of obsidian tool production (i.e. political control over artisans, with claims on the products of their labor) relies on specialized craft activity
Products/by-products reveal production behavior	patterned distribution of stone tools and debris across a site allows one to get at socially important activities and their significance in the functioning and development of society
Sources of obsidian can be determined chemically	obsidian, with its advantages of traceability to a few known sources and imperishability, can act as a surrogate for other exchange systems of perishables
Distribution patterns mark trade routes and transport systems	proposing trade routes based on movements of obsidian from geologic origin to archaeological site should address direct procurement, informal trade, gifts, and/or artifact scavenging
Intrasite distribution patterns reflect status differences	different consumers had different requirements/potentials for obtaining obsidian products; studying consumption patterns within sites can reveal similarities, links, and differences
Obsidian is well-suited for production and trade analysis	obsidian provides a means of monitoring the flow of trade or the quantities of products produced at quarries and transported to consumer sites
Processed obsidian commodities have unique assemblage signatures	one of the logical implications of lithic reduction and technological analyses is that each fabricated product should be associated with specific waste by-products

Trade issues are issues of garbage	most materials employed in studying ancient trade are discarded waste; inferences of production and consumption depend on identifying waste type and its depositional context
Local exchange trumps long-distance exchange	the greater the distance the more modest and energetically insignificant the # of products that came into a system; local agriculture and regional exchange were of greater importance
Context is essential for understanding trade	identification of different kinds of goods and consumption patterns depends on inferring the cultural context

Obsidian Sources and Locations

In Mesoamerica, most obsidian artifacts have been matched to 41 known sources (29 in Mexico, 12 in the rest of Central America), of which only about 10 were used extensively by the Maya (Braswell 2003: 131; Cecil et al. 2007: 507; Figure 3). The highlands of Mexico, southern Guatemala, Honduras, and El Salvador were volcanic zones replete with obsidian (Figure 3, #s 1-8) but the lowlands had no obsidian. Instead, they had an overabundance of sedimentary limestone; however, artifacts of obsidian appear throughout the wider Mesoamerican region, and from numerous sources, indicating that there must have been exchange networks among these zones (Moholy-Nagy 1984: 104, 181-182; Rice 1984: 181; Rice and Rice 2009: 335).

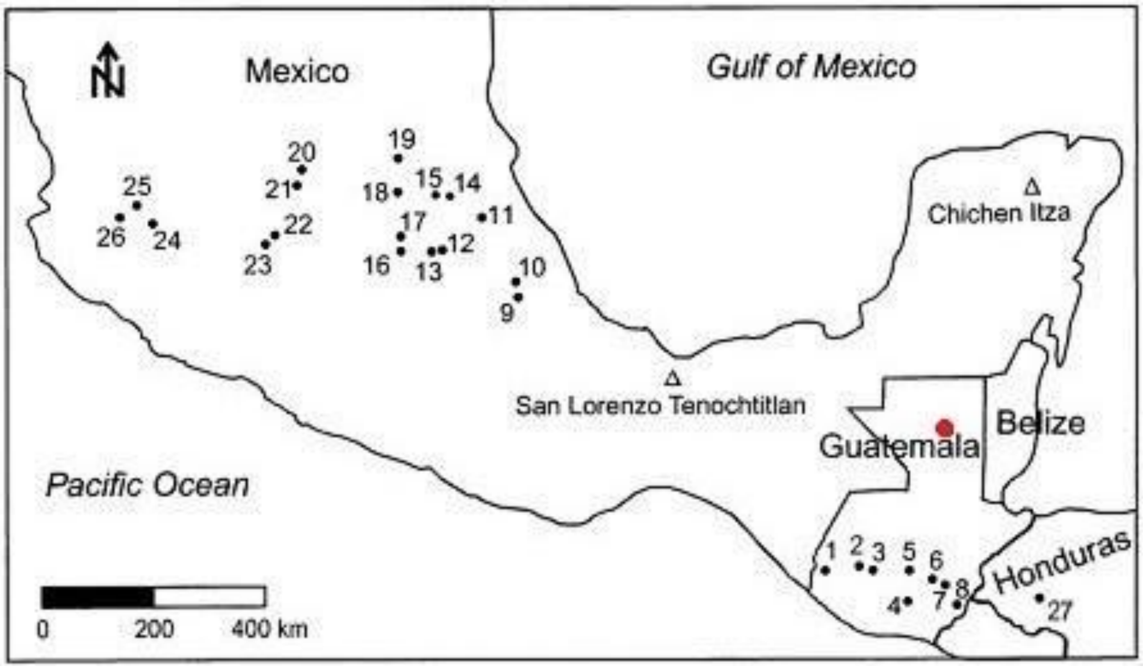


Figure 3. Map of Mesoamerica showing the locations of major obsidian sources and the location of the island of Flores (red dot). The sources in Guatemala are (1) San Lorenzo, (2) San Martin Jilotepeque, (3) San Bartolomé, Milpas Altas, (4) Laguna de Ayarza, (5) El Chayal, (6) Sansare, (7) Jalapa, and (8) Ixtepeque. The sources in Mexico are (9) Pico de Orizaba, (10) Guadalupe Victoria, (11) Zaragoza, (12) Paredon, (13) Santa Elena, (14) Tulancingo, (15) Tepalzingo, (16) Otumba, (17) Malpais, (18) Pachuca, (19) Zacualtipan, (20) El Paraiso, (21) Fuentezuelas, (22) Ucareo, (23) Zinapecuaro, (24)Tequila, (25) Magdalena, and (26) Teuchitlán. The sources in Honduras are (27) La Esperanza and Güinope (not shown). (Glascock 2002: 613; Sheets et al. 1990: 145; modified by McArdle 2013)

Multiple analyses of obsidian artifacts recovered from lowland Maya archaeological sites indicate that the inhabitants of most of these sites obtained their obsidian from a variety of sources (Rice and Rice 2009: 335). Of these, three in the Guatemalan highlands appear to have been the most significant to the Maya in terms of quantities of obsidian imported, scale of geographic distribution, and use over time (Rice 1984: 181-182). The three most commonly used sources are El Chayal (Figure 3: #5), located approximately 15 miles north of Guatemala City and spread out across multiple quarries and outcrops; San Martin Jilotepeque (SMJ) (Figure 3: #2), located in the Chimaltenango basin northwest of the El Chayal outcroppings; and Ixtepeque

(Figure 3: #8), located in southeastern Guatemala near the borders with Honduras and El Salvador (Rice 1984: 181-182).

Timeline of Source Use

Even though evidence shows that most sites in the Maya lowlands were exploiting multiple obsidian sources at any given time, each of these sources was utilized to different degrees at different times (Rice 1984: 182; Rice and Rice 2009: 335). During the Middle and Late Preclassic periods (~ 800 BC – AD 300), SMJ appeared to be the most important source utilized by lowland Maya, but this preference changed at the beginning of the Early Classic to El Chayal (Braswell and Glascock 2011: 129; Rice 1984: 182). El Chayal remained the major source of obsidian utilized throughout the Classic period (~ AD 300-950) (Braswell 2003: 140; Rice 1984: 182), a period during which obsidian became more widely available and evenly distributed throughout the lowlands. The increased availability may have been due to more groups importing obsidian directly from the highland Guatemalan sources and getting direct access to pre-formed cores rather than already prepared blades (Aoyama 2007: 9; Rice 1984: 190). This change in source utilization during the Classic period is likely due to heavier exploitation of obsidian in general (Braswell 2003: 140; Hirth and Flenniken 2002: 127). While El Chayal remained a major supplier into the Postclassic (~ AD 950-1450) (Rice 1984: 182), there was a dramatic decline in its dominance in the transition from the Late Classic to Postclassic, as well as a decline in use of SMJ obsidian; these changes were perhaps due in part to a disruption of overland trade networks that carried El Chayal obsidian into the lowlands (Braswell 2003: 140; Rice 1984: 182-183; Rice and Rice 2004: 129). Almost simultaneously with this decline, there was a surge in utilization of the Ixtepeque source during the Terminal

Classic, especially in the Petén lakes region, which primarily depended on that source until the end of the Early Postclassic around AD 1100 (Rice 1984: 182-183; Rice and Rice 2004: 129). Archaeological evidence suggests that the production and circulation of obsidian increased in the Postclassic (Smith and Berdan 2000: 285), especially in the central Petén lakes region where "there was a higher ratio of obsidian per occupation in the Postclassic period than there was in the Classic," perhaps because trade was facilitated by an increase in coastal shipping (Rice 1984: 187, 194) or increased activity in other networks of exchange (Braswell 2003: 155).

Obsidian Exchange Spheres in the Postclassic

To contextualize the increased circulation of obsidian in the Postclassic, it is beneficial to examine exchange spheres because these networks facilitated the increase. According to Braswell (2003:131), there are three factors that make obsidian suitable for the study of Postclassic exchange networks: (1) obsidian was principally a utilitarian rather than prestige good, (2) the number of volcanic sources from which workable obsidian could be quarried was limited, and (3) each volcanic source is distinct due to its unique geological history, making it possible to identify the geological origin of an artifact and posit possible exchange routes based on the location of the source versus where the artifact was ultimately found.

The exchange sphere at work during the Postclassic has traditionally been described as largely undifferentiated, with a geographic range extending from the northern Yucatan and narrowing southward to the Pacific coast. However, this generalization of a single generic exchange sphere in lieu of regionally specific exchange routes is doubtless a consequence of the paucity of source data for obsidian artifacts dating to the Postclassic (Rice and Rice 2009: 329). Accordingly, Braswell (2003: 131) proposed organizing the scant data that are available into broad spatial patterns he termed obsidian exchange spheres, meaning that all sites within a given sphere accessed the same obsidian sources, possibly indicating similar cultural and/or political arrangements. The central Petén lakes region occupies an obsidian exchange sphere all its own.

During the Terminal Classic (AD 800-1050), Braswell (2003: 134, Table 20.1) found that the central Petén lakes region had 65% of its obsidian come from El Chayal, 20% from Ixtepeque, 5% from SMJ, and 10% from an unknown source (Rice et al. 1985). During the Early Postclassic (~ AD 950 - 1250/1300), Braswell (2003: 142, Table 20.2) found that the Central Petén lakes region had 19% of its obsidian come from El Chayal, 58% come from Ixtepeque, 15% from SMJ, and 8% from an unknown source (Rice et al. 1985). Braswell (2003: 146) noted that the primary change in obsidian procurement strategies in the Early Postclassic was the expansion of the southeast Maya exchange sphere resulting in a substantial increase in procurement from Ixtepeque, a source that he postulated was most likely managed by local inhabitants of the southeastern Guatemalan highlands. Unfortunately, Braswell (2003: 148-150, Table 20.3) did not have collective information for the central Petén lakes region for the Late Postclassic (AD 1250/1300-1520). However, he did include information for one site in the region, Topoxte. At Topoxte, Braswell (2003: 150) listed 38% of the obsidian as coming from El Chayal, 45% from Ixtepeque, and 17% from SMJ. Based on the data that indicated varied degrees of use of the different sources, Braswell (2003: 152) concluded that the Postclassic was a period of increased integration, perhaps due to fewer barriers to trade throughout surrounding exchange spheres.

These data suggest "that most sources were peripheral, rather than central, to the exchange spheres in which artifacts ascribed to those sources circulated;" additionally, there are few indications that source areas were directly controlled by major polities during the Early

Postclassic period (Braswell 2003: 155). Consequently, "the peripheral or interstitial locations of obsidian sources, the directional pattern of distribution, and the lack of clear controlling central places all suggest that obsidian extraction and circulation were governed more by demand than by central planning" (Braswell 2003: 155).

Logistics of Procurement and Transportation

It has long been suggested that rough polyhedral cores were fashioned at the obsidian quarry sites before being transported to lowland sites (Aldenderfer 1991: 139; Hester 1972:98; Rice 1984: 182; Sidrys 1976: 451). This circulation of cores, rather than of finished prismatic blades (as suggested by Coe and Flannery 1964:48 and Rovner 1973) is now the widely accepted and prevailing theory on how obsidian entered the lowland Maya region. It is the accepted theory of obsidian distribution because it is arguably more efficient to transport obsidian "in bulk rather than as fragile blades (Rice 1984: 182), but not as completely un-worked raw material because large cobbles weigh more than worked cores (Hirth 2012: 408) and would be inconvenient to transport over the long distances obsidian had to travel to lowland sites. Regarding the fragile blades, Sheets (1975: 99) pointed out that it would have been easier to transport a pre-formed core rather than the 50-150 individually wrapped prismatic blades that would have come from that core because the possibility of snapping blades and/or damaging their sharp edges during transport would have been great. Additionally, the scarcity of fully cortical flakes but the presence of flakes with partial cortex at lowland sites indicate that rough polyhedral cores were "further reduced at the site, with subsequent pressure removal of the prismatic blades" (Sidrys 1976: 451). Aldenderfer (1991: 139) and Demarest (2004: 162-163) both suggested that after obsidian reached the lowland region in core form, it may have been directly sent to "center communities” which would use it first in endeavors of craft production; then, it was likely re-circulated or exchanged with other communities, and finally may have been scavenged and recycled for domestic use in more peripheral communities.

A study of the El Chayal obsidian source by Suyuc-Ley (2011: 132) revealed five quarry-workshop areas amidst the outcrops; defined as a context “with evidence for the extraction of raw material in association with, but typically distinct from, areas devoted to the processing of obsidian,” the five identified quarry-workshop complexes are: Nance Dulce, El Remudadero, San Antonio Este, El Fiscal, and La Joya. When Coe and Flannery (1964: 43, 46) first surveyed the area, they concluded that the obsidian industry at El Chayal dated solely to the “Formative” period (i.e. Archaic) that roughly ranged between 5000 and 1500 BC, because they were unable to locate pre-Columbian ceramics and narrow prismatic obsidian blades. They were however, able to locate polyhedral cores throughout the various outcroppings (Coe and Flannery 1964: 44). However, in light of recent evidence (Sheets 1975: 98; Suyuc-Ley 2011: 132), it is more likely that the obsidian industry at El Chayal was extant throughout all the periods of pre-Columbian occupation and the lack of ceramics and prismatic blades was because El Chayal was utilized solely as a quarry. Sheets (1975: 99) dismissed the assumption that all stages of stone tool manufacture were completed at quarry sites because numerous exhausted blade cores were found at the majority of archaeological sites throughout Mesoamerica suggesting that prismatic blades were typically manufactured at habitation sites, not quarries. Sheets’ (1975: 101) conclusion that the El Chayal obsidian industry focused on pre-forming polyhedral cores for transport rather than on-site manufacturing of prismatic blades is bolstered by Suyuc-Ley’s (2011: 132) recent survey, which concluded that all the quarry-workshops at El Chayal were exclusively “primary workshops, where pre-forms were prepared” rather than “secondary workshops, where pre-forms were reduced to finished artifacts.”

The continual use and reuse of obsidian is likely due to the long and often difficult distances obsidian had to travel to the lowlands; even when its importation increased in the Postclassic, the routes by which it had to travel were never quick or easy. Hirth and Andrews (2002: 11) described the differences in source distances in a way that puts the impressive logistical feat of obsidian transport into perspective. They described “proximate sources” as ones that were within a 10-100 kilometer (km) radius, precluding round-trip obsidian collection in a single day and thus requiring advanced planning (Hirth and Andrews 2002: 11). They estimated that for areas 75-100 km away from a source, it might take a group anywhere from one to three weeks for a round-trip collection of obsidian, depending on whether they quarried the obsidian themselves or traded for partially processed forms (e.g. cores) with local groups at the quarry (Hirth and Andrews 2002: 11). Any sources beyond a 100 km radius were described as “distant sources,” which Hirth and Andrews (2002: 11) suggested would have been places “where knowledge of source locales and the groups that control them would have been limited” and though these distances did not preclude direct procurement, the methods of procurement likely were more indirect and more dependent on exchange mechanisms. For obsidian to travel from the highland Guatemalan sources that were most often utilized in the Postclassic to the central Petén lakes region where Nojpeten is located, they often had to travel distances in excess of 400 km, clearly categorizing them as “distant sources” using Hirth and Andrews’ (2002) definitions. Mesoamerica has relatively few navigable rivers, and all obsidian deposits are located inland, away from waterways where raw obsidian could have been moved in bulk (Hirth and Andrews 2002:11); additionally, the Maya had no beasts of burden or wheeled transportation methods with which they could move obsidian in great quantities; consequently, transportation costs were high (Hirth 2012: 408). The Postclassic Maya would have relied on a “tumpline economy,” one where cargo had to be moved overland on the backs of human porters when canoeing, along coastal routes or navigable rivers, was not possible (Hirth 2012: 408; Hirth and Andrews 2002: 7). With obsidian continually moving as far and as often as it did throughout the Maya lowlands despite the high costs in labor and time, it is apparent that it was a resource of utmost importance to the Postclassic Maya (Hirth 2012: 408).

Possible Obsidian Trade Routes

While obsidian exchange spheres may give a better or more accurate picture of resource circulation within a region, attempting to reconstruct specific trade routes can aid in illustrating the logistics necessary for long-distance transport. Trade networks proposed by Norman Hammond (1972) based on evidence derived from topography, ethnohistory, ethnography, and the results of trace element analysis of obsidian from 23 Classic Maya sites (Johnson 1976: 83), suggested that Nojpeten was well-situated to participate in expansive inland networks of exchange (Figure 4). The occupation of the Petén during the Postclassic focused heavily on the lakes region, and at all lakes, evidence suggested that more obsidian was available in the Postclassic than in the Classic (Rice et al. 1985: 602). These central Petén lakes provided a natural transportation route for water travel between the eastern rivers of Belize and the rivers to the northwest of the Petén (Cecil et al. 2007: 508) facilitating exchange. Demarest (2004: 162-163) further described these inland routes suggesting that some “have led from the highlands of the Verapaz region of Guatemala via the upper Pasion River and the Maya trading port of Cancuen at the head of navigation. From Cancuen, obsidian nodules or macroblades were transported [along] the Pasion River into the northern and central Petén, up the Machaquila River to the southeastern Petén and Belize, and up the Usumacinta to major Maya centers." The sources most likely traded through these inland routes were El Chayal and SMJ (Johnson 1976: 83), although these sources could also have been traded via coastal routes.

Ixtepeque appeared to have been utilized most often in the central Petén lakes region during the Postclassic, and obsidian from this source would most likely have been distributed via a coastal trade route (Figure 4). A coastal trade route from Ixtepeque may have led from the Motagua River out to the Caribbean, followed by a canoe trade route up the coast of Belize (Hammond 1972), or from the Rio Dulce north toward the Yucatan, "with a feeder route running upstream along the Hondo [and/or along the New River] from Chetumal Bay" as was documented in early Colonial sources (Hammond et al. 1984: 818). After traveling up the coastline, obsidian would have then been brought inland, upriver, or on overland routes into the central Petén lakes region (Healy et al. 1984: 416). Regardless of the route taken, it is clear that they all required traversing great distances and it is therefore likely that Postclassic "Maya obsidian trade mechanisms, trading dynamics, and commodity distribution were more intricate than the dual route, interior-coastal model" would suggest and that obsidian was traded throughout the lowlands via multiple routes and/or methods (Healy et al. 1984: 416).

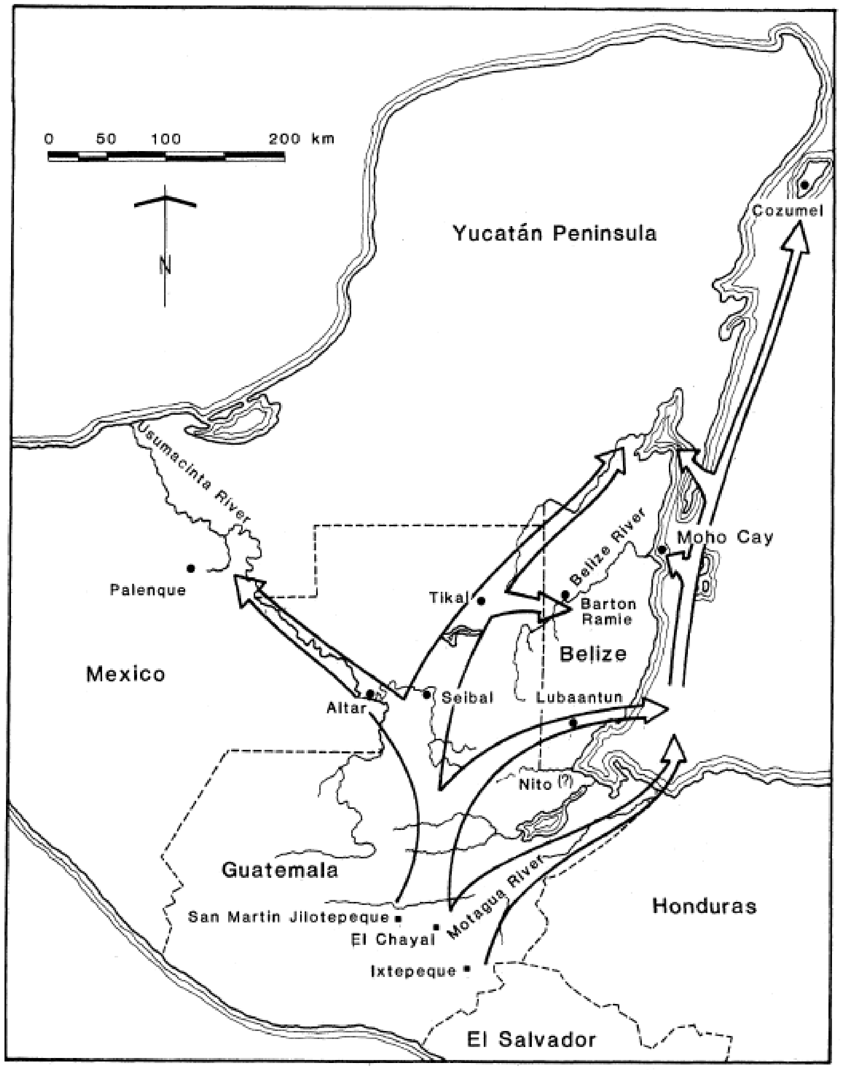


Figure 4. Possible obsidian trade routes originating from obsidian sources in the Guatemala highlands: Ixtepeque, El Chayal, and SMJ (Healy et al. 1984: 415)

METHOD

Laboratory Sourcing of Cache Contents with PXRF

In order to ascertain the sources of the obsidian cores from the Nojpeten cache, and to contribute to the gradually growing body of source data available for study of the central Petén lakes region during the Postclassic, I utilized an x-ray fluorescence spectrometer to test all 190 cores and core fragments (Figure 5). For my study I used a Bruker Tracer III-SD T3S1995 PXRF owned by Cornell University; the portable nature of this spectrometer allowed me to travel to the FARES laboratory in Guatemala City to test each of the obsidian cores and core fragments, avoiding the sometimes lengthy and logistically difficult process often associated with international artifact exportation. Because the cores and core fragments range in size from approximately 16 mm to 98 mm in length and 8 mm to 32 mm in width (thickness), they comply with the aforementioned optimal obsidian sampling parameters for use with a PXRF; thus, the cores were ideal candidates for sourcing. The cores were tested over a period of several days, the 13th-18th of February 2014, using the parameters listed in Table 4 below.

Table 4. XRF spectrometry testing parameters for the Nojpeten obsidian core cache

Filter	0.006” Cu, .001” Ti, .012 Al Filter (Green Filter)
Kilovolts	30 kV - 40 kV *
Micro amps	10 uA (n=41) or 12uA (n=184) *
Time	120 seconds
Chamber Specifications	No vacuum
Sample Shield Accessory	With Cover (n=184) or No Cover (n= 41)*
CFZ File	GL1.CFZ

* see discussion on variable parameters below

All (n=184) but six cores were able to fit on the sample stage and be tested with use of the sample shield accessory, a cover that aids in isolating the sample so that readings of the sample’s elemental markers avoid contamination from unrelated outside matter. The initial setting of 40 kV and 12uA was used to test 149 cores and core fragments. The six cores that were too large to fit underneath the sample shield accessory were tested at 40kV and 10uA along with the remaining 35 cores and core fragments that were tested after a PXRF malfunction[1]; these 35

[1] Due to an unexpected malfunction of the PXRF on the third day of testing, not all cores were tested using the same parameters. The x-ray generator in the unit suffered a high-voltage system failure of the 30-40kV circuit board caused by an air bubble in the insulating liquid. After the malfunction, the spectrometer was still able to generate x-rays, albeit at lower voltages; the settings were left at the initial 40 kV and 12uA for the remaining 35 cores and core

were tested twice, at 40kV and 10uA without a sample shield accessory cover, and at 40 kV and 12 uA, in order to increase the odds of procuring usable source data in the face of a failing PXRF unit.

Figure 5. The Bruker Tracer III-SD T3S1995 PXRF set up for testing in the FARES laboratory.

Once PDZ files for all 190 cores and core fragments were generated, the elemental compositions of each obsidian sample were compared with known obsidian source files, provided by Michael Glascock of The Archaeometry Laboratory at the University of Missouri Research Reactor. With the assistance of Bruce Kaiser, of Bruker Elemental, I matched the

fragments small enough to fit under the sample shield, but the spectral maps for these cores indicate that no readings were taken at voltages higher than 30kV. While inconvenient for uniformity in sampling, this malfunction did not preclude identification of elemental concentrations within the obsidian because the six elements most pertinent to sourcing (Fe, Rb, Sr, Y, Zr, and Nb) are all measured at voltages less than 30 kV (Ferguson 2012: 407-408).

spectral maps of the 190 cores and core fragments to the known obsidian source files; results are provided below.

RESULTS

By comparing the elemental compositions (especially of Fe, Rb, Sr, and Zr) of the 190 cores and core fragments it is evident that at least three distinct sources, possibly four, are present in the cache (Table 5; Figures 6 and 7). Of the 190, 186 could be definitively matched to three distinct obsidian sources in the Guatemalan highlands: Ixtepeque, SMJ, and El Chayal. The remaining four cores have similar chemical compositions to those from SMJ, but are not definitively clustered with them (Figures 6, 7, and 11); this could indicate that they are from an outcrop of SMJ with a slightly different elemental composition or that they are from a fourth unknown source.

Table 5. Breakdown of obsidian sources represented in the Nojpeten core cache.

Source	**# of Cores**	**Percentage**
Ixtepeque	114	60%
SMJ	44	23.2%
El Chayal	28	14.7%
Unknown	4	2.1%
Total	190	100%

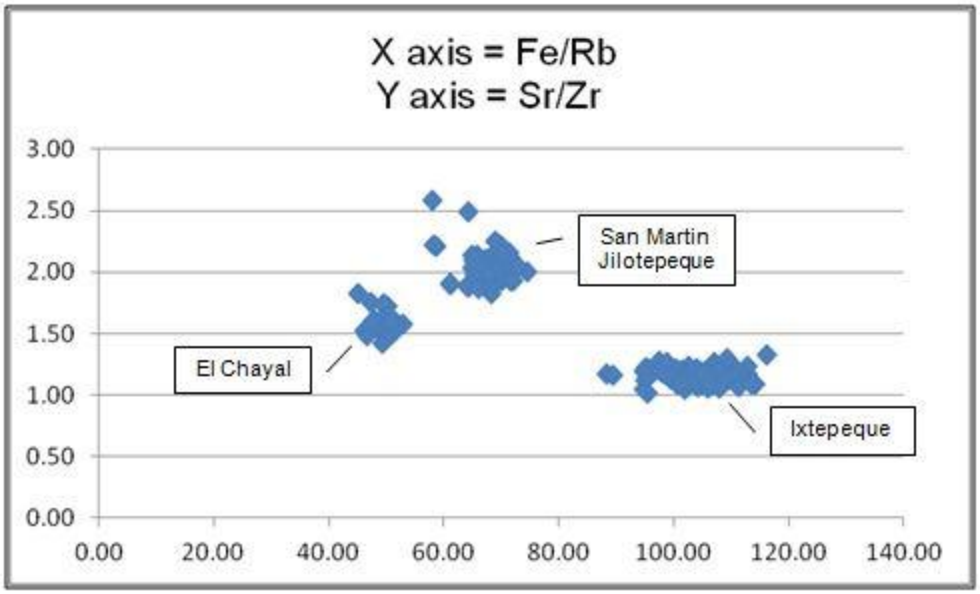


Figure 6. Nojpeten obsidian core cache source concentrations derived from comparisons between Iron and Rubidium with Strontium and Zirconium in parts per million (ppm)

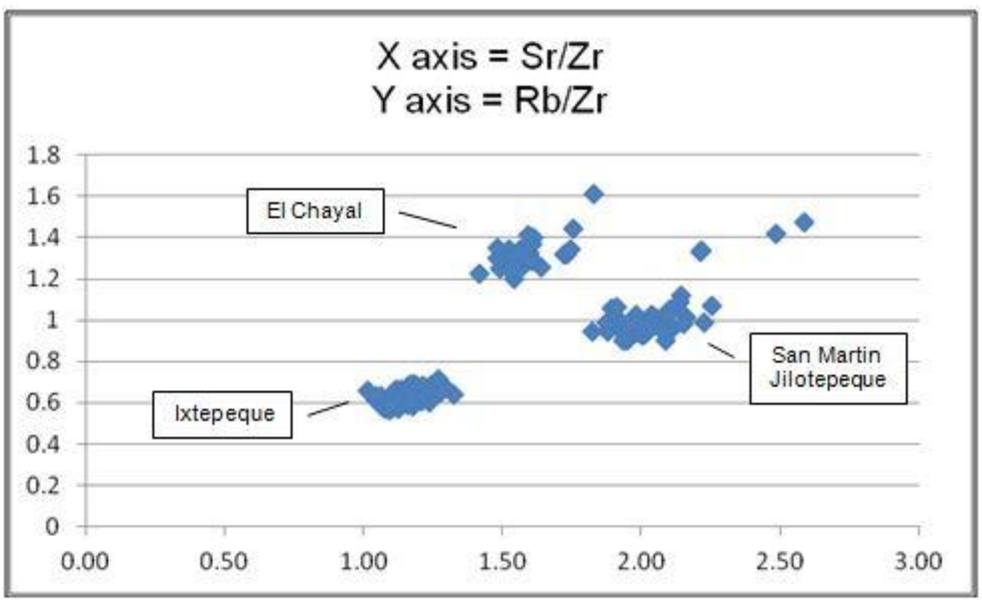


Figure 7. Nojpeten obsidian core cache source concentrations derived from comparisons between Strontium and Zirconium with Rubidium and Zirconium in parts per million (ppm)

The majority of the cores (n=114), making up 60%, were sourced to Ixtepeque (Figure 8). The cores sourced to Ixtepeque exhibited the tightest and most definitive clustering pattern, which may indicate that as a source Ixtepeque does not have significant intra-site variability, or that all the samples of Ixtepeque obsidian extant in this cache came from the same outcrop. Obsidian from Ixtepeque is primarily a grayish brown color with a refracted color of a brown similar to “dark sherry or cola” or mahogany, and a reflected color of black, or of medium gray in the more opaque specimens; if banding is present it is often narrow and of a dark or light gray with “a milky color” (Aoyama et al. 1999: 241; Braswell et al. 2000: 272). Generally, it is very lustrous and translucent (though banded portions are opaque giving it a medium luster), which gives it the appearance of artificial glass (i.e.it sharply refracts light), and its texture is described as smooth, glassy, and very fine (Aoyama et al. 1999: 241; Braswell et al. 2000: 272). Although inclusions are infrequent, when present they are large and grainy in texture, which can cause the typically smooth surface characteristic of Ixtepeque obsidian to appear somewhat pitted (Aoyama et al. 1999: 241; Braswell et al. 2000: 272). The cortex is described as generally thin and relatively smooth or irregularly “frothy” in appearance with a “perlitic” surface (Aoyama et al. 1999: 241; Braswell et al. 2000: 272).

Figure 8. Examples of Nojpeten cores sourced to Ixtepeque (photo by McArdle 2013)

The second most frequently represented source in the cache was SMJ, with 44 cores, making up 23.2 % of the cache (Figure 9). Obsidian from the SMJ source ranges in color from black to dark gray with a refracted color of dark gray with a brown hue and a reflected color of black (but lighter than the black of El Chayal); some specimens may have dark gray banding or reddish brown/mahogany spots (Aoyama et al. 1999: 241; Braswell et al. 2000: 272). This obsidian has a low to medium opacity that is irregular due to a high density of ubiquitous inclusions that range in size from "dusty to sand-grain-sized particles" (Aoyama et al. 1999: 241; Braswell et al. 2000: 272). Due to the sheer number of inclusions (substantially higher than in obsidian from El Chayal or Ixtepeque), obsidian from SMJ does not have a strong luster (it is the least glassy of all the sources), though its surface can sometimes have an oily sheen; its surface is not smooth and appears pitted or pockmarked, like the skin of an orange (Aoyama et al. 1999: 241; Braswell et al. 2000: 272). The cortex is variable; Aoyama and colleagues (1999: 241) described it as "relatively thin with an irregular frothy appearance," but Braswell and colleagues (2000: 272) described it as "medium to thick, often rough."

Figure 9. Examples of Nojpeten cores sourced to SMJ (photo by McArdle 2014)

The third most frequent source was El Chayal, with 28 cores, making up 14.7% of the cache (Figure 10). Obsidian from El Chayal exhibits high variability in its appearance (Moholy-Nagy 1987: 20); its color ranges from black to dark or light gray, sometimes grayish brown (Aoyama et al. 1999: 241), particularly with a refracted color of "medium gray with a milky or waxy appearance" or "clear, dark gray, or black" and a reflected color ranging from medium gray to black (Braswell et al. 2000: 272; Suyuc-Ley 2011: 130). Some El Chayal obsidian is classified as having a "medium translucency" while others appear opaque, particularly those with wide banded portions of dark or light gray; these properties sometimes give it an appearance similar to frosted glass (Aoyama et al. 1999: 241; Braswell et al. 2000: 272; Suyuc-Ley 2011: 130). Its texture is generally smooth and unmarried, like that of soap-stone, giving it a medium luster; however, particulate inclusions, frequent but small, are common, especially in clearer specimens (Aoyama et al. 1999: 241; Braswell et al. 2000: 272). When cortex is present, it appears relatively smooth and thin (Aoyama et al. 1999: 241; Braswell et al. 2000: 272). The cores sourced to El Chayal were the least tightly clustered, meaning there was a considerable amount of variability in their elemental composition; this variability is likely due to the wide distribution of its outcroppings. Distributed over an area of approximately 300 sq km, the series of related obsidian deposits known as El Chayal consists of at least 58 distinct outcrops, although not all were exploited by ancient peoples (Suyuc-Ley 2011: 130).

Figure 10. Examples of Nojpeten cores sourced to El Chayal (photo by McArdle 2014).

The four cores that could not be definitively sourced are seen below in Figure 11, circled in red, and in Figure 12. They are closest in elemental composition to the SMJ concentration, and may actually be from that source, but from a different outcrop within it (i.e. sub source). If they do represent a sub-source of SMJ, then its collective representation within in the cache increases from 23.2 % to 25.3%

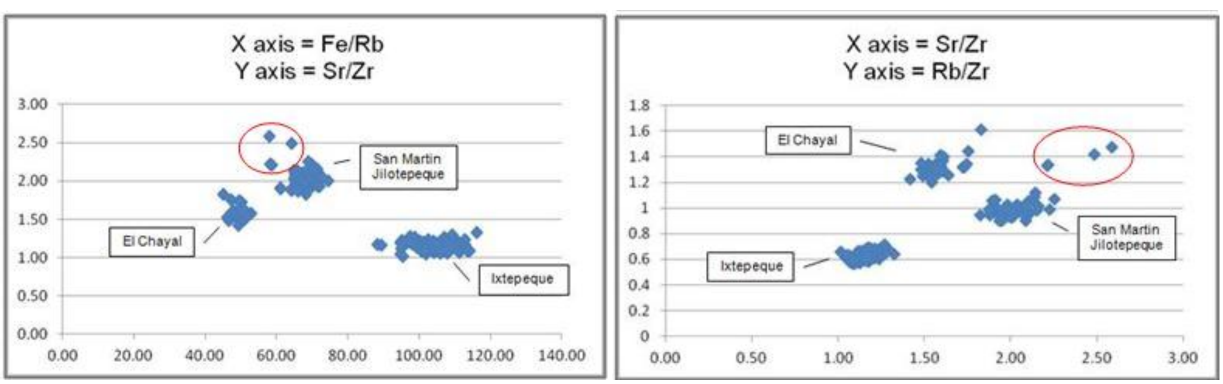


Figure 11. The four cores without a definitive source match are circled in red (graphs by Bruce Kaiser 2014; modified by McArdle 2014).

Figure 12. The four Nojpeten cores without a definitive source match (photo by McArdle 2014).

ANALYSIS

Extant data on sourced obsidians from Postclassic sites throughout the Maya lowlands (e.g. Yucatan, Belize, and Petén) indicate that Guatemalan sources dominated the supply, particularly Ixtepeque, but also that they were not distributed equally in each of the three regions (Rice and Rice 2009: 336-338). In the Petén lakes region (e.g. Topoxte, Macanche, Salpeten, Zacpeten, Quexil, Ixlu, and Trinidad de Nosotros), Rice and Rice (2009: 336-338) noted that all three Guatemalan sources (Ixtepeque, SMJ, and El Chayal) were used extensively, but that SMJ was used substantially more than in surrounding regions where it was present in only small amounts. The results of the sourcing of the obsidian cache from Nojpeten mirror this pattern with 60% of the cores coming from Ixtepeque, 23.2% of the cores coming from SMJ, and 14.7% coming from El Chayal.

The predominance of the Ixtepeque source is not surprising, as it is well established as the most utilized source throughout the Maya lowlands during the Postclassic; Ixtepeque obsidian likely reached the Petén lakes region by moving along the coast of Belize, then up the Belize River to Tipu, ultimately moving west into the central lakes region (Rice and Rice 2009: 336). SMJ, the source with the second highest representation within the cache, probably arrived through overland transportation routes, and obsidian from El Chayal, could have been transported along either inland or coastal routes (Rice and Rice 2009: 336). It is surprising that the second highest concentration of obsidian is from SMJ since it "is not a particularly desirable material in comparison to that of Ixtepeque and El Chayal because of the presence of tiny [inclusions] that raise the possibility of errors in flaking" (Rice and Rice 2009: 336). Additionally, while it was the most utilized source during the Middle and Late Preclassic periods, use of SMJ obsidian steadily declined at the beginning of the Early Classic (Braswell and Glascock 2011: 129; Rice 1984: 182), making it an unusual find in a Postclassic context. Its substantial presence as part of the Nojpeten cache may suggest that it was easier to acquire, perhaps due to its transport via overland routes or perhaps because its lower quality meant there was less competition and thus, it was cheaper to procure (Rice and Rice 2009: 336). The presence of a third source, El Chayal, suggests that Nojpeten was utilizing a variety of resources and that their location in the central Petén was one that likely situated them at the nexus of several different Postclassic trade routes. Additionally, the presence of all three sources in the cache context suggests that no differentiation was made between each source's suitability for use in a ritualized or ceremonial context.

On the northern shoreline of Lake Petén Itza, approximately 30 km away from Flores, Cecil and colleagues (2007:15) tested 70 obsidian artifacts dating to the Postclassic from Trinidad de Nosotros. Using a PXRF at MURR they conducted tests on the obsidian samples with the following parameters: 30 kV, 45 μA, 400 seconds, and a 0.8 mm primary aluminum filter (Cecil et al. 2007: 513). They were able to source all 70 obsidian samples; the majority of the samples (56%, n=39) were from Ixtepeque, 29% (n=20) were from El Chayal, and 11% (n=8) were from SMJ. In addition to these Guatemalan sources, two Mexican sources were identified: Pachuca (3%, n=2) and Zaragoza (1%, n=l) (Cecil et al. 2007: 515; Rice and Rice 2009: 339). The ratios of the different sources are similar to those from Nojpeten, but the order of prevalence differs; Ixtepeque is the primary source used by both sites, but the secondary source at Nojpeten was SMJ and the tertiary source was El Chayal, and at Trinidad de Nosotros it was the opposite. This could indicate differential access to obsidian sources between the neighboring sites, but the sample size at Trinidad de Nosotros is too small to make that claim definitively; or, the difference in ratios could be attributed to the different depositional contexts of the obsidian artifacts at each site.

In discussing the differences in obsidian source prevalence between these adjacent sites, it is important to note that it is likely that the core cache from Nojpeten is more representative of obsidian procurement patterns throughout the central Petén lakes region than Trinidad de Nosotros. It is likely that the Nojpeten sourcing information is more representative of the region because it provides a larger sample size (190 versus 70) and all the Nojpeten artifacts sampled were cores, which represents a much larger labor investment (i.e. 20,000+ prismatic blades), than the obsidian tools tested at Trinidad de Nosotros.

III. MANUFACTURE

BACKGROUND

While obsidian prismatic blades first appear in Mesoamerica around 2500 BC, they are relatively rare in the archaeological record until 1200 BC and only begin to appear regularly throughout the Maya lowlands after 1000 BC (Hirth 2012: 402). It is likely that from the Middle Formative period (900-500 BC) onward, obsidian prismatic blade production was a “specialized craft activity,” meaning that it took considerable practice and training to acquire and maintain the skills necessary for production (Hirth 2012: 405). The products, the obsidian blades themselves, were cutting tools that fed both domestic and state-level consumption needs (Hirth 2012: 401) and their manufacture was “remarkably stable over time” as most variations were a result only of the types of obsidian available to local producers (Hirth 2012: 403). However, changes in the techniques of manufacture did occur; one major change occurred between AD 600-700, when faceted platforms were replaced by pecked and ground platforms (a common characteristic of Postclassic cores, but not exclusive to the Postclassic), presumably making prismatic blade removal faster and easier and prolonging the use-life of the core by facilitating the removal of more prismatic blades (Flenniken and Hirth 2003: 104; Hirth 2012: 403; Rice and Rice 2009: 335; Rovner 1978: 125).

Analyzing the manufacturing aspect of this cache requires a “reading” of the visible scars of the obsidian cores in such a way as to reveal the production methods and techniques that were employed in their creation (Crabtree 1972: 1). Inizan and colleagues (1999: 16) suggested that reading takes place on two levels: observation and inference. They described the observation level as the “initial reading of knapping scars,” a kind of “technical reading” that is independent of the archaeological context and allows the artifact to be situated within a chaîne opératoire

(Inizan et al. 1999: 16). The second level, inference, assesses the interdependence of artifacts in the chaîne opératoire by noting the presence and/or absence of artifacts that reflect prior or subsequent stages of manufacture (Inizan et al. 1999: 16). Reading at both levels requires a "uniform[ly] descriptive vocabulary" to effectively communicate the results of the analysis (Inizan et al. 1999: 17); accordingly, a brief list of the terms most frequently used in describing the manufacturing of the cores in this cache are included below.

Terminology

Throughout this paper, certain terms are used in reference to prismatic blade-core lithic technology. The following terms are compiled from various resources (Bradley 1975; Crabtree 1972; Inizan et al. 1999; Trachman 2002) and are not meant to serve as an exhaustive dictionary; rather, they are a sampling of those terms deemed germane to the lithic technology at work in the production of the contents of this specific cache.

- **Arris:** A linear edge formed by the meeting of two surfaces, specifically the line formed by the meeting of two flake removal negatives, or of one negative removal meeting with cortex (Inizan et al. 1999: 130).

- **Blade**: A specialized flake with relatively parallel lateral edges and a length equal to, or more than, twice the width. Cross sections can be plano-convex, triangulate, rectangular, or trapezoidal. Blades can have various arrises on their dorsal surface. Their manufacture is often indicative of a prepared core and blade technique; consequently, they are not thought of as randomly generated flakes (Crabtree 1972: 42; Inizan et al. 1999: 130-131).

- **Core**: A block or mass of raw stone material sometimes fashioned into a pre-formed shape to allow for the removal of a flake or blade. Recognizable primarily by its negative flake scars, which reflect the detachment of one or more flakes at an earlier stage and by the surface(s) on which force was applied, known as striking or pressure platforms. Cores are typically viewed as waste products because once exhausted they no longer serve a utilitarian function (Crabtree 1972: 54, 56; Inizan et al. 1999: 59, 137).

- **Crutch**: A knapping tool designed for pressure-flaking blades from a prepared core. In Mesoamerican blade-core technology, it is typically a wooden staff with a chest-rest crosspiece at the end closest to the body and a pressure tip insert (i.e. bit) at the working end near the feet. Size and construction vary (Crabtree 1972: 57; Inizan et al. 1999: 138).

- **Exhausted**: A term most often used to describe cores that are used up or wholly consumed, meaning that it appears that no more flakes or blades could be struck off. Exhaustion may be a result of step and/or hinge fractures, a reduction of platform size or angle such that predictable trajectories of force can no longer be generated, or a lack of material resulting in a core that is too small for continued reduction (Crabtree 1972: 62).

- **Feather Termination**: A termination indicative of successful blade production where the blade ends "with a minimal margin," that is thin and sharp (Crabtree 1972: 64).

- **Hinge Termination:** A result of a fracture at the distal end of blade that terminates the blade at a blunt or rounded right angle due to the premature intersection of the fracture plane. Results in a shorter than intended blade and a concave hook-like blade scar (Crabtree 1972: 68; Inizan et al. 1999: 143). It is the cause of most terminal errors in the manufacture of prismatic blades (Hirth 2002: 86).

- **Lip:** A projection found on the platform of a core that results from the bulbar scar. A concavity causing an overhang usually found on the leading edge (Crabtree 1972: 74).

- **Platform:** The table or surface area that receives the force necessary to detach a flake or blade. Can be either natural or prepared (Crabtree 1972: 84).

- **Polyhedral Core:** A core with multiple blade scars and a cylindrical or conical shape. Typically unidirectional (i.e. blades originate from a single platform) generated primarily by percussion techniques, as opposed to a prismatic blade core, which has been further reduced via pressure techniques (Crabtree 1972: 84).

- **Pre-form:** An unfinished implement that has been modified to an intended stage of a lithic reduction sequence in a specified assemblage. It should have the morphological potential for further modification (Bradley 1975: 6). A pre-formed polyhedral core is a core that is roughly prepared for later stage blade removal.

- **Prismatic Blade:** A long and narrow specialized flake with parallel arrises. Triangulate or trapezoidal in section with two or three prism-like dorsal facets (Crabtree 1972: 86).

- **Rejuvenation:** To renovate, renew, restore, re-create, or re-establish. A process used when the condition of the pressure platform of a core precludes continued flaking, so the exhausted or ineffective platform is removed and a new platform is established. May involve removing the striking or pressure platform by means of a single thick flake or of several thinner rejuvenation flakes (Crabtree 1972: 89; Inizan et al. 1999: 153).

- **Step Termination:** The result of a premature intersection of the fracture plane, possibly caused by a dissipation of force or blade collapse, which "terminate[s] abruptly in a right angle break" leaving a sharply step-like blade scar (Crabtree 1972: 93).

Methods and Techniques

The manufacturing stage of lithic technology is comprised of two factors, the method, and the technique, which work together to meld mind with body to accomplish the end goal of production. Crabtree (1972: 2) describes the method as the preconceived plan of action rooted in the mind of the knapper, a mental plan born of a systematic flaking process "based on rules, mechanics, order and procedure." Inizan and colleagues (1999: 30) echo this delineation, stating that the method refers to "an elaborate conceptual scheme" that consists of a well thought-out sequence of steps, a predetermination of action, or a cognitive map for the manufacture of stone tools. Accordingly, the technique is the bodily execution of this cognitive scheme. Techniques are the physical application of the mental methods (Crabtree 1972: 2) and in the scope of manufacturing stone tools can include the hands-on actions of shaping, flaking, and reducing the stone (Inizan et al. 1999: 30).

Methods

A discussion of the cognitive aspect of manufacture, the method, is germane to this study because the contents of this cache are peculiar; obsidian cores are the leftover waste of prismatic blade manufacture, not the desired product. Cores are not an end-goal of production; rather, they are vehicles for blade manufacture, and once they are exhausted, they are no longer of utilitarian use to a knapper. In essence, obsidian cores are trash. However, obsidian was a valuable resource and once cores were exhausted, they were often repurposed. Braswell and Glascock (2011: 126) noted that during the Terminal Classic, the Maya of Calakmul did not discard polyhedral blade cores once they were exhausted; instead, they recycled them into small *manos*, "perhaps employed to prepare pigments, spices, or other powders." At Kaminaljuyu, Chich'en Itza, and Texcoco, Kidder (1947: 29) found that cores were sometimes repurposed as "rubbing tools" like pot polishers or reamers, evidenced by rounded and polished platforms. At Piedras Negras, Tikal, Yaxha and others, many of the eccentric obsidians found in caches were made from exhausted prismatic cores while unmodified cores were rarely found in caches (Coe 1959: 30-31, Figs 21-36; Moholy-Nagy 1984: 113-114; Moholy-Nagy 1997: 297; Rice 1984: 192). What then are so many exhausted cores doing in a cache, a context typically associated with ritual, ceremony, elite status, and exotic goods, without having been modified or repurposed? Inizan and colleagues (1999: 15) claimed that knapping activities are elaborate projects. If so, one can read this cache as the result of a ceremonial project whose purpose was to create cores specifically for ritual deposition (Kidder 1947: 20), or as a utilitarian project where the cores were the byproducts of routine prismatic blade manufacture, but then deposited afterward in a ceremonial context. Alternately, perhaps they were deposited because they were leftover consecrated material that had been produced for a ritual purpose. An exploration of both method and technique helps to narrow the possibilities.

Manufacturing flaked stone tools is a reductive technology limited by mechanical constraints on technical procedures (e.g. the physics of conchoidal fractures) and the kind, quantity, accessibility, and quality of raw materials (Collins 1975: 16-17; Soressi and Geneste 2011: 337). But is also limited by "the capacities of cultures for exerting and controlling forces," meaning that emic lithic manufacture is a response to the needs of a culture and of "the choice, skill, and knowledge on the part of the artisans" (Collins 1975: 16-17). These artisans are "enculturated members of a group" (Collins 1975: 23-24) who identify processual goals based on functional needs, the available time, their own individual skill as flintknappers, and the traditional techniques of which they are aware (Soressi and Geneste 2011: 337; Wynn and Coolidge 2010: 90). With all of these considerations in mind (i.e. the methods), the Maya flintknapper(s) would have been able to move forward and use intentional and standardized (Moore 2010: 29; Soressi and Geneste 2011: 337) techniques of prismatic blade manufacture, which manifest as morphological homogeneity in an assemblage (Kuhn 2010: 109, 125).

Techniques

The techniques employed in traditional Mesoamerican prismatic blade manufacture utilized a combination of percussion and pressure flaking. Percussion techniques, where a hammer stone in one hand is used to strike a flake from a core that is held in the other hand, were used to generate the polyhedral cores that were likely pre-formed at source quarries prior to their circulation throughout the lowlands; although typically thought of as a technique used only in the initial stages of prismatic blade manufacture, percussion techniques can also sometimes be used for maintenance and rejuvenation of the core at later stages in the reduction process (Hirth 2002: 83; Hirth and Andrews 2002: 2). Pressure techniques (Figure 13) involved placing a pressure tool (e.g. a chest or shoulder crutch) on the margin of a core's platform (either natural or prepared) and applying "pressing force" in order to detach a blade (Crabtree 1972: 14-15); for prismatic blade manufacture, the tip of the pressure tool should be placed in line with the ridge left from the previous blade's detachment (Crabtree 1972: 16). The blades produced from pressure techniques are narrower (i.e. < 2.5 cm wide) and more uniformly parallel than those generated by percussion techniques and can be categorized in three different series: first and second series blades have fewer dorsal arrises than the genuinely prismatic (i.e. at least three dorsal scars) third series blades (Hirth 2002: 83; Hirth and Andrews 2002: 4; Inizan et al. 1999: 78-79).

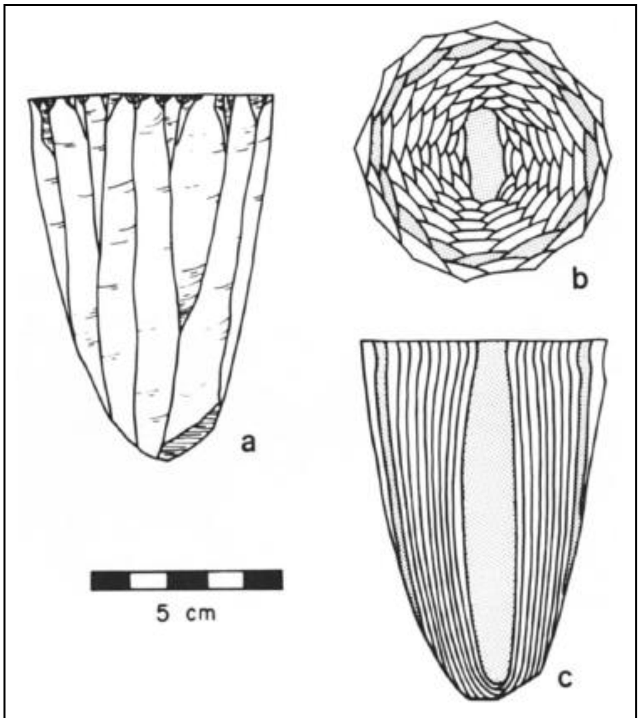


Figure 13. Illustration of the pressure reduction sequence from polyhedral core to exhausted prismatic blade core. a. polyhedral core (pre-form) prior to reduction; b. platform view of a reassembled core showing series of prismatic blades; c, cross-section of reassembled core, emphasizing the changes in core morphology that occur as blades are removed. (Clark 1984: 56)

Crabtree (1968; 1972) proposed that the pressure techniques used by the pre-Columbian inhabitants of Mesoamerica involved a crutch operated by the knapper that drove force into a core stabilized by a clamp or vice. However, Clark (Hirth and Andrews 2002: 5) has repeatedly and convincingly argued that based on the Spanish accounts of prismatic blade manufacture, there were major discrepancies with Crabtree's hypothesis that concerned "the tool used, the manner of tool use, the position of the worker, the method of securing the core, and the rate of blade manufacture" (Clark 1982: 356-357). After conducting several experiments, Clark (1982: 354, 368) proposed that a crutch with a hook was placed on the edge of a core, and prismatic blades were subsequently flaked off by pulling the shaft portion of the crutch toward the chest from a seated position; the core would have been held with the naked feet, not a vice or clamp, because pressure from the feet pushed the core securely into the ground, stabilizing it (Figure 14). Clark (1982: 372) concluded that the crutch must have measured approximately 135-150 cm in length and had a small attachment at one end that formed a hook while the other end would have been placed near the chest, abdomen, or crotch of the knapper. He found that if the tip of the hook (i.e. the bit) was carefully placed on the margin of the core platform that faced the knapper and pressure was exerted outward (parallel to the ground surface) from the chest/abdomen/crotch followed by an upward pull of the crutch toward the body, a prismatic blade was successfully removed from the core; this process could be repeated until the core was too small for the feet to stabilize it (Clark 1982: 372).

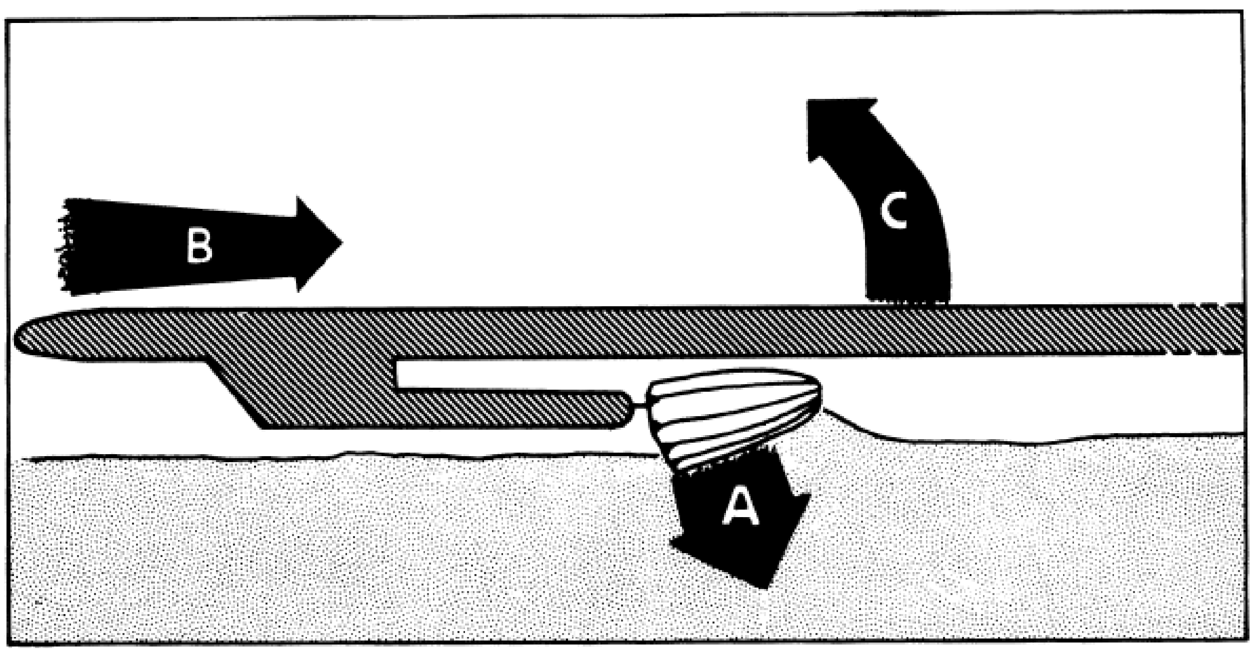


Figure 14. Representation of forces involved in prismatic blade manufacture: a. downward and outward force of feet pushing the core into a slight hollow in the ground for stabilization; b. outward force pushing the bit against the core platform from the chest; c. an upward pulling (toward the knapper) force perpendicular to force b (Clark 1982: 368)

METHOD

Macroscopic analysis of the manufacturing techniques took place in the FARES laboratory in Guatemala City over several weeks in the summer of 2013. I conducted the analysis using the obsidian cores (stored in 20 bags distributed between two boxes), digital calipers (Carrera Precision CP5906 6-Inch Digital Caliper), a handheld magnifying lens (Jewelers Eye Loupe 30x Loupe + Dual 10X-20X), and a digital scale. Analysis consisted of collecting and recording the following data from the cores (Table 6; see also Appendix A for complete data table). For the measurements, millimeters were used and in the following discussion, the measurements are rounded to the nearest half-mm. The proximal width indicates the width of the main platform of the core (determined by whichever platform had the most blade scars originating from it), the medial width was measured mid-way down the length of the core, and the distal width was measured at the end opposite of the platform, or if the core had two platforms, the one with fewer blade scars originating from it. For the data collected on platforms and ends: platform collapse was defined as a crushed edge of the platform resulting from excessive force caused by the force being directed inward, collapsing a portion of the platform, instead of downward into a blade. Platform constriction was defined as lipped margins with concavities directly beneath the platform edge.

Table 6. Data taken from the Nojpeten obsidian cores

Inventory	Artifact #, Lot/Level #, Bag # (1-20)
	Degree of Completion (whole or fragmentary)
	Refit Status if fragmentary
Measurements	Core Length (mm)
	Maximum Proximal, Medial, and Distal Widths (mm)
	Minimum Proximal, Medial, and Distal Widths (mm)
	Core Weight (g)
Platforms and Ends	# of Platforms (1 or 2)
	Main Platform Type: Flat or Angled, Natural or Ground, or Multifaceted
	Main Core Platform Shape: Circular, Oblong, or Irregular
	Main Platform Collapse (Y/N)
	Main Platform Constriction (Y/N)
	# Blades originating from Main Platform
	2nd Platform Type: Flat or Angled, Natural or Ground, or Multifaceted
	2nd Core Platform Shape: Circular, Oblong, or Irregular
	2nd Platform Collapse (Y/N)
	2nd Platform Constriction (Y/N)
	# Blades originating from 2nd Platform
	End Rejuvenation: Proximal End, Distal End, or Neither
Blade Scars	Total # of Blade Scars
	Maximum and Minimum Blade Scar Widths (mm)
	# Step, Hinge, and Feather Terminations
Patterns	Platform Groove Present
	Distal Bulge Present
Appearance of Obsidian	Black or Grey (B/G)
	Matte or Glossy/Glassy (M/G)
	Banding: Grey, Clear, None (G/C/N)
	Inclusions Present (Y/N)
	Cortex Present (Y/N)

RESULTS

Numbers and Degrees of Completion

The cache consists of exhausted prismatic blade cores and core fragments, all manufactured of obsidian. Including complete and fragmentary pieces, there are 190 cores. However, this number is likely an inaccurate representation of what was originally interred due to the fragmentary nature of some of the cores and the loosely defined boundaries of the cache deposit.

The majority of the cores are complete (n=159), meaning that the core is whole and both ends are present and identifiable as either platforms or termination points for the blades that were removed. Of the remaining 31 proximal, distal, and medial core fragments, 15 can be refitted to create 6 more complete cores (each of these was broken into 2 pieces) and 1 proximal fragment (broken into 3 pieces) for a minimum total of 165 complete cores. The remaining core fragments (n=17; those with no readily apparent refits) consist of 8 proximal fragments (includes the previously mentioned refit of 3 pieces), 8 distal fragments, and 1 medial fragment. Using these figures, the minimum number of individuals (MNI), meaning complete cores, that could have been originally interred in this cache deposit would be 173, a number reached by adding the complete core count of 165 to the distal OR proximal core fragment count of 8; it is standard to add the number of the fragments with the highest representation in the collection to generate a MNI, but in this case either the distal or proximal count is acceptable because they are equal in number. This 173 total would be an accurate MNI if it were assumed that the remaining uncounted fragments refitted to the counted fragments using additional fragments that were not found with the cache. However, due to the variable and incompatible shape and composition of the respective proximal, medial, and distal core fragments (i.e. they do not refit to one another), it is likely they each represent an individual complete core, distinct from one another and all others in the cache, so the actual number of cores that were originally interred with the cache may be higher than 173. Assuming that none of the 17 remaining core fragments refits to one another, there is a maximum possibility of 182 cores (165+8+8+1=182) that were originally a part of the cache. Thus, the actual number of individual cores represented in the cache is somewhere between 173 and 182.

Excavation information reveals that some of the 190 cores and core fragments were removed from Lots 11 and 12 before the core concentration was recognized as an intentional deposit; the excavation notes indicated that excavators realized they had encountered a cache at the end of Lot 12 and at the beginning of Lot 13. Accounting for spatial discrepancies from these earlier lots adds another dimension to the estimation of the number of cores originally interred. There are three cores listed as coming from Lot 11, two complete cores and one barely recognizable (due to its small size and shattered nature) medial fragment of a core. Lot 11 spans a depth of 32 cm, and there is no indication of where these three cores and core fragments were specifically found within the lot; additionally, considering that the shattered medial core fragment was the only medial fragment found, it is unlikely it was intentionally deposited as part of the cache. However, the remaining two complete cores from the level do fit the profile of the remainder of the cache, so it is likely they were excavated near the transition point between Lot 11 and Lot 12 and are an intentional part of the cache. Based on these assumptions, the maximum possible number of cores is reduced from 182 to 181 and the likely cache count now ranges between 173 and 181. In Lot 12, the lot beneath Lot 11, which spans a depth of 20 cm, there are 10 cores listed in the artifact counts: eight complete cores and two core fragments (one of which refits to another core fragment in Lot 13). Like those encountered in Lot 11, the specific locations of these 10 cores within Lot 12 are not documented so it is difficult to say with confidence, which should or should not be included in the cache count. Considering that all but one of the core fragments found in Lot 12 were complete (or could refit to another fragment to become complete), it is possible to speculate that perhaps that lone proximal fragment may not have been a part of the original cache, further reducing the maximum number of cores from 181 to 180. Because of the targeted nature of the excavation of Lot 13, all 177 cores and core fragments found in that level were likely intentionally deposited as part of the cache.

All of this number crunching and speculation gives a probable range between 173 and 180 for the intended core-count of the cache. Given that there is a Maya precedent of caching items in quantities that have numerological significance (Morley 1956: 523), I think the likely number of unique cores originally deposited in this cache was 177, 178, or 180, due to those numbers' particular importance to the Maya (Fitzimmons 2009: 97-98; Mckillop 2004: 212; Milbrath 1999: 25-26; Morley 1956: 578; Pharo 2014: 193-194, 196; Schellhas et al. 1904: 116, 201; Sharer and Traxler 2006: 116-117). Alternatively, if all 190 cores and core fragments were intentionally deposited as part of the original cache, and those fragments that do refit together were already broken prior to deposition so that they would have been counted and interred as individual specimens, it is still possible to argue for numerological significance. The 177 that were excavated from the lowest level, Lot 13, could represent the 177 days of the lunar cycle (Milbrath 1995: 69-70; Morley 1956: 578; Schellhas et al. 1904: 116, 201; Sharer and Traxler 2006: 116-117); the remaining 13 cores and core fragments excavated from Lots 11 and 12, which were found above the 177, may also be ritually significant because of the number 13's association with celestial levels and the 260-day calendar (McKillop 2009: 213; Morley 1956: 523; Rice 2009: 59).

Obsidian Quality

Determination of obsidian quality is necessarily a subjective endeavor because it depends on macroscopic factors of appearance as well as the presence or absence of inclusions within the extant material of the core; thus biasing the determination of quality because it is impossible to know whether there were inclusions in the larger parent material the cores were knapped from and judging appearance is not an objective skill. Additionally, the human factor is an important one when assessing quality of material because as Crabtree (1972: 4-5) noted, even though the first concern of the toolmaker may be to obtain "good" lithic material, the skill of the worker ultimately governs the shape and functional performance of the tool; that is to say, it is possible to find good work on lower quality material and poor work on higher quality material. As a result, a determination of quality is plagued by a multiplicity of factors.

Given that macroscopic techniques are subject to the biases of visual acumen, in assessing the appearance of the core material I chose two generalized categories that I thought would be the most inclusive (broad in definition) and objective so that the results might be replicable if performed by other analysts. The cores' appearance is defined as either "matte" or "glossy." The cores exhibit a range from the dully granular and lackluster at the most extreme representative of "matte" to the smooth homogeneity and glass-like reflective shine of the most lustrous in the "glossy" category. The assumption made here is that those that appear "matte" are likely more granular and have a lower silica content, making them lower quality and less desirable for knapping. Conversely, those cores that appear "glossy" would likely have a more cohesive matrix due to their higher silica content, creating more predictable fracture planes and sharper edged tools, and thus be of higher quality and more desirable for knapping.

Examining aesthetics to determine which obsidian type would have been more culturally desirable, "matte" or "glossy," is not the aim of this categorization of quality, as the data do not lend themselves to the more nuanced question of wholesale desirability. The categorization system used here examines only the technological suitability for knapping. However, due to the more reflective nature of glossy obsidian which lends itself to use as mirrors (Healy and Blainey 2011: 229; Heyden 1988: 217; Saunders 2001: 224; Sharer 2006: 180), often found in elite contexts both archaeologically and in depictions of courtly life in Mesoamerica, I would venture a guess that glossier obsidians were more valued for both their technological suitability as well as their culturally appreciated aesthetic qualities.

Of the 190 pieces of stone in the cache, 73 are categorized as "matte" and 117 as "glossy." Using these categories as determinations of quality, 38.4% of the cores are made of lower quality obsidian and 61.6% of higher quality. When looking only at definitively complete cores in the collection (n=159), 59 are categorized as "matte" and 100 as "glossy" for a similar percentage of 37.1% lower quality and 62.9% higher quality. However, these ratios do not necessarily correlate with another factor in the determination of obsidian quality: the presence or absence of inclusions.

Inizan and colleagues (1999: 23) stated that the most important quality in suitability for knapping is homogeneity. Inclusions, foreign bodies that reduce the homogeneity of the lithic material (Crabtree 1972: 70) - such as saccharoid nodules, crystals, or bubbles - create cracks and impurities within the raw material that can render an outwardly desirable stone unworkable. Inclusions within the obsidian matrix disrupt the predictable conchoidal fracturing necessary for controlled knapping; consequently, the higher the frequency of inclusions, the lesser the quality of the stone, which likely lessens its suitability for the production of prismatic blades, a relatively uniform product. The lowered suitability of an inclusion-ridden stone is due to the probability of a higher frequency of errors during the knapping process, most notably an increase in hinge fractures (Hirth and Andrews 2002: 7); hinge fractures result in an asymmetrical and interrupted core surface that affects not only the halted blade produced during the initial error, but also subsequent blade removals.

The cores of the cache contain few inclusions. Only 9.4% (n=18 of the 190) of the cores and core fragments are marred by inclusions (8.9% if the two fragments with inclusions that refit together are counted as one core). Aside from the refitted fragments, which are assumed to have been complete at interment, there are only two fragments, both proximal, that have inclusions. These two fragments (F09A.13.64/173 and F09A.13.64/156) both broke at the inclusion point in a hinge fracture and do not refit with any other core fragments found in the cache. The number of hinge fractures evident on the blade scars on the faces of the cores with inclusions range from 0 to 7, with an average of 1.8 hinge fractures per core, higher than the average of 1.2 hinge fracture per core with the total core count. When compared to the average number of blade scars, the frequency of hinge fractures in cores with inclusions is still higher. There is an average of 13.8 blade scars per core in the total cache group and an average of 13.5 blade scars per core in the group of cores with inclusions, which results in a ratio of 1.2/13.8 (.09) for the total cache and 1.8/13.5 (.13) for the cores with inclusions.

One might expect that if the lower quality category was all-inclusive, that there would be a positive correlation between the “matte” obsidians and a higher number of inclusions. However, of the 18 cores with inclusions, only four of them are categorized as “matte,” the remaining 14, the overwhelming majority, are “glossy.” This result could indicate several different things: (1) there is no positive correlation between observably “matte” obsidians and a higher frequency of inclusions; (2) there may be a positive correlation but there are more “glossy” cores than “matte” ones deposited in the cache so the ratios are skewed toward “glossy;” or (3) the sample size is too small to generate a statistically significant pattern. The higher number of "glossy" cores in the cache may in actuality indicate that there are fewer "matte" cores with hinge fractures in the cache not because they fractured less often and were thus of higher quality, but instead that they fractured more often, and thus were unsuitable for deposition with the higher quality "glossy" cores designated for caches.

Inizan and colleagues (1999: 23) made the generalization that the more glossy a rock, the greater its suitability for knapping, regardless of the rock's granularity since percussion knapping allows large blades to be predictably struck even in granular material. However, the majority of these cores appear to have been knapped by pressure techniques. Application of force via pressure techniques are more affected by granularity as the concentrated force travels better through a more cohesive matrix.

Measurements

Including all 190 cores and core fragments, the lengths range from 16 mm to 98 mm with an average core length of 55.6 mm; however, if only the 159 complete (unbroken/non-fragmentary) cores are included, the lengths range from 29.5 mm to 98 mm with an average core length of 58.8 mm. The proximal widths of the cores range from minimums between 2.67 mm and 20.5 mm and maximums between 4.26 mm and 29.5 mm (no difference in the ranges between complete and fragmentary cores). The medial widths of the cores range from minimums between 7.5 mm (6.5 mm including fragments) and 20 mm and maximums between 8.5 mm and 33 mm. The distal widths of the cores range from minimums between 1.5 mm and 14 mm and maximums between 2 mm and 19 mm (no difference in the ranges between complete and fragmentary cores). Including all 190 cores and core fragments, the average minimum proximal width is 7.8 mm and the average maximum proximal width is 11.2 mm. The minimum and maximum averages for medial widths are 12 mm and 14.3 mm and the minimum and maximum averages for distal widths are 6.4mm and 7.6 mm respectively. For all 190 cores and core fragments, which all together weigh 2548 g, the range in weights is between 2 g and 70 g, with an average weight of 13.4 g; if only the 159 complete cores are included the range in weights shifts to between 3 g and 70 g, with an average weight of 14.1 g.

Shape

Crabtree (1968: 455) noted that "polyhedral cores have numerous variants and do not have to be necessarily cylindrical in section" and this appears to hold true for the cores in this cache. The majority of the cores and core fragments are generally cylindrical in section but range between fully cylindrical and relatively rectangular. I did not differentiate between cylindrical and rectangular because there was a substantial amount of overlap between them, which would make any attempt to differentiate between them an overly arbitrary one. Additionally, the cylindrical and rectangular cores are both products of almost exclusively pressure flaking techniques. Consequently, I chose to group them together; this shape group (Figure 15) makes up 154 out of the 190 cores and core fragments for a percentage of 81%. The remaining 36 cores and core fragments are categorized as having a half-conical shape (Figure 18), and they make up 19% of the cores of the cache. In this assemblage, the half-conical shape is most often a product of blade scars that indicate both percussion and pressure techniques resulting in large, wide, irregular blade scars on one-half of the core and uniformly narrow and parallel pressure blade scars on the opposite face. This shape is also a result of one face of the core having been left covered in cortex while the opposite face was uniformly flaked as evident by the parallel blade scars. Crabtree (1968: 455) encountered this type of cortical half-conical core at the Museo de

Antropologia Nacional in Mexico City, about which he wrote, "I saw much evidence of blades removed from just one side of an irregular piece, or pebble, of obsidian. Evidently, the worker had found a piece of stone with natural ridges and had simply removed blades from one side of the stone. It is not uncommon to still find exhausted cores that retain the original surface cortex on the base and on one or more sides, indicating that blades were removed from one or more faces of the pre-formed core but not around the entire perimeter. This suggests incomplete core preparation, or the use of naturally tabular pieces of obsidian."

Platforms

Crabtree (1968: 457) categorized the platform surfaces of cores into five different types of flat surfaces, differentiating them by the various preparatory actions that were used on them like scratching, multi-flaking, leaving natural cortex on the surface, grinding, and abrading; he concluded that all of these treatments of the platform were done to prevent slippage of the pressure tool during blade removal. While informative, this list does not adequately represent the range of platform types that are evident in the cache. Trachman (2002: 107) offered a more comprehensive and useful list of platform surface types from her experiences at Dos Hombres that are more applicable to the Nojpeten cores. The classifications that I used correlate with some of the categories Trachman (2002: 107) identified, and are included in Table 7 below.

Table 7. Platform Types

Flat Natural (FN) or Angled Natural (AN)	the single-facet or simple platform, prepared by creating a single-facet or smooth, flat surface
Multi-flaked (MF)	the multifacet platform, prepared with two or more facets usually by the removal of two or more flakes to prepare or rejuvenate the platform
Flat Ground (FG) or Angled Ground (AG)	the ground platform consisting of a pecked-and-ground platform surface
Platform Collapse and/or Constriction	the crushed (or shattered) platform, consisting of an undetectable platform that was obliterated during the blade removal process

The first noticeable difference in core platforms was the number of platforms each core had. The number of platforms was determined by looking at the direction of the compression waves, or ripples, in each of the blade scars; the ripple patterns indicated which side of the core the blades had originated from (i.e. their striking platform) and indicated if the core was unidirectional or bidirectional (Crabtree 1972: 38, 97). Recording the number of blade scars originating from each end of the core allowed me to determine how many platforms each core had, as well as which end had been the primary or main platform in the final reduction stages, defined as the end with the majority of the blade scars emanating from it. The majority (n=153) of the cores, 80%, had only one platform, meaning all apparent blade scars originated from the same end of the core. The total number of blade scars on cores with one platform ranged from 7 to 23, with an average of 13.6 blade scars. The remaining (n=37) cores had two platforms, meaning 20% of the cores in the cache had blades struck from both ends of the core, making them bidirectional (Figure 15). Of the 37 cores with two platforms, the number of blades originating from the main platform ranged from 5 to 18, with an average of 10.2 blade scars. The number of blades originating from the second platform ranged from 1 to 8, with an average of 3.8 blade scars, substantially less than the blades that originated from the main platform. The total number of blade scars on cores with two platforms ranged from 8 to 21, with an average of 14 blade scars. Both the range of the number of blade scars (7-23 and 8-21) and the average number of blade scars (13.6 and 14) were similar between cores with one platform and cores with two platforms.

Figure 15. Exhausted cylindrical prismatic blade core with two platforms from Nojpeten (photo by McArdle 2013).

There are varieties of platform types used in prismatic blade manufacture; they can be prepared in multiple ways depending on the needs/skills of the knapper and the physical properties of the stone. Platforms can be made by removing one or more flakes via percussive techniques, by abrading a core surface, by intentionally flaking to create a desired angle, or by removing weaker lipped areas to strengthen the striking or pressure surface (Crabtree 1972: 12). For the Nojpeten cache, platform types were categorized into the groups listed in the above table (Table 7). Ten of the 190 cores have no listed platform type because they are either medial or distal fragments; accordingly, they are not included in the discussion and the following percentages are generated using 180 as the total number of cores.

Platforms designated as flat natural have a horizontal plane with no apparent subsequent preparation (e.g. grinding, polishing, faceting, etc.). No cores in the cache have a flat natural main platform, and only one core has a flat natural second platform. This core is a proximal fragment that appears to have been broken in half at a clean hinge break, it was then pecked and scored along one lateral face of the core (near the margin of the platform, but not on top of it) and then one blade was struck from it before it was discarded. Flat natural surfaces may not have been a desired platform type for prismatic blade manufacture, as the only evidence of one seems to be an experimental strategy that attempted to salvage a core that had already broken. Like the flat natural platform type, angled natural platform types also lack preparation, but they do not have an even horizontal plane; this type is similarly scarce in the Nojpeten cache. They make up only 6% (n=11) of the main platform types, and for those cores with two platforms, only 10% of the second platform types (n=4). Unmodified, or natural, platforms are uncommon in this cache.

Platforms that were pecked and ground (Figure 16) make up the overwhelming majority of this cache, bolstering its dating to the Postclassic, as pecked and ground platforms are highly characteristic of this period (Braswell and Glascock 2011: 126; Clark 1985: 9; Hirth 2002: 84; Rice and Rice 2009: 335; Titmus and Clark 2003: 92; Trachman 2002: 107). Pecking and grinding the platforms prior to flaking, likely done with an abrasive stone in one hand or by grinding the platform in a circular motion against a groundstone, had many advantages: it strengthened the platform, prevented the slippage of the pressure tool during blade removal, allowed for larger blades to be flaked off, reduced the force necessary to induce fracture, reduced the frequency of platform collapse, facilitated the use of bits (e.g. bone and antler), and increased the efficiency of prismatic blade production while simultaneously reducing the skill required in the final stages of blade making (Clark 1985: 9, 12; Crabtree 1972: 8, 12, 68, 84; Flenniken and Hirth 2003: 104; Hirth 2002: 89; Inizan et al. 1999: 129, 154; Rice and Rice 2009: 335; Titmus and Clark 2003: 92; Trachman 1999: 122-123).

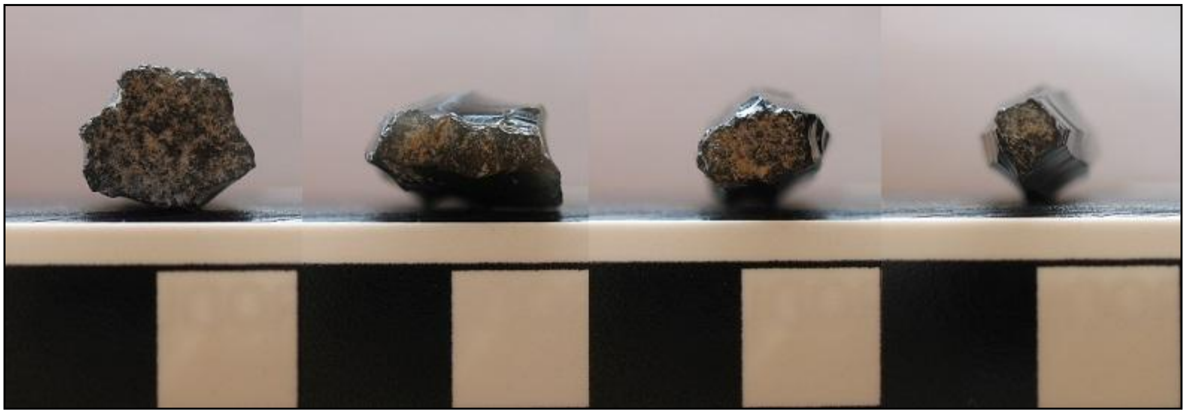


Figure 16. Pecked and ground platforms in the Nojpeten cache (photo by McArdle 2013).

Of the 180 cores and core fragments with discernible platforms, 160 of them have their main platform as either flat ground or angled ground, representing 88.8% of the cache. For the cores with two platforms, approximately 61% (n=23) have either a flat or angled ground platform. Clearly, the preference in this cache was for pecked and ground platforms. Additionally, differentiating between flat ground and angled ground suggests a preference for flat ground over angled ground platform surfaces because 149 of the 160 cores (~93%) with a ground main platform have a flat ground platform, only 11 were angled and ground. Similarly, in the cores with two platforms, only 4 out of the 23 second platforms (17%) are angled ground; the majority (n=19) have flat ground platforms, representing 83%. It is likely that a flat ground platform was the ideal because the topographic differences inherent in an irregular or angled platform can adversely affect blade removal. In fact, Clark (1985: 9-12) proposed that the most important attribute of Postclassic platforms may have been their flat surface, over that of their ground surface because a uniformly flat platform enables a flintknapper to establish a rhythm of rotating the core and removing blades, knowing that if he maintained a constant angle between the tool and platform and used the same force, blades would fly off the core cleanly. Titmus and Clark (2003: 92) similarly concluded, “natural-, multi-, and single-facet platforms create problems for blade removal because of surface irregularities. In contrast, the pecked and ground platform offers a flat, undistorted surface," which is ideal for prismatic blade manufacture.

Three cores in the cache appear to have an incised linear groove medially bisecting their main platform (Figure 17). It is not readily apparent what these grooves signify. Crabtree (1972: 8) noted that stones were sometimes used to sharpen the tips of pressure tools and punches, and that continual use of the abrasive stone would form a groove of a distinctive pattern; however, obsidian is not typically considered an abrasive stone and it seems unlikely that a platform of an exhausted core would be used for sharpening. Another possibility is that these cores may have been used as bit pressure tools, the groove perhaps aiding in securing it within the crutch; Clark (1985: 3-4) noted that "a small, exhausted blade core would be the ideal shape and size for a bit" and that when used in this fashion "the only damage…to the obsidian bit [would be] slight pitting." The distal ends of all three cores exhibit what appears to be grinding or pitting, which may indicate that they were used as bits after they were exhausted.

Figure 17. Cores with platform grooves. From left: F09A.13.64 - 97, 59, and 28 (photo by McArdle 2013)

While assessing the core platforms, I noted lipping (i.e. overhang) around the platform margin on 135 of the 190 cores, and subsequently categorized the cores with this feature as having platform constriction, a projection of the pressure platform over the negative bulbs underneath (Inizan et al. 1999: 147). Although platform constriction can sometimes occur as a natural part of the pressure flaking process when force is directed inward before traveling longitudinally down the face of the core, there were several half-conical cores in the Nojpeten cache whose platform constriction was reminiscent of a rejuvenation technique Trachman (1999) noted in the cores of Dos Hombres in Belize. Trachman (1999: 19) noticed that on the polyhedral cores in her collection "with pressure blade scars only partially around the perimeter [there were] certain abraded areas on the proximal end," a pecked and scored area that was not found on the prismatic blade cores with blade scars on all sides. She noted that this area occurred "around the core's circumference on or near the platform, following a line generally perpendicular to its long axis [and ranged in width] from less than 1mm to more than 5mm" (Trachman 1999: 122). Because obsidian lacks a natural plane of weakness (i.e. cleavage), Trachman (1999: 123) suggested that the pecked and scored area near the platform margin was an intentional strategy employed to create an artificial plane of weakness that would aid in directing the removal of blades and/or serve as a platform rejuvenation technique when a platform became too small for continued use (Crabtree 1968: 457; Trachman 2002: 116). Several half-conical cores from Nojpeten appear to have been rejuvenated using this pecked and scored technique (Figure 18), and these same cores appear to have had their cortical faces (Figure 19), which lacked prismatic blade scars, pecked and ground. It is unclear what advantage pecking and grinding the cortical face of the cores would have provided, but one possibility is that it may have made the cores easier to stabilize during the knapping process.

Figure 18. Half-conical cores from the Nojpeten cache that exhibit platform constriction similar to Trachman's (1999) proposition of a pecked and scored area for the cores of Dos Hombres (photo by McArdle 2013).

Figure 19. Opposite face, with pecked and ground cortex, of half-conical cores from the Nojpeten cache that exhibit platform constriction (photo by McArdle 2013).

Another rejuvenation technique utilized with these cores was what is known as either an *outrepasse* (meaning to exceed or go beyond) plunging technique that would remove a flake "over and beyond the opposite margin," typically removing a large section of the distal end of the core (Crabtree 1972: 12, 80; Inizan et al. 1999: 149-151). Plunging could have been either accidental or intentional; but either is indicative of working the cores until exhaustion. If intentional, it is done to refresh the distal end to accommodate further blade removal and if accidental, it likely occurred because as the core is "worked until it is spent" it gets progressively smaller and flakes less predictably (Inizan et al. 1999: 76-78). The use of plunging, pecked-and-scored lines, and two platforms in 20% of the cores (all rejuvenation techniques) seems to indicate that extending the use-life of the cores was a priority.

Perhaps the most unusual example of rejuvenation in the collection is found in a half-conical core, sourced to Ixtepeque, which looks as if it was a polished tool (perhaps an ax-head or celt) prior to being flaked into a core. The type of polishing that is apparent on the lateral face of the core without blade removal scars (Figure 20) looks like it is the remnant of the finishing stages of an attempt to intentionally smooth and shape a tool (Crabtree 1972: 84; Inizan et al. 1999: 151). However, after consulting with John Clark (personal communication, 2014), he suggested that the artifact appears to have also been polished after it was flaked saying that "the polish was posterior to the initial flaking because it decapitates the fissures that turn up from the crest or ridge." In the left side of Figure 20, note the two kinds of polishing extant on the core: the upper half just above the central arris with a polish of diagonal striations and the lower half that appears to have been polished with more gusto because the striations are multidirectional and the surface is smoother.

Figure 20. Two opposite lateral faces of core F09A.13.64/115. Left: evidence of two polished areas. Right: prismatic blade removal scars (photo by McArdle 2013).

Another pattern of note in this cache was represented by cores that seemed to have what I termed a distal bulge, a slight expansion of width in the body of the core toward the lower distal portion of the core (Figure 21). Rovner (1978: 126) noted a similar pattern at Mayapán, although he described it as a medial bulge; he concluded, “the thickness of the bulb and the curvature of the detached blades eventually create a medial bulge or ‘barrel’ effect on the core. At some point, the placement of the detaching tool on the more rapidly shrinking platform is resisted by too great a mass of core in the medial section to detach blades successfully.” Perhaps the burgeoning barrel effect Rovner noted on the cores from Mayapán was responsible for the premature terminations of the blades evident on the Nojpeten cores with bulging distal ends.

Figure 21. Examples of cores from the Nojpeten cache with bulging distal ends (photo by McArdle 2013).

Blade Terminations

When pressure-flaking blades, the quality of the raw material and the amount and angle of the exerted force combine to either successfully or unsuccessfully remove a blade; the terminations (i.e. distal ends) of the blades and their equivalent blade scars can indicate whether the blade removal was successful (i.e. feather termination) or errant (hinge or step fracture terminations), which in turn can reveal additional information about the skill of the flintknapper (Crabtree 1972: 12). Feather terminations are indicative of successful blade production where the blade ends “in an edge, with a minimal margin,” which can be very thin and sharp (Crabtree 1972: 64). Hinge terminations are a result of a fracture at the distal end of blade that terminates the blade at a blunt or rounded right angle due to the premature intersection of the fracture plane, resulting in a shorter than intended blade and a concave hook-like blade scar (Crabtree 1972: 68; Inizan et al. 1999: 143); these kinds of fractures are the cause of most terminal errors in the manufacture of prismatic blades (Hirth 2002: 86). Step terminations are similarly the result of a premature intersection of the fracture plane (e.g. possibly caused by a dissipation of force or blade collapse), but these “terminate abruptly in a right angle break at the point of truncation” leaving a sharply step-like blade scar (Crabtree 1972: 93).

The cores in the Nojpeten cache had on average 13.8 blade scars per core; these blade scars were categorized into the three termination types discussed above and the results show that on average there were 12.4 feather terminations per core, 1.2 hinge terminations per core, and .2 step terminations per core. The overwhelming majority (~90%) of the blade scars in the Nojpeten cache ended in feather terminations, indicating that prismatic blades were removed with a high rate of success. The frequency of blades ending in hinge terminations is notably small when comparing across assemblages. For example, the cores at the highly specialized prismatic blade workshops at Teotihuacan averaged 1.0 hinge fractures per core, while the cores at Xochicalco averaged 1.7 hinge fractures per core; both rates are considered low and thus indicative of highly specialized and skilled knappers (Hirth 2002: 86). With its low rate of hinge fracture at 1.2 per core, and only 1.4 errant terminations per core when the step fracture rate is added, the Nojpeten cache appears at first glance to have been created by a skilled knapper or group of knappers. However, upon closer inspection, the low rate of errant terminations is not an accurate representation of the cache, which actually exhibits a great deal of variability in skill of execution. For example, 44% (n=84) of the cores in the cache have perfectly executed feather terminations on every apparent blade scar, indicating that whoever created them was highly skilled. If we include cores that have only 1 or 2 errant terminations (step and hinge included), that adds another 66 cores, increasing the percentage of cores likely created by a skilled knapper from 44% to 81%. That means that 19% of cores (n=36) had three or more errant terminations, with some as many as 8 or 10 per core. All three sources (Ixtepeque, SMJ, and El Chayal) are represented relatively evenly in both the 81% of the cores produced with a high rate of successful blade removal and the 19% of cores with a lower success rate. These results seem to indicate that the cores in the Nojpeten cache were created by more than one individual and that the skill levels of the knappers involved in their production varied.

ANALYSIS

In sum, the 190 cores and core fragments from the Nojpeten cache exhibit several notable traits: an adherence to the pecked and ground platform modification technique that is highly characteristic of the Postclassic period throughout the Maya lowlands, a high degree and variety of rejuvenation techniques (e.g. two platforms, pecked and scored platform constriction, plunging at distal ends, recycling of a polished tool), very small sizes with the majority exhausted (i.e. no more blades could be removed), the utilization of a variety of obsidian qualities from a variety of sources, and a significant gap in the skillful execution of blade removal (81% skilled, 19% errant). Combined, these traits indicate that these cores were maximized to their full blade production capabilities regardless of obsidian quality or knapper skill level; this could be due to a shortage of obsidian in the region, or a perception of obsidian as a resource not to be wasted for reasons other than accessibility, or perhaps these cores were the product of an instructional event, a suggestion put forth by Titmus and Woods (1992) and bolstered by the wide range in blade removal skill extant in the cache.

A look at production efficiency estimations can provide a better picture of the labor investment and production output associated with the production of these cores. Sheets and Muto (1972: 632) conducted an experiment in which they were able to remove 83 blades from a pre-formed obsidian polyhedral core that began at a weight of 820 g and length of 12.7 cm and after 2.5 hours of pressure flaking was declared exhausted at 50 g and 8.2 cm long. They acknowledged that the prismatic blades produced in the Maya lowlands were consistently thinner and narrower than the ones produced in their experiment, so they hypothesized that the average 700 g pre-formed polyhedral core could produce anywhere between 200-300 roughly 3-cm long prismatic blades (Sheets and Muto 1972: 633). Clark (1989: 319) proposed that approximately 200 or more blades could come from one core, but that not all of them would be of suitable quality for use; so, a reasonably conservative estimate would be that one core could produce approximately 100 usable blades in about two hours. Taube (1991: 61) echoed the estimate of 100 or more prismatic blades per pre-formed polyhedral core, but guessed that it would take even less time, only an hour. Using an average of these production estimations, 150 prismatic blades per core at a rate of 1.8 hours per core, and the minimum (n=173) and maximum (n=182) numbers of cores that may have been originally interred in the cache, it is reasonable to conclude that somewhere between 25,950 and 27,300 prismatic blades were produced from these cores and that it would have taken somewhere between 311.4 and 327.6 hours. In other words, it would take one individual almost two weeks to produce this cache if he were working a full 24 hours a day; this is clearly impossible, but it demonstrates that there is a substantial time and labor investment in producing this cache and if this cache was produced by one person, it would have been the result of several months of work. More likely, this cache represents the combined efforts of multiple knappers, and while I do not think it is the product of any single instructional event, it is possible that these cores represent the culmination of a series of instructional events involving multiple instructors and students.

Regarding the Nojpeten cores' small sizes and the evidence of multiple rejuvenation techniques resulting in their exhaustion, a comparison with similar patterns found at the Late Classic site of Xochicalco in Mexico might prove illustrative. Obsidian was a scarce resource for Xochicalco; excavations indicated that obsidian pieces were imported as pre-formed prismatic blade cores, instead of larger polyhedral cores, from sources over 200 km away (Hirth 2002: 81-84, 87). Hirth (2002: 81-84) proposed that the importation of "small, used and re-worked prismatic cores," evidenced by cores that "were completely exhausted, broken, or recycled" with evidence of "multiple platform rejuvenations," was an indication of an "economizing production strategy designed to maximize the usage of a scarce commodity." The cores from Nojpeten came from obsidian sources in the Guatemalan highlands, all at distances greater than 400 km, making their distance traveled almost twice as far as those of Xochicalco.

Because of the inordinately small size of the exhausted cores at Xochicalco, Hirth proposed an alternate prismatic blade manufacturing technique for cores that were less than 8 – 10 cm in length; he suggested that these cores were likely the products of a handheld technique rather than the previously discussed foot-held technique (Flenniken and Hirth 2003: 98-99; Hirth 2002: 86-87). Hirth (2002: 86-87) argued that use of a handheld technique was more likely because: (1) "as cores decrease in size they become difficult to hold in the feet without some supplemental way of …stabilizing them;" (2) "the handheld technique not only would have required the production of short cores but it also would have favored the use of pecking and grinding to prepare platform surfaces…for the easier removal of long blades;" and (3), while it is possible "to remove blades from cores as small as 2 cm in diameter using a modified foot-held technique, there are some cores in [the Xochicalco] collection that have diameters of.5 to 1 cm, which…would have been impossible to reduce using anything other than a handheld technique."

A drawback to this theory is that there are no corroborative ethnohistoric descriptions of handheld prismatic blade production; however, Flenniken and Hirth (2003: 98-99) maintained that "it is the most likely solution to working with small cores" because "hand strength and dexterity make it possible to stabilize small cores while applying pressure with a hand-held pressure tool" and because the exhausted cores from Xochicalco, which average only 4.95 cm in length and 1.11 cm in diameter, could not have been produced using traditionally proposed foot-hold techniques.

Similarly, of the complete Nojpeten cores (n=159), their length averages 5.88 cm and their average proximal diameter ranges from 0.76 cm to 1.11 cm (using minimum and maximum proximal width measurements). The shortest complete core in the Nojpeten collection is 2.95 cm (F09A.13.64/153) and the longest is 9.82 cm (F09A.13.64/90). The shortest proximal platform diameter in the Nojpeten cores measures 0.27 cm (F09A.13.64/76) and the widest diameter measures 2.05 cm (F09A.12.63/15). These measurements demonstrate that the Nojpeten cores are on average even smaller than the cores from Xochicalco, which may indicate that they were manufactured in a similar fashion, possibly via handheld techniques.

IV. DEPOSITION

Overview of Nojpeten and the Itza Maya of the Central Petén Lakes Region

Nojpeten, the ancient capital city of the Postclassic Itza Maya, is located on the island of Flores, the current capital of the Petén Department of Guatemala (Cecil 2013: 186; Figures 2 and 22-24). A relatively small and roughly circular island, Flores measures approximately 375 meter (m) east-west by 400 m north-south, and is only 500 m across at its widest point (Henderson 1997: 59). The island is located within Lake Petén Itza, a large lake in the center of the southern Maya lowlands that is shaped like a crescent moon and measures approximately 32 km east-west by 5 km north-south (Reina 1966: 16). Lake Petén-Itza is part of the central Petén lakes region, an area of uninterrupted Maya settlement that spans at least two millennia; this region includes "lakes Sacnab, Yaxha, Macanche, SalPetén, Petén Itza (including the small lakes of Quexil and Peténxil), and Sacpuy" (Rice and Rice 2004: 125). Archaeological evidence suggests that this region was "a center [or] cross-roads, the nexus of transitions both geographic (from east to west, and north to south) and temporal (from Classic to Postclassic)" (Rice and Rice 2004: 125-126). Flores, while not originally joined to the mainland, is now connected to the southern shoreline town of Santa Elena by a causeway that was built on the foundation of a smaller rock-outcrop to the south of the main island (Chase 1983: 1066; Figure 23).

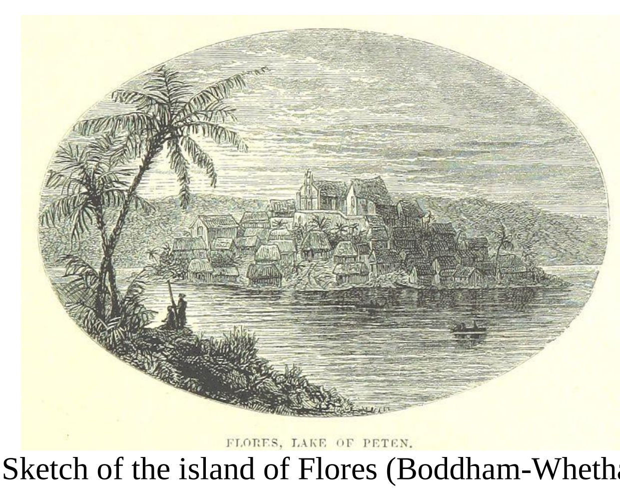


Figure 22. Sketch of the island of Flores (Boddham-Whetham 1877: 7)

Figure 23. Aerial view of Flores, Guatemala facing north (photo by Deras 2008)

Figure 24. Aerial view of Flores, Guatemala facing southwest (photo by Aroche 2008)

Nojpeten is recorded as resisting Spanish colonization up until 1697, meaning that the people of Nojpeten, the Itza Maya, remained an autonomous community for almost 175 years after the Spanish first came to the mainland, longer than any other documented Maya group (Andrews 1993: 41; de Borhegyi 1963: 16; Cowgill 1963: 4; Jones 1998: 8; Jones et al. 1981). The people of Nojpeten were conquered in 1697 by a Spanish military force under command of Don Martin de Ursua y Arizmendi (Governor General of Yucatan) and made into a penal colony the following year, in 1698 (de Borhegyi 1963: 16). However, the first Spanish accounts of Nojpeten date to much earlier and are attributed to Hernan Cortes, who first encountered the "Itza kingdom" when traveling through the central Petén lakes region in the spring of 1525 (Andrews 1993: 41; Cortes 1986: 373; Rice and Rice 2009: 43). Spanish accounts from both centuries indicate that Nojpeten was the bustling capital of the Itza Maya people, who controlled the areas to the south and west of Lake Petén Itza (Cecil 2013: 186).

Ethnohistorical sources report that the Itza people were migrants to the Southern Maya lowlands, migrating from the Yucatan Peninsula to Lake Petén Itza in the mid-15th century in response to the disintegration of Chich'en Itza and conflict with Mayapán (Cowgill 1963: 4; Jones 1998: 12-13; Rice and Rice 1984: 48; Rice and Rice 2009: 43), long after the so-called "collapse" of the Classic-era Maya (~ AD 200-900). During the Postclassic, Mayapán had emerged as an important political center in the northern Yucatan peninsula while Chich'en Itza had fallen into decline (Henderson 1997: 242-243); the societal upheavals that undoubtedly accompanied these changes were likely a major impetus in the exodus of Itza peoples into the central Petén lakes region.

However, while migration from the northern lowlands into the Petén is evident during the Terminal Classic and Early Postclassic (Rice and Rice 2004: 130), and while the Mayas' own documentary history from the books of Chilam Balam suggests the Itza left the Yucatan around k'atun eight ahau (either AD 1201 or 1458) (Cecil 2013: 186; Rice and Rice 1984: 48), there is also evidence (e.g. linguistic) to suggest that "the origin of the Postclassic lowland Maya group known as the Itza was in north-central Petén, more specifically in the region around Tikal and its allied centers near what is now known as Lake Petén Itza" (Rice and Rice 2004: 126-127). This evidence dates to centuries before their presence is noted in the Yucatan (~ AD 800) (Jones 1998: 8). If this is the case, then the Postclassic migrations of the Itza into the central Petén lakes region may represent a "return to the homeland" (Rice and Rice 2004: 127) and/or a "reestablishment [of] their capital on the 'great island' of Nojpeten" (Rice and Rice 2009: 43). Intriguing, as these ideas of a return home are, there is not much ethnohistoric or archaeological evidence to substantiate them; consequently, the following descriptions of the Itza are only representative of their settlement in the central Petén lakes region during the Postclassic period, following their likely migrations from the north.

During the Postclassic, the Itza lived in three types of communities spread throughout the "Itza core region" of the central Petén lakes area: the capital island of Nojpeten (the largest), some 40 surrounding towns, and many smaller neighboring hamlets (Jones 1998: 61). Geographically, these three Itza community types were representative of small, densely settled and nucleated Postclassic communities throughout the wider region in that they were concentrated on the mainland slopes of basins and the naturally defensible islands and peninsulas of the lakes (Rice and Rice 2004: 130). Politically, these communities were part of a complex quadripartite system of elite governance that was based on dual rulership (Andrews 1993: 56-57; Jones 1998: 60). This quadripartite system was reflected on every level of governance within the region. Jones (1998: 60) suggested that the broader Itza territory "was divided into four cardinally arranged provinces that mirrored or were mirrored by the four quarters of the capital of Nojpeten, which was, in essence, a fifth province." Beyond the Itza territory, Rice and Rice (2004: 139) identified an east-west divide between the ethnographically and socio-politically distinct Kowoj Maya to the east and the Itza Maya to the west that has its parallel in the preceding centuries in both the northern and southern lowlands; this observation led them to propose "that this might represent a new Postclassic quadripartition of the geopolitical landscape."

Like the quadripartite system, the principle of dual rulership was also reflected in multiple levels of government throughout the Itza region. Each of the four provinces was governed by a pair of rulers (known as *batabs*): a junior ruler who lived in his respective province and a senior ruler who lived in the quarter of the capital (Nojpeten) that corresponded with his respective province (Henderson 1997: 59; Jones 1998: 60). In the capital, a fifth ruling pair reigned supreme; Jones (1998: 60) claimed that these two men, likely a king and a high priest, "ruled, at least symbolically, as a single political persona, embodying dynastic rule over all of Itza territory and over Nojpeten, the political and cosmological center." The pairs of rulers in each province were likely representatives of the dominant lineage groups in the region, which may indicate that the Itza employed a small-scale version of the *multepal* (meaning joint) style government, similar to the government styles postulated for Mayapán and Chich'en Itza (Andrews 1993: 56-57; Cecil 2013: 186; Henderson 1997: 59).

It is estimated that the entirety of the Itza Maya political sphere encompassed a population of approximately 20,000 people, 2,000 of which populated the civic core of Nojpeten in an estimated 200 houses (Henderson 1997: 59; Rice and Rice 1984: 48). As the coincidental preponderance of "twos" might suggest, these figures are rough approximations based on ethnohistoric records (i.e. Spanish accounts) and as such should not be taken as absolutes. Ethnohistoric records have also complicated the naming conventions associated with the ancient capital and surrounding territory. Jones (1998: 7) noted that the Itza rulers referred to their territory as Suyuja Petén Itza, which may be translated to something akin to "Whirlpool of the Province of the Sacred-Substance Water;" however, early Spanish accounts referred to the provinces and polities belonging to the Itza by the ancestral name that gave rise to the word "Tayasal" (e.g. Tah Itza, TajItza, Ta Itza, Tayca), a name that now refers specifically to the archaeological site that occupies the peninsula directly to the north of the island of Flores (Cortes 1986: 373; Henderson 1997: 59; Rice and Rice 2009: 43). All of these variations "are apparently Hispanicizations of *ta* (or ta-aj) itza [meaning] 'at the place of the Itza'" (Jones 1998: 7; Rice and Rice 2009: 43) and may not have been what the Itza actually used as a place name. However, they did identify the island of Flores, their capital, as Nojpeten, which literally means "Big/Large Island" or "Great Island" (Jones 1998: 7). It is on this island that the obsidian core cache was deposited; thus, a more detailed summary of its layout is provided below to provide greater context for the cache.

Modern Flores is divided into four quarters defined by a north-south, east-west grid that centrally intersects at the highest point of the island, a space now occupied by the central park and the main church; this layout, with the streets connecting the cardinal points to a central plaza, is likely a survival of the original Itza Maya street plan (Jones 1998: 68-69) as quadripartition was a common feature of Maya urban planning (Rice 2004: 21). In general, Itza architecture is characterized by formal open halls, raised shrines, and architectural sculptures (Cecil 2013: 187); Spanish accounts of Nojpeten described these same architectural features in detail. Spanish chroniclers described Nojpeten as a small island, "4 blocks in diameter and 16 in circumference," that was densely packed with buildings that were divided between temples in the higher central area and houses that ringed the temples stretching all the way to the shoreline of the island (Henderson 1997: 59; Jones 1998: 68-69). The "elaborate masonry and stucco temples, palaces, and administrative halls" (Henderson 1997: 59) of the island center and the surrounding private elite residences, stylistically similar to the temples but with wooden walls and thatched roofs, were collectively described by the Spaniards as "brilliant in their whiteness" making them easily visible from about "two leagues" (~ 8 km) away (Rice and Rice 1984: 48).

The number of temples in the center of the island reported by the Spaniards varied between "12 or more" (Jones 1998: 72-73), "as many as 15" (Rice and Rice 1984: 48), and "between nine and twenty-one" (Rice and Rice 2009: 43), but all agreed that they were for the keeping and worshipping of idols. No explanatory description of the "idols" is given but it seems that only the highest ranking lords and their retainers lived on Nojpeten; consequently, the main temples were likely dedicated to "aristocratic cults and tutelary deities of the nobles" (Henderson 1997: 59). The temples were the larger structures on the island; they had thick plastered stone masonry wall foundations (possibly low platform mounds) of variable heights up to 1.75 m high whose upper surfaces served as masonry benches, presumably for participants, worshippers, and/or observers to occupy during large event gatherings, ceremonial dances, and other rituals (Cowgill 1963: 437; Jones 1998: 72-73; Rice and Rice 1984: 48). Jones (1998: 72-73) concluded that these temples served the same function as typical Maya plaza-temple complexes at larger sites. Because Nojpeten was too small to accommodate large open plazas and grand pyramids, the grouping of multiple public temples with their presumably private interior rooms accessible only to priests and their ritual objects may have been the primary locale of public ceremony on Nojpeten.

While no grand pyramids of the caliber seen in the Yucatan during the Postclassic were present on Nojpeten, the Spaniards did note that there was one principal temple, larger than any other structure, which dominated the capital from the island center (Jones 1998: 73-74). The Spanish called this temple the Castillo (the castle) because it was square at its base (~ 16.5 m wide) and it projected upward in nine terraced tiers made of stone (i.e. a stepped pyramid) that supported a castle-like construction (i.e. high masonry external walls with a flat roof) at its apex (Jones 1998: 73-74; Rice and Rice 2009: 43). Both Jones (1998: 73-74) and Rice and Rice (2009: 43) concluded that the Castillo at Nojpeten was modeled after the principal pyramidal temples (also referred to by the Spanish as Castillos) at Chich'en Itza and Mayapán because all three pyramids had square bases, nine terraces, stairways on each of the four sides, and castle-like temple structures at their respective summits. In addition to describing the layout and architecture of Nojpeten, the Spanish also mentioned that the Itza imported "salt, hard stone for grinding tools, obsidian for cutting tools, and other vital resources" making it heavily dependent on external exchange networks (Henderson 1997: 60).

Rice and Rice (1984: 51) noted that the type and distribution of structures (e.g. low platforms) found at the nearby site of Zacpeten was similar to the ethnohistoric descriptions of Nojpeten; consequently obsidian distribution there may have been similar to that of Nojpeten. At Zacpeten, Pugh (2004: 364) found that "important trade items such as obsidian cores varied positively with residence size." Pugh (2004: 364) thought that the positive correlation between obsidian cores and elite households could be due to a greater access to trade networks, more involvement in production activity, an elite desire to first obtain and then redistribute blades to the larger population, and/or because higher status individuals may have generated more waste than lower status individuals.

Overview of Previous Archaeological Work at Nojpeten

The first archaeological work undertaken in the central Petén lakes region was completed by Teoberto Maler in the first decade of the twentieth century (1908-1910); he photographed and described archaeological remains he found at several sites throughout the region, including Flores (Cowgill 1963: 5). The Carnegie Institution of Washington followed in his footsteps and conducted two seasons of fieldwork (1921-1922) on the Tayasal peninsula just north of Flores, under the direction of Carl Guthe, who never published more than brief reports on his findings, but claimed he recovered primarily Classic period archaeological material from excavations of five mounds (Andrews 1993: 41; Cowgill 1963: 5; de Borhegyi 1963: 22).

George Cowgill (1963) of Harvard University was the next to conduct fieldwork in the region in 1959. Cowgill (1963: 11) dug two test pits in the central plaza of Flores, picking this location because, as it was the central and highest part of the island, it seemed likely that it would have been the locus of the most important structures of ritual and government (as it is currently) and consequently, would likely provide rich concentrations of artifacts from all periods of occupation. According to Cowgill (1963: 71), the stone artifacts collected from these two test pits as well as from the surface were minimal. He noted that obsidian prismatic blades were sparsely scattered throughout the test pits, with usually only 0-2 in a given level; those that were found were usually fragmentary, less than 1 cm in width, and showed no signs of incising or retouch beyond ordinary use-wear. There is no mention of any other type of obsidian artifact. He speculated that much of his archaeological material might have come from temple contexts due to the unusually high concentrations of effigy incensarios and Tachis Red ceramics (Cowgill 1963: 46; Chase 1983: 1070). During this excavation, Cowgill also encountered two east-facing human skulls, which he suggested were likely cached on the east-west axis of the structure with which they are associated; similar associations between structures and human skulls are evident at Chich'en Itza (Cecil 2013: 187). This information, coupled with his discovery of Postclassic ceramics on the Tayasal peninsula and on Flores, led him to conclude that this area had belonged to the Itza Maya thought to have migrated from the Yucatan (Andrews 1993: 41; de Borhegyi 1963: 22). Ultimately, Cowgill's (1963: 509) conclusion was that there was a sizable population in the Petén dating from at least the Middle Postclassic and probably from as early as the Early Postclassic, but that these populations were substantially smaller than the levels of their Classic period predecessors.

Cowgill (1963: 437) did not excavate on Flores beyond the two previously discussed test pits but in his report he stated that one of the Maya temples "was converted into the first Christian church in Flores immediately after the conquest" and suggested that the modern day Roman Catholic church that stands east of the central park may be in the same location as that original temple. A few years after Cowgill made this suggestion, Reina (1966: 27) published an article that mentioned the discovery of "an old prehispanic wall" that was found during remodeling of the Roman Catholic church in Flores and used as the foundation of the modern church. He concluded, "Flores evidently had some important oratorio or Maya temple at its highest point and the Spanish clergy may have used it for the building of the Christian church" (Reina 1966: 27). Based on the Spanish descriptions of Nojpeten, it is possible that the modern church was built over the dismantled foundation of the Castillo.

Around the same time (February 1959), in addition to the archaeological investigations on Flores and the surrounding shorelines, underwater investigations were undertaken in Lake Petén Itza by Nelson Reed and Guillermo Mata-Amado in the areas around the islands of San Andres, Santa Barbara, Jacinto Rodriguez, Hospital Island, and at the beach along the Aldea San

Miguel and around Hobon and Nitun (de Borhegyi 1963: 19-20). Most of the underwater area they surveyed revealed a "uniform deposit of limestone…completely devoid of artifacts" but to the north and west sides of the main island they encountered an "ancient man-made talus slope of boulders which fell off rather sharply to a fairly clean bottom at a depth of about thirty feet" (de Borhegyi 1963: 19-20). Two tubular effigy incense burners and fragments of several more effigy censers were found concentrated in an area of approximately four feet in diameter at the outer edge of the man-made talus slope (de Borhegyi 1963: 20). The Postclassic materials these divers found underwater resembled the archaeological materials found by Guthe in his excavations of Tayasal decades earlier (de Borhegyi 1963: 22).

Between 1973 and 1981, Rice and Rice conducted archaeological investigations throughout the central Petén lakes region, focusing on Lakes Yaxha, Sacnab, Macanche, SalPetén, Quezil and Peténxil (Andrews 1993: 42). Their studies led them to revise the ceramic sequence because they demonstrated regional continuities in style from the Classic to the Postclassic, which challenged the prevailing idea of the time that the Itza Maya of the central Petén lakes region were exclusively migrants from the north (Andrews 1993: 42). In 1977, the Tayasal Project conducted archaeological investigations throughout the region and found that ceramics on the island of Flores differed greatly from those on the mainland; rare decorated Postclassic ceramic types (e.g. effigy censerware and polychromes) were more prevalent on Flores and appeared to date to the Early Postclassic (Chase 1983: 1070, 1081-1082). Chase (1983: 1234, 1278) concluded that the archaeological data from Flores indicated that there were substantial Early Postclassic and Middle Postclassic settlements, possibly comprised of a few buildings on raised superstructures or of huge platforms supporting low structures, but that it was impossible to tell because of the density of the modern development. Chase (1983: 1081-1082) speculated that additional excavations on the island would produce extensive Postclassic materials, but that finding a locus of pristine Postclassic stratigraphy would be difficult because of the intensive habitation of the island and its disruptive affect on the depositional patterns.

Finally, during the 1992 excavations on Flores that will be discussed in the following section, a cache of incensarios was found in the water main trench near the cathedral (Hansen 2014, personal communication), which could indicate that the center of the island held ritual significance to the Itza people.

In sum, the few and sporadic archaeological investigations of the twentieth-century revealed that Flores and the surrounding shoreline had substantial Postclassic occupation, while the recovered ceramics indicated that the island of Flores itself may have been of particular importance to the Itza Maya due to the preponderance of rare “elite/status” goods like the effigy censers similar to those found at Postclassic Mayapán (Sharer and Traxler 2006: 616-617). Ceramic evidence also demonstrated that continuities existed between Classic and Postclassic period populations (Andrews 1993: 42), which when coupled with the findings of stylistic similarities to the ceramics of the northern Yucatan, indicated that Itza culture of the Postclassic Petén was likely an amalgam of autochthonous innovation and migratory influence. More recent ceramic studies (Aimers 2007: 337; Cecil 2013) examined technological styles throughout the region and identified two distinct Maya groups (the Kowoj and the Itza) that occupied the central Petén lakes region from AD 900 to AD 1200; archaeological evidence indicates that there may have been tension between these two groups but the similarities in their respective ceramic styles indicates a steady flow of trade and communication. The combination of ethnohistoric descriptions of Nojpeten with previously conducted archaeological investigations throughout the region provides an informative contextual foundation that works to clarify the results of the subsequent 1992 excavation of the obsidian core cache from Nojpeten.

METHOD

The obsidian core cache in question was uncovered by an excavation (Operation 09-A) undertaken from August to December of 1992 by UCLA-RAINPEG/PRIANPEG's Lago Petén Itza project (Regional Archaeological Investigation of the North Petén, Guatemala Project) (Hansen 1997). According to the field report by archaeologist Judith Valle (1997: 187), this operation was located in the courtyard of the Bishop "Monseñor de Petén" Rodolfo Bobadilla Mata's house on the island of Flores, in the block bounded by the northern road, "Avenida Flores," and the road "Callejon Santa Cruz" to the east (Valle et al. 1992: 13; Figure 25). However, the eastern road on modern maps is not listed as "Callejon Santa Cruz," instead; it is listed as "Avenida Santa Ana." This block is also bounded by the central park, "Parque Central," to the west and to the south by the street "Calle 10 de Novembre/Pasaje Progreso." The bishop's house is located within the same block as, and to the east-southeast of the "Iglesia Nuestra Senora de los Remedios," the main church (Roman Catholic) in the center of the island. According to statements provided by the then Bishop and Sacristan, the courtyard had been used to plant vegetables and dispose of trash (in pits); however, no mention of archaeological material encountered while digging the trash pits was provided (Valle 1997: 189).

After mowing the lawn and clearing debris in this courtyard, Valle (1997: 189) stated that a 2 x 2 m unit was excavated to a depth of 3.55 m (Figure 26). The unit was excavated in 18 arbitrary levels, denoted as "lots" and defined in terms of the nature of the construction fill the archaeologists - Judith Valle, Renaldo Acevedo, Polo Gonzalez, Marco T. Alvarado, and Rosa Maria Chan - encountered (Valle et al. 1992: 1).

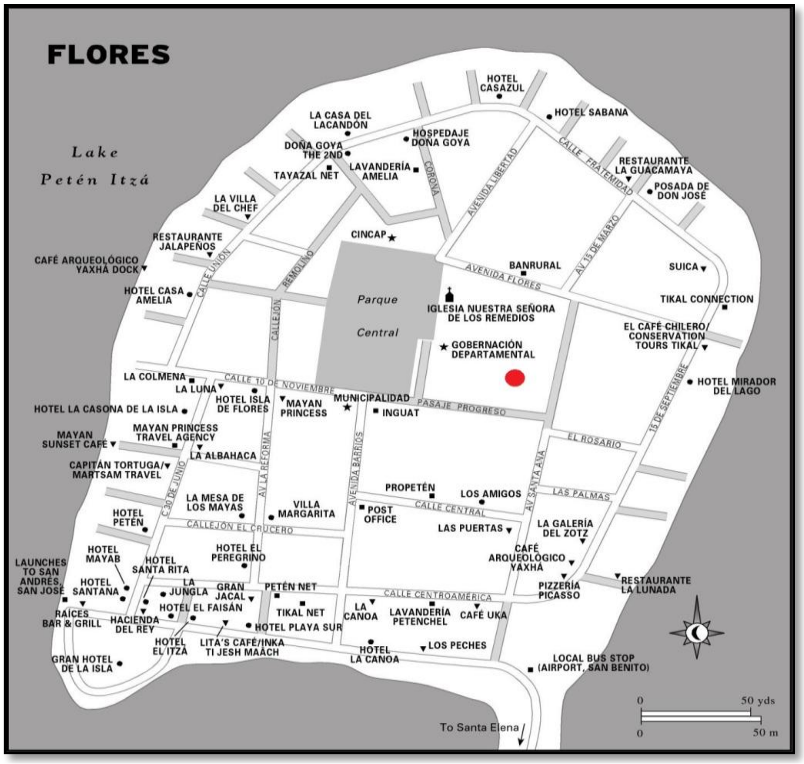


Figure 25.Street map of Flores, Guatemala. Red dot indicates location of Operation 09-A. (Argueta 2013: 313; modified by McArdle in 2014).

The archaeologists recovered abundant cultural material including lithics (chert and obsidian), worked and un-worked shells of local gastropods (univalve) and possibly imported pelycypods (bivalves), and ceramic sherds dating from the Late Classic to Postclassic (dated by Bernard Hermes in 1992) (Valle 1997: 187, 190). In the eastern profile of the unit, first encountered at a depth of 1.60 m, a structure with architectural elements consisting of a "double cornice" and a "slope to the south" was found; the structure extended to a depth of 2.95m (Valle 1997: 187, 190, 196-197). Beginning 20 cm to the west of, and 20 cm below the level of the structure, the obsidian cache appeared at a depth of 3.15 m and extended downward another 16 cm to a depth of 3.31 m. Valle (1997: 187-188) noted that the cache was a "gift of obsidian" consisting of cores, and dated it to the Late Classic or Postclassic based on associated ceramics. However, a Postclassic date is suggested in this report based on several factors, one of which is that in the Postclassic period it is very common for considerable quantities of Late and/or Terminal Classic ceramics to be intermixed with Postclassic deposits (Rice 1984: 185).

Because the discovery was made in the last days of the field season, Valle noted that it was not possible to discover more about the context of the obsidian offering and its relation with the structure. Collected archaeological material was placed in plastic bags and labeled at the excavation unit. Subsequently, the material was washed, dried, packed for its preservation and storage, and taken to the lab to be counted (Valle 1997: 189-190).

Figure 26. View of Operation 09-A facing north (photo by Hillman 1992).

RESULTS

Valle's report delineated 18 lots, or excavation levels, that made up Operation 09-A (Figures 26-32). Lots 1-5 ranged from 0 cm to 1.60 m below surface and appeared to consist primarily of construction fill and refuse. Postclassic ceramic sherds, marine and snail shells, turtle and deer bones, a fragment of a human juvenile mandible, a flint hammerstone, groundstone mano fragments, flakes, a core, and an ax all of flint, and obsidian prismatic blade fragments were found mixed in with contemporary roofing tiles (Lots 1 and 5), glass fragments (Lots 4-5), and dense quantities of plastic and metal (Lot 5) indicating a compromised stratigraphy (Valle 1997: 191-193).

Lots 6 and 7, which both ranged between 1.60 m and 1.85 m, were the levels in which the structure was first encountered. In plan view, Lot 6 was the northern portion of the unit and Lot 7 was the southern portion. In Lot 6 archaeologists encountered two rectangular stones, aligned on the east-west axis (upper cornice) and another line of rectangular stones situated along the north-south axis (lower cornice) that sloped downward toward Lot 7 (Figures 27, 29-32). Like the levels above them, these two lots were also replete with a mixture of contemporary refuse and Prehispanic cultural materials like obsidian flakes, stucco fragments "of good quality," *Pomacea* and *Pachychilus* snail shells, unidentified animal bones, and Postclassic ceramic sherds (Valle 1997: 193-194).

Contemporary refuse (i.e. roofing tiles) was encountered for the last time in Lot 8, which ranged from 1.85 m to 2.25 m below the surface. Most notable at this depth for the excavators was the uniformity of the size and shape of the stones that made up the structure in the eastern portion of the unit. The slope to the south, reminiscent of a *talud*-style architectural form, became clearly defined. Valle (1997: 194) noted that the structure must have had a stucco exterior as evidenced by a fragment of stucco found attached to the corner of the fifth stone down from the top the structure's slope. Cultural material, primarily Postclassic ceramic sherds, and flint flakes, increased in abundance from the preceding lots (Valle 1997: 194).

Lots 9 and 10 both ranged from 2.25 m to 2.63 m in depth; Lot 9 designated the eastern half of the unit "directly associated with the structure" (Valle 1997: 195) and Lot 10 designated the western half of the unit. In these lots, archaeologists encountered quarried/straight-edged stones, similar to those of the intact structure, scattered in disarray in the northern portion of both lots (Valle et al. 1992: 6); likely, these were once a part of the architecture and are indicative of some form of structural collapse. Stucco fragments were encountered toward the southern half of the unit, again indicative of the structure having stucco on its exterior. Additional cultural material collected included animal bones (metatarsals), obsidian and flint flakes, worked and un-worked gastropod shells, and Late Classic (*Encanto Estriado*) and Postclassic ceramic sherds (Valle et al. 1992: 6-8, Valle 1997: 195-196). Two of the most striking ceramic pieces encountered, were a zoomorphic snake or crocodile head with residual stucco that may indicate its prior attachment to a censer, and a rim sherd with an incised woven mat motif reminiscent of the *pop* symbol of kingship. These are standard designs found throughout the Central Petén in the Postclassic (Rice 1983).

Archaeologists uncovered the base of the structure in Lot 11 (Figures 27-30); this level ranged from 2.63 m to 2.95 m below surface depth and was only excavated in the eastern half of the unit due to time constraints of the field season. The quantity of archaeological material in this level increased substantially, obsidian especially. Obsidian prismatic blades and blade fragments (n=68) were found concentrated in two areas: one near the northern profile of the unit in line with the corner of the highest level "cornice" and above the area of the obsidian core cache, and the other on the same north-south axis as the first concentration but located further south at the corner of the second, lower “cornice” (Valle et al. 1992: 11). The latter concentration was smaller and had obsidian blade fragments; the former had obsidian flakes, cores, and a “*pequeno perforador,*” or small perforator, in addition to the blade fragments (Valle et al. 1992: 11). Additional cultural material encountered consisted of flint percussion flakes and projectile points, animal bones, shell fragments, and more Postclassic ceramic sherds (including censer fragments and an anthropomorphic figure of a human face) (Valle 1997: 196-197).

Figure 27. Plan view of Operation 09-A. Eastern unit profile at top (photo by Hillman 1992).

The obsidian core cache that is the focus of this thesis became obvious to the archaeologists during the excavation of the area between 2.95 m and 3.15 m below surface, designated as Lot 12. Directly underneath the stones of the structure and above the concentration of obsidian cores there was a mixed layer of sand and small stones that may have been foundational fill supporting the structure, or a "*piso en mal estado*," the remnants of a badly damaged floor (Valle et al. 1992: 16, 21). Scattered throughout the fill were 36 obsidian blades and blade fragments, one flint flake, and a few ceramic sherds; those sherds that were present (e.g. rim sherds with serpent motifs, scrolled tripod feet) dated to the Postclassic (Rice 1983; Valle 1997: 197). Beneath the fill layer, the excavators encountered the concentration of obsidian cores and concluded they were indeed a cache offering (Figure 28), instead of workshop debris as they had initially thought. The cache occupied an area with an east-west diameter of 30 cm and a north-south diameter of 35 cm; its eastern edge was located 20 cm west of the structure, at what appeared to be the southwest corner of the highest "cornice" (Valle et al.1992: 16). Lot 12 was the last level that spanned the entire north-south extent of the unit.

Figure 28. Plan view of Operation 09-A obsidian core cache (photo by Hillman 1992).

Lots13-18 were smaller, targeted excavation levels that the excavation crew labeled as "*registros*" or registers (Valle et al. 1992: 18 and 21). Once the layer of sand and small stones ended at 3.15 m, Lot 13 began and continued to a depth of 3.25 m. Valle (1997: 198) noted that this level was excavated from beneath what she presumed to be the floor in poor condition from Lot 12. The cultural material encountered in Lot 13 was primarily more material from the obsidian core cache, but archaeologists also recovered some unidentifiable (due to poor preservation) bone fragments, small shells, ceramic sherds, and five obsidian blade fragments (Valle et al.1992: 17; 1997: 198). In the final report, Valle (1997) did not provide additional detail about the excavation of the cache offering. However, the field notes (Valle et al. 1992: 17) stated that 177 obsidian cores and eight flakes were recovered from between 3.15 m and 3.25 m, but suggested that the number of obsidian artifacts associated with the cache was likely higher because other obsidian artifacts were found and removed in the previous lots before the archaeologists realized it was a feature. Field notes indicated the cache was between 3.15 m and 3.31 m; thus, the bottom extent of the cache extended past the 3.25 m boundary of Lot 13 an additional 6 cm into Lot 18 (Valle et al. 1992: 17).

Lot 14 was excavated inside the fill of the structure to determine its internal makeup (Figure 29). This lot was placed on the top of the structure in an area measuring 40 cm east-west by 50 cm north-south and extending from 1.75 m to 2.25 m in depth; the contents consisted of a mixture of gray sand and small stones, none of which were shaped or worked, and a small number (n=4) of ceramic sherds (poor condition precluded dating) and charcoal fragments (Valle 1997: 199).

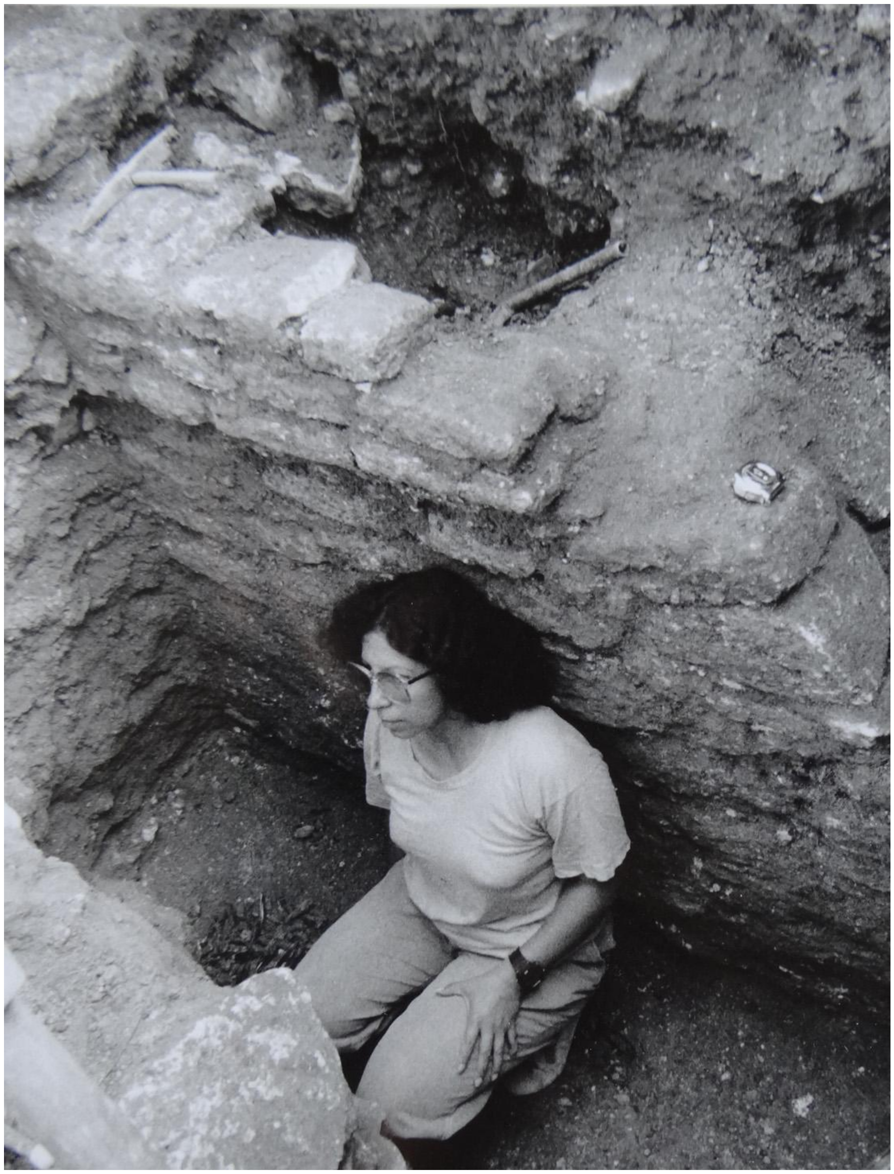


Figure 29. Archaeologist Judith Valle in Operation 09-A with view of Lot 14 excavated inside structure (photo by Hansen 1992).

Not much was recovered from Lot 15, a level limited to the southeastern corner of the excavation unit in order to uncover cultural material associated with the southwest corner of the structure's slope. This lot extended to 3.5 m below surface and measured 30 cm north-south by 60 cm east-west (Valle 1992: 23). Neither the field notes nor the final report made mention of any cultural material; they simply noted that a soil sample was collected (Valle 1997: 199).

Lot 16 was situated in the center of the unit, directly underneath the area of the smaller obsidian blade concentration that was revealed in Lot 11, at the corner of the second lower architectural "cornice" (Valle et al. 1992: 11, 17, 18). It began at a depth of 3.25 m below surface and extended downward to 3.37 m and encompassed an area (in plan view) approximately 55 cm north-south by 50 or 60 cm east-west (Valle et al. 1992: 17, 23). Valle and colleagues (1992: 17-18) noted that this lot was excavated with the intention of discovering bedrock; however, instead, archaeologists encountered a well-preserved floor measuring 7 cm in thickness located from 3.30 m to 3.37 m below surface. Ceramic sherds recovered from above the floor in this lot dated to the Postclassic (Valle 1997: 199). Because the floor in this lot began at 3.30 m below surface, and the lowest extent of the core cache from Lots 11-13 was at 3.31 m, it would seem that the cache was situated directly above this 7 cm thick floor.

Archaeologists excavated another 18 cm beneath the floor discovered in Lot 16, again in search of bedrock; but they were ultimately unable to reach it due to time constraints (Valle et al. 1992: 18; Valle 1997: 200). The area excavated beneath the floor, designated as Lot 17, extended from 3.37 m to 3.55 m below surface. Archaeologists noted the soil was yellow and the cultural material encountered was minimal. Artifacts recovered included Postclassic ceramic sherds, shell, flint, and a fragment of obsidian (either a "*perforador*" or a "nucleus"; there was a discrepancy between the field notes and the final report) (Valle et al. 1992: 18). This lot extended to the greatest depth of any in the excavation unit (3.55 m); consequently, the presence of Postclassic sherds here beneath the floor provided a Postclassic *terminus post quem* for the cache.

The final stage of excavation during Operation 09-A was to completely excavate the core cache and examine the area directly beneath it once the cores were removed. The area beneath the core cache, designated as Lot 18 and measuring from 3.31 m to 3.40 m below surface, was the closing level of excavation unit. When excavating Lot 18, the floor that was encountered in Lot 16 was not present underneath the core cache. Even though the same depth was reached, presumably the cache pit removed it. The field notes and final report only stated that a shell fragment, a few poorly preserved ceramic sherds dated to the Postclassic, and spines (notes say "*espinas*" but no elaboration on quantity or type) were encountered in these 9 cm of excavated earth (Valle et al. 1992: 19; Valle 1997: 200).

Examination of the contents of the boxes labeled as the obsidian core cache from Operation 09-A gives a clearer delineation of the spatial differentiation of the obsidian artifacts that were encountered. Of the 190 cores and core fragments in the storage boxes, 3 are from Lot 11, 10 are from Lot 12, and 177 are from Lot 13. Of those in Lot 11, two are complete and one is a small shattered medial fragment (F09A.11.54/52), barely recognizable. Considering how different this small shattered fragment is from the nature of the rest of the cores in this cache, and taking into account that it is the only medial fragment that does not articulate with any other fragments in the cache, I think it may not have been intentionally interred as part of the cache and thus should not be considered in the total core count.

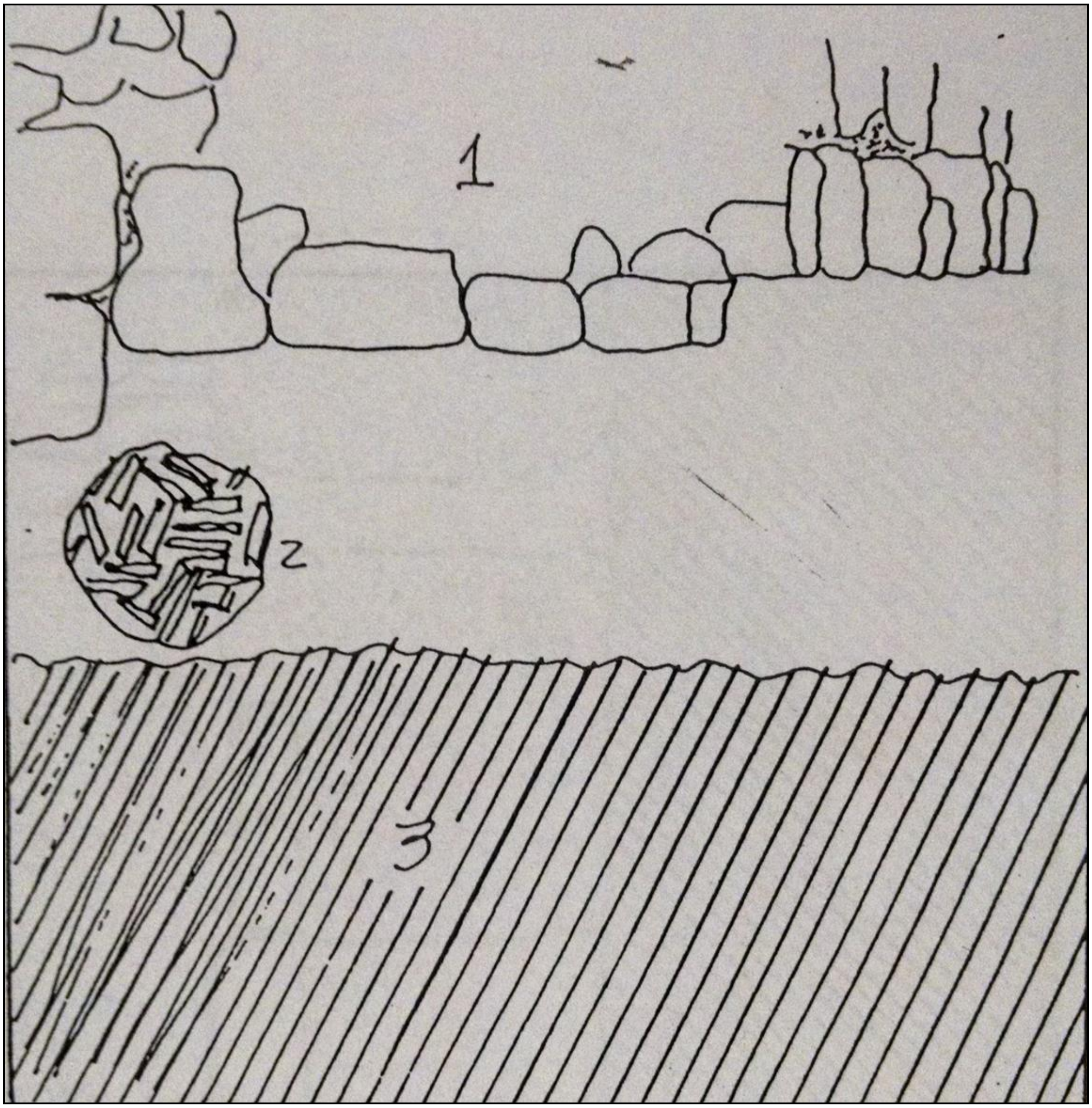


Figure 30. Plan view of Lot 10, Operation 09-A. (1) Structure; (2) Obsidian Cache; (3) Unexcavated portion. (Valle 1997: Fig. 19).

Figure 31. Northeast view showing cache proximity to structure (photo by Hansen 1992).

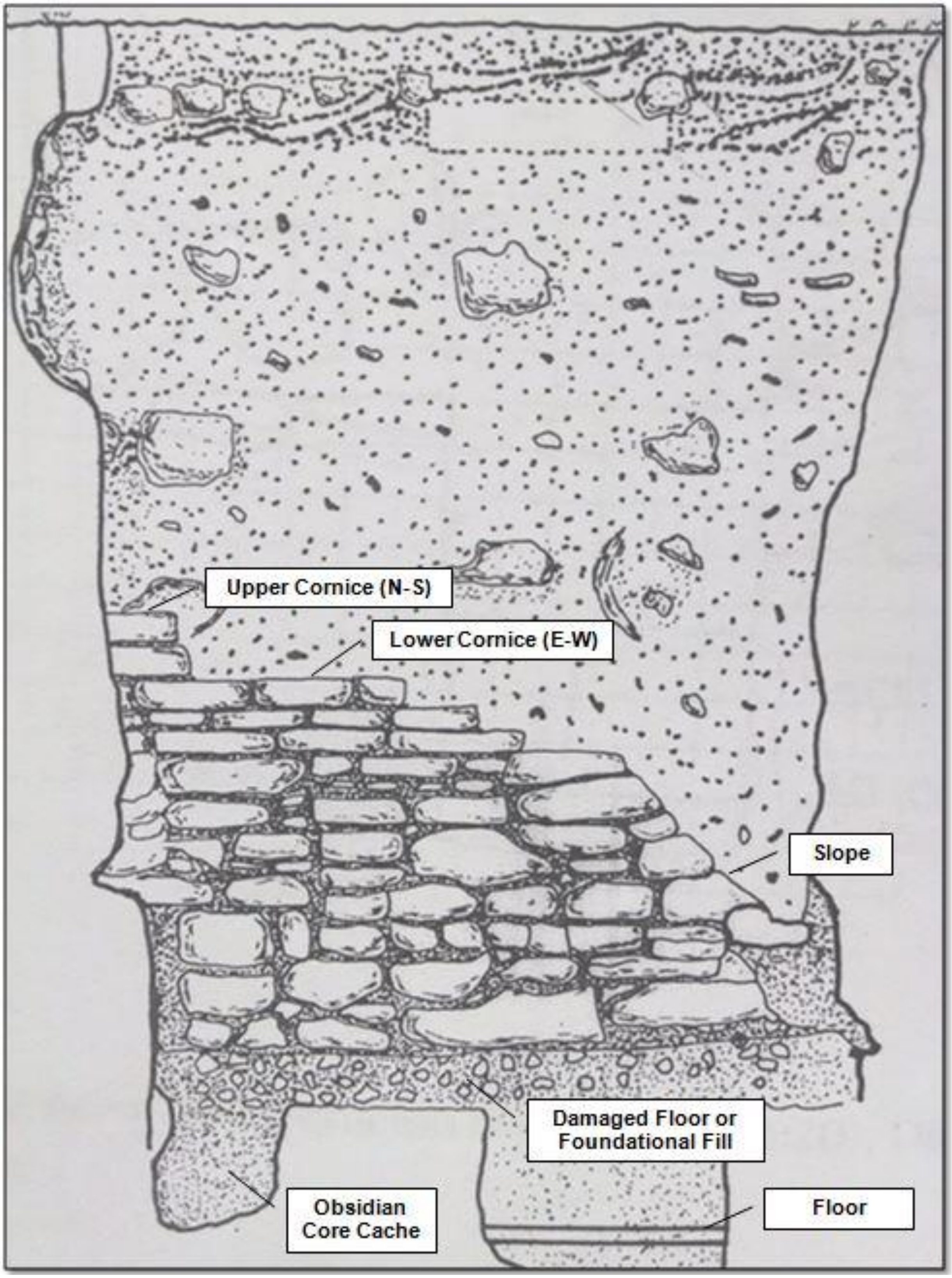


Figure 32. Eastern profile of Operation 09-A. (Valle 1997: Fig. 16; modified by McArdle 2014).

ANALYSIS

Operation 09-A revealed a pre-Columbian structure buried beneath 1.60 m of disturbed construction fill and refuse that was located adjacent to and above (albeit not directly over top of) a cache of obsidian cores. This structure, measuring 1.30 m in height, appears to have had two cardinally aligned rows of rectangular stones suggestive of a double cornice in addition to a southward descending slope suggestive of the *talud* architectural form commonly found throughout Mesoamerica. The proximity of the obsidian core cache to this structure (Figure 31), and its likely placement between two plaza floors that abutted the structure, suggest there may be an association between the two; consequently, exploring the associated architecture of the cache's depositional context may aid in interpretation.

Although it provides only a 2x2 m glimpse into the Postclassic civic center of Nojpeten, the excavation of Operation 09-A exposed an architectural design that seems to mirror that of other northern Maya cities like Chich'en Itza and Uxmal: one of spacious plazas interspersed with temples and other structures like low, flat stone ceremonial platforms (Inomata 2006: 810-811; Rice and Puleston 1982: 139; Treister 2013: 36, 57). The two floors uncovered during excavation may be remnants of plaza floors from the civic center of Nojpeten. Bishop Diego de Landa described Maya plazas as large paved expanses of "strong cement" surrounding multiple structures (Treister 2013: 69). Inomata's research (2006: 810-11, 814) suggested that these open plazas provided space for large audiences to partake in "mass spectacles" where low, flat platforms served as stages for rulers to address their people, or perhaps for entertainment like the "preparation, practice, or execution of dances."

Platforms were small structures characterized by a square or rectangular surface often "formed by the application of plaster mortar on a bedding of stone ballast" (Rice and Puleston

1982: 137) and surrounded by four symmetrically placed stairways (either inset or projected from the side) that led to the top of the platform (Milbrath and Lope 2009: 593-594). Thus, platforms typically had straight, vertical corners with stairways forming sloped walls on each of the four sides (Pollock 1965: 399; Treister 2013: 57), a fitting description of the structure encountered in Operation 09-A with its straight vertical cornices and its southward slope that may have been one side of a stairway. Additionally, “stairs, balustrades, and the platform’s vertical wall were often embellished with stone bas-relief” (Treister 2013: 57) and/or “numerous coats of plaster (Pollock 1965: 399). The stucco fragments encountered alongside and attached to the stones of the structure’s slope in Lots 8-10 suggest a similar construction. Platforms also served as support structures for other constructions built of perishable materials; these platforms consisted of masonry retaining walls filled with rough fill (e.g. dirt, mud, stone, *sascab*, mortar, habitation debris, etc.) similar to the rubble that was found inside the structure from Lot 14 (Pollock 1965: 397-398; Rice and Puleston 1982: 137; Valle 1997: 199). Because only a small portion of the structure was exposed, any interpretation of its overall design and purpose is limited; however, what was visible seems to indicate that the cache was interred between two plaza floors at the inner corner of a platform stairway (Figure 33).

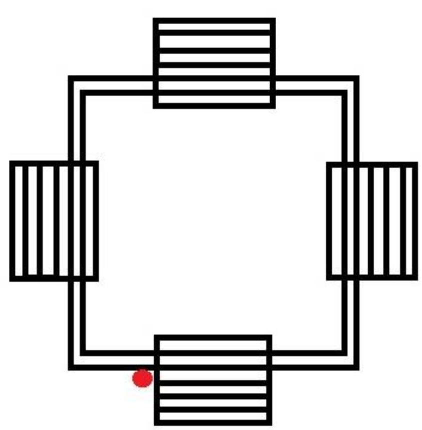


Figure 33. Hypothetical schematic of structure encountered in Operation 09-A with location of obsidian core cache represented by the red dot (McArdle 2014).

Due to similarities in construction and its location in the center of the island, it is probable that the structure uncovered in Operation 09-A may have been comparable to the Postclassic platforms at Chich'en Itza (e.g. Platform of Eagles and Jaguars, Platform of the Skulls, Platform of Venus) or Mayapán (e.g. Q77, Figure 34), platforms that likely served as stages for private and/or communal rituals or dances (Milbrath and Lope 2009: 593-594; Pollock 1965: 436; Treister 2013: 3). Furthermore, there is evidence at Mayapán to suggest that platform structures could be related to marking the passage of time because in the area between its Castillo pyramid and the Q77 platform (and nowhere else) there were 13 sequential plaza floor layers that Milbrath and Lope (2009: 601) believed corresponded with the katun cycle. Marking time through platform-abutting plaza floors may be comparable to marking time by caching calendrically significant numbers of obsidian cores around platforms.

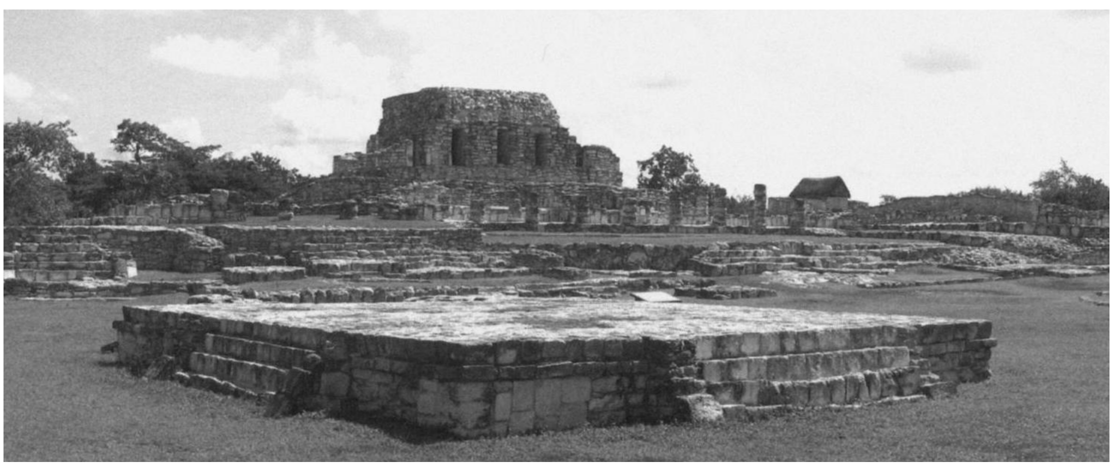


Figure 34. Platform Q77 in the Central Plaza of Mayapán (Milbrath and Lope 2009: 588)

Schele (1998:512) proposed that Maya architectural programs functioned to center the world in the time and space of creation, meaning that structures were earthly manifestations of cosmological creation ideologies. Freidel and colleagues (1993: 131) proposed that centering the world by recreating creation ideologies in the material world was a way of making the supernatural accessible to the Maya in their daily lives. Ceremonial centers with their pyramids, platforms, and plazas would then be the materialization of "complex patterns of repetition and symmetry in both human and cosmological time," or codified versions of calendrical cycles that "formed a matrix of complex ritual in which the rhythms of village life, elite politics, intercommunity warfare, trade, and interactions with the Otherworld occurred" (Freidel et al. 1993: 131). Accordingly, the structure encountered during Operation 09-A in the center of the capital city of Nojpeten may have performed a similar role in centering the world for the Itza Maya; further, it is likely that the obsidian cache offering magnified this role.

Coe (1965: 462) noted that the majority of lowland Maya caches were intentionally hidden and that their location and content distinguished them as ceremonial. Chase and Chase (1998: 326) stated further that ritual offerings likely defined both architectural and sacred space because they were intentionally incorporated into buildings at moments of construction, modification, or destruction. Without knowing the full extent of the structure it is difficult to discuss the orientation of the obsidian cache with any certainty; however, we know that the solar orientation of many Maya buildings "endowed them with the function of both clock and calendar" (Treister 2013: 26) and that caches were often placed in reference to axial lines (Kunen et al. 2002: 204). Caches have been found aligned with both horizontal and vertical axes and are thought to have been markers that "act[ed] as pathways of ritual action" connecting the occupants of the terrestrial world (humans) with the supernatural realms of the underworld and heavenly world (Kunen et al. 2002: 204-205). The obsidian cache from Operation 09-A may have been aligned with a vertical axis connecting the terrestrial platform with the supernatural; additionally, it may have been one of several caches placed at axis points around the structure that worked together to situate it within Maya cosmology.

Caches are ripe with symbolism; their contents were often associated with aspects of the cosmos (e.g. obsidian often linked with the underworld) and the positioning, quantity, and nature (i.e. whole or fragmentary) of those contents are often indicative of further ideological associations (Rodriguez 1997: 89-90; Schele and Miller 1986: 179). Caches can also “represent sacred aspects of the earth including mountains, caves, and water:” liminal spaces that become active “channels of communication and portals of travel between the natural and the supernatural” once activated (Kunen et al. 2002: 199-200). In this capacity, caches were more than a symbolic assemblage; rather, they were active participants in “a power process that transformed spiritual beings into corporeal existence in the human realm and allowed people and objects to become the sacred beings they represented” (Schele et al. 1986: 66). Activating these pathways via cache placement transformed an inanimate structure to a powerfully animate structure “suitable for action” both politically and supernaturally (Rodriguez 1997: 91-92; Schele and Freidel 1990: 438).

Based on discussions with modern descendents of the ancient Maya, Freidel and colleagues (1993: 234-325) proposed that the Classic and Postclassic Maya believed all places and objects made by the gods had been “imbued with sacred force and an inner soul from the beginning of time” but that any manmade objects or buildings had to receive “their inner souls, *ch’ulel*” during dedication ceremonies. Excavations throughout the lowlands indicate that cache offerings accompanied most architectural undertakings in urban centers; these dedication ceremonies took variable forms but usually included some action intended “to make proper, to bless, to circumambulate (through the four quarters), to cense with smoke, to deposit plates full of offerings, [or] to set something in the ground” before an object could receive its soul (Freidel et al. 1993: 234-235). Consequently, if the obsidian cache was an offering associated with the dedication of the structure it was found near, it follows that the ritual act of its interment was meant to reestablish “the conditions of the first act of Creation” by “ensouling” the structure (Garber et al. 1998: 128; Freidel et al. 1993: 234-235). Once the rituals associated with the deposition of the cache were complete, the Maya would have considered the structure animate, alive with its soul, until such time when other rituals might undo the process (i.e. termination rituals). Stross (1998: 35) proposed that interpreting cache offerings for buildings as animation rituals suggests the insertion of a metaphorical heart into the building “– a heart that in all likelihood was ensouled and fed through blood sacrifice.” Throughout Mesoamerica, obsidian has often been associated with blood sacrifice (Heyden 1988: 217; Saunders 2001: 223, 224; Sidrys 1976: 460; Taube 1991: 66); perhaps, the preponderance of obsidian cores in the Nojpeten cache is representative of either a literal or figurative blood sacrifice related to dedication rituals associated with the cache’s interment, and subsequent animation of the associated structure.

V. CONCLUSIONS

Examining this cache from the three different perspectives of procurement, manufacture, and deposition enables a comprehensive analysis that accounts for the logistics of physical acquisition and transportation of the raw material (i.e. obsidian), the extent of labor investment and skill required to produce the cached obsidian cores, and the probable symbolism behind the cache's content and depositional context. Preliminary results from these three analyses revealed:

- the cores came from three or four obsidian sources in the Guatemalan highlands: 60% from Ixtepeque, 23.3% from SMJ, 14.7% from El Chayal, and 2.1% from an unknown source (possibly an outcrop of SMJ)
- while the total number of cores and core fragments recovered from Lots 11-14 equaled 190, it is likely that the original number of cores placed in the cache was between 173 and 182
- the cores were exhausted, meaning they were maximized to their full blade production capabilities regardless of obsidian quality or knapper skill level
- between 25,950 and 27,300 prismatic blades were likely produced from the cores over a time between 311.4 and 327.6 hours indicating a significant labor investment behind the production of the obsidian cores for the cache
- the cache dates to the Postclassic based on its depositional context, associated ceramic sherds, and the techniques used in its manufacture
- the cache was likely buried at the corner of a low platform structure between two plaza floors in a dedication or activation ceremony meant to ensoul the structure

From these results, comparisons with other caches can be made, and further conclusions can be drawn about the symbolism of the significance of acquisition, the specific number of cores that made up the cache, the symbolism of obsidian as a raw material in this cache, the dual nature of the cache contents, and the transformation of raw materials as it relates to the act of caching.

Comparative Caches

While unique, the cache from Nojpeten is not the first to have unmodified obsidian cores makeup its contents. In her analysis of the contents of 505 caches, Rodriguez (1997: 47, Table 1) found that 30 caches had obsidian cores listed in their contents and these caches were from seven sites: Altun Ha, Copan, Chalchuapa, Piedras Negras, Quirigua, Tikal, and Uaxactun. At Altun Ha, obsidian cores were cached with other items like chert debitage, jade, hematite, and shell: 22 cores in cache B-4/2, 1 core in cache E-14, and 41 cores in cache F-1 (Moholy-Nagy 1997: 302-303; Pendergast 1979: 121; Pendergast 1990: 128, 250-252). At Tikal, archaeologists rarely found complete cores suggesting that few exhausted cores were discarded; rather, most appear to have been reworked into eccentrics and deposited, but “exhausted cores and identifiable core fragments” were also regularly found in “special deposits” or caches (Moholy-Nagy 1976: 99). At Uaxactun, 41 cores were cached under Stela A6, 30 cores were cached under Stela A7, and 5 cores were cached under Stela D3; however, the cores were cached with other items like chert flakes and nodules, jade, and shell (Ricketson and Ricketson 1937: 152-153, 171, 187, 197, plate 60, 61; Smith 1950: 92). In all the caches analyzed by Rodriguez, even though cores were present, other artifacts (e.g. shell, ceramic, bone, chert, etc.) were always mixed in with them. This pattern was also found at other sites like Aguateca, Caracol, and Yaxha. At Aguateca, Inomata (2003: 57) found concentrations of “non-pressure blade artifacts” mixed in with exhausted obsidian cores cached in termination ritual deposits M7-22 and M7-32 in the Palace Group. Chase and Chase (1998: 318-319) found multiple Early Classic caches in public structures at the epicenter of Caracol that they described as “a distinctive kind of cache characterized by obsidian cores and eccentrics”; however, in addition to the obsidian cores these caches also consisted of *Spondylus* shells, round objects of jadeite, albite, and malachite, and other obsidian debitage. At Yaxha, in its main center, a cache found beneath Stela 30 in Late Classic Plaza E consisted of 14 obsidian eccentrics, 5 exhausted obsidian cores and core fragments, 13 flint eccentrics, and 1, 334 blades, flakes, and shatter of both flint and obsidian (Rice 1984: 192). The comparative caches discussed thus far are similar in that they all consisted of unmodified obsidian cores; however, the contents are a combination of multiple types of artifacts and the number of obsidian cores in these caches is relatively low in comparison to the number of cores cached at Nojpeten.

However, there are a few sites including Lamanai, Cancuén, and Guaytan, which had caches with higher quantities of obsidian cores and as a result, these may make a more apt comparison with the Nojpeten core cache. Two structures at Lamanai, N10-9 and N10-43, had caches which consisted of a large number of unmodified obsidian cores (Pendergast 1981: 34-35, 41). The Classic period cache at Structure N10-9 consisted of a few carved jade objects (e.g. jade ear ornaments) and 571 obsidian cores (Pendergast 1981: 34-35). The Late Classic period cache at Structure N10-43 consisted of a large black-on-red bowl with a red-ware dish lid, and inside, a small group of *Spondylus* shells, one piece of jade, 7,503 prismatic blades and flakes, and 1,024 obsidian cores (Pendergast 1981: 41). Based on these and other caches found throughout the site, Pendergast (1981: 41) proposed that obsidian "was of special importance for major construction offerings in the Late Classic at Lamanai."

Archaeological evidence from Cancuén indicated that this site served as a central place for trade and that it played a significant role in long-distance exchange networks of exotic goods like jade, pyrite, and shell; additionally, due to its opportune location near the Guatemalan highlands, it also served as a nexus of trade for various types of obsidian (Demarest 2013: 382; Kovacevich 2006: 308-309). Investigations revealed that obsidian was evenly distributed throughout Cancuén, which led Kovacevich (2006: 308-309) to conclude that obsidian was exchanged in a market setting and that while elites may have extracted the polyhedral cores, it was unlikely that they controlled their importation and/or distribution. However, the inordinate presence of obsidian cores in elite caches instead of in general refuse deposits at Cancuén suggests “a different disposal pattern” than that of other lowland sites (Kovacevich 2006: 292-293); consequently, at Cancuén, obsidian appears to have served both utilitarian and elite-associated ritual functions. In 2006, a cache with 13 exhausted obsidian cores from El Chayal was found inside a burial in the Royal Palace; it likely was the burial of the last ruler of Cancuén, Kan Maax, and the 13 cores may have represented the 13 levels of the underworld (Kovacevich 2006: 292-293). A few years later in 2013, many more caches filled with exhausted obsidian cores were found (Demarest 2013: 382). Demarest (2013: 382) noted that archaeologists recovered “a total of 940 whole spent cores from the AD 656 to 800 period of Cancuén’s existence,” 90 percent of which had been found in elite or public caches. This quantity eclipses the number of cores “recovered for the entire Late Classic of Tikal – a site many times bigger, with a 60-year excavation sample that is literally hundreds of times larger than that of Cancuén” (Demarest 2013: 382). Demarest (2013: 382) hypothesized that since many of the cores in these caches were not completely exhausted, Cancuén may have been heavily involved with long-distance exchange of cores and “large-scale blade production for the local and regional Upper Pasión and northern Alta Verapaz communities.” It is possible that the rough polyhedral cores, which eventually became the exhausted cores of the Nojpeten cache, passed through Cancuén before continuing north to the central Petén lakes region.

Even more similar to the Nojpeten cache are those caches found at Guaytan (or Guayatan), a major craft production and exportation center that focused on manufacturing jadeite artifacts, obsidian blades, shell ornaments, and stone beads (Evans and Webster 2001: 422; Rochette 2009: 217). Obsidian tool manufacture, using obsidian quarried from El Chayal, SMJ, and Ixtepeque, was a “major enterprise” conducted by several Middle Motagua centers, including Guaytan, during the Late and Terminal Classic (Evans and Webster 2001: 309, 422, 423). Investigations undertaken by Walters (1980: 7, 20) found numerous obsidian cores and fragments of cores and blades outside jade workshops suggesting that there was a direct association between the two, perhaps that obsidian workshops supplied cutting implements for the manufacturing and maintenance of jade working tools. These cores were not found in ritual contexts. However, excavations at Guaytan 4, an area with a small group of modest domestic structures spread over a series of low platforms, revealed a Late Classic cache of 245 exhausted obsidian polyhedral cores (Figure 35), a possible jaguar claw, and four pieces of jade (Rochette 2009a: 212; 2009b: 148, 156, 361). This cache was found at the base of the exterior face of a platform wall, which is a consistent placement with 14 previously found caches from the southern portion of Guaytan 4 that collectively consisted of 5,199 obsidian blade cores (Rochette 2006: 27; Rochette 2009b: 156, 214). It seems as though the low platforms of Guaytan 4 were bounded by multiple caches of exhausted obsidian cores. Both the placement and content of the Guaytan caches are similar to the Nojpeten cache, which suggests that there may be more than one obsidian core cache in the center of Nojpeten; additionally, whatever function they served at Guaytan may be comparable at Nojpeten.

Figure 35. Plan-view of obsidian core cache from Guaytan 4, Unit IE-02 (Rochette 2006: 30).

Acquisition

One way to interpret the obsidian core cache is to assess its value in terms of what is involved in acquiring the items that make up the cache. Helms (1993: 3) proposed that an adequate discussion of acquisition accounts for the acquirer, the act of acquiring, and the items acquired. For the purposes of this cache, this means that a comprehensive appreciation of its acquisition would reference the individuals who arranged for the transportation and importation of the raw obsidian, the distance the obsidian traveled, the craftsmen that manufactured the cores, the consumers/users of the cores, and the value of the cores themselves. Transporting goods over long distances can sometimes increase their value because faraway places are "other"; these places are different and therefore seen as either superior or inferior to the acquiring community (Helms 1993: 32, 101; Mitchum 1989: 375). Consequently, to acquire goods from somewhere else demonstrates power and prestige on the part of the acquirer, in this case, likely the elites because of their powers of wealth and access and their privilege of material manipulation and use (Aoyama 2007: 9; Helms 1993: 4, 101, 165; Rodriguez 1997: 22-24). Acquiring items from distant places like obsidian from the highlands of Guatemala allowed elites to demonstrate their competence and reinforce their status in the eyes of others of their same socioeconomic status as well as in the eyes of their subordinates (Rodriguez 1997: 24-25). Additionally, Helms (1993: 174, 196) argued that distant places function in the same way that supernatural places do because both are external to the acquiring society; thus, establishing a connection with "faraway lands and people" is somewhat equivalent to establishing connections with other supernatural worlds, which simultaneously can increase the value of the imported items as well as the importance of the elites that acquired them (Rodriguez 1997: 22-24). However, despite the great distances obsidian sometimes had to travel and its apparent scarcity at multiple sites throughout the Lowlands, these characteristics of its acquisition are not necessarily definitive markers of its value (Mitchum 1989: 375, 462; Sidrys 1976: 459). Moholy-Nagy (1984: 116) noted that the distance over which obsidian is imported is not always a good indicator of its function or value once it reaches its destination because there are sites where obsidian from the Guatemalan highlands was being used for ceremonial eccentrics while obsidian coming from the farther central Mexican sources was used for utilitarian items and vice versa. Regardless, the elites at Nojpeten responsible for the acquisition and interment of the obsidian core cache were able to use their position and connections to obtain obsidian from three or four different and distant sources, which suggests that their reach was relatively substantial.

Numerical Significance

Sacred or significant numbers in Maya cosmology (e.g. 7, 9, 13, and 20) were a prominent feature of cache offerings throughout the Lowlands (Garber et al. 1998: 127; Mock 1998: 6), so determining the specific number of obsidian cores that made up the contents of this particular cache could aid in its interpretation. It appears that there were between 173 and 182 obsidian cores in the cache; within this range, three numbers have been documented as being significant to the Maya for their relation to calendrical cycles: 177, 178, and 180. The numbers 177 and 178 both are representative of lunar cycles. According to modern astronomy, the average length of a lunation is a little over 29.53059 days; the Maya tracked lunar cycles with sequences of either 29 or 30 days, interchanging the two so that a half-year of six-lunation cycles would equal either 177 or 178 days averaging to approximately 29.5 days per cycle (Morley 1956: 578; Schellhas et al. 1904: 116, 201; Rice 2009: 38; Sharer and Traxler 2006: 116-117).

Additionally, there may be an ideological connection between obsidian and lunar cycles; there is a Central Mexican deity, Itzapapalotl, whose name means “obsidian butterfly,” that is sometimes represented as an earth-moon goddess or personified obsidian knife (Milbrath 1995: 69-70). Milbrath (1995: 70) noted that this deity might symbolize a "night butterfly” or moth, specifically the *Rothschildia Orizaba* species, which has patterns on its wings that look like obsidian knives; moreover, in several colonial period codices (e.g. Borgia) Itzapapalotl is depicted as a moth whose wings are decorated with knives. Consequently, it is possible that the obsidian cores in this cache were meant to correlate with a lunar cycle, specifically the half-year lunar count (i.e. six lunations).

Another numerical possibility corresponds to a different Maya calendrical cycle: half of the 360-day complete calendar year, or 180 days. Ethnographic data suggest that the Maya divided the 360-day year cycle into two halves; this seasonal duality focused on a light half (dry season) and a dark half (rainy season) divided by the first solar zenith on April 25th (Milbrath 1999: 25-26). Fasting may also have played a part in the placement of the cache. In a passage from the Popol Vuh, the Quiche Maya are documented as fasting for 180 days as part of their worship, “and 180 days they prostrated themselves and burned offerings” (Fitzimmons 2009: 97-98; Mckillop 2004: 212). This 180-day half-year sequence was celebrated at its beginning and end was significant to the Postclassic Maya as evidenced by the seasonal tables in the Dresden Codex; “time [was] thereby ceremonially ordered or structured” (Pharo 2014: 193-194, 196). If the obsidian cache played a part in the ceremonial structuring of Nojpeten’s Itza Maya by tracking either the lunar cycles of 177 or 178 days, or the half-year of 180 days then perhaps another cache with similar contents was placed at a second corner of the platform to account for the other half of the year. However, it is also possible that the number of cores interred were not meant to correlate with calendrical cycles and that instead, they were accumulated over time by obsidian craftsmen or consumers and cached for reasons other than commemorating the passage of time.

Material Significance

In addition to the numerical symbolism, the use of obsidian as a material can also be illustrative. The Maya had many different uses for obsidian; they used it for ritual bloodletting, sacrifice, shaving, surgery, political and religious regalia like lip/nose plugs and ear spools, figurines, mirrors, ceremonial axes, eccentrics, wood carving, meat and hide processing, carving shell and bone, and as war club inserts (Aoyama 2007: 11; Michels 1971:267; Moholy-Nagy 1984: 113-114; Sidrys 1976: 460). In addition to being a collection of waste products from prismatic blade production, this cache of obsidian cores may have also been a symbolic representation of a mirror.

Archaeological evidence indicates that Maya mirrors were in use from the Middle Preclassic through the Late Postclassic, with the majority of mirrors found in the Lowlands dating to the Late Classic (Healy and Blainey 2011: 232). Most Maya mirrors were constructed as flat circular plaques (sometimes oval or square) with a back made of slate or wood and a shiny reflective front mosaic made up of pieces of polished pyrite, hematite, or obsidian (Healy and Blainey 2011: 229-230; Saunders 2003:18–21; Sharer 2006: 180). Data from 73 Maya mirrors that were found intact indicated that mirror diameters ranged between 5.6 cm and 29 cm, with an average diameter of 15.1 cm (Healy and Blainey 2011: 230). Mirrors are relatively rare artifacts at most Lowland Maya sites, and most that are found are recovered as fragments from elite Maya burials or ceremonial caches, which may indicate that they were intentionally broken at the time they were interred (Healy and Blainey 2011: 229-232). A discussion of mirrors is germane to interpreting the obsidian core cache because iconographic and ethnographic evidence suggests that obsidian mirrors were used in ritual contexts by specialized keepers of esoteric knowledge (e.g. seers, shamans, priests, elites), possibly to act as a bridge between the human world and the supernatural worlds of the heavens above and the underworld of Xibalba below (Healy and Blainey 2011: 233; Heyden 1988: 217; Saunders 2003: 224, 238). Coe (1959: Fig. 42) thought that a group of cores he found arranged in a circle at Piedras Negras might represent a "pyrite mosaic mask (mirror) portal into the underworld [because] the edges of the mosaic pieces are similar to the edges of the core's blade scars, and vary in number from 3 to 8 sides."Additionally, obsidian as a material was often associated with sacrifice, bloodletting, and heart removal; consequently, obsidian sometimes served as a metaphor for death and could represent a perceived link to the underworld or simply a metaphorical allusion to it (Heyden 1988: 217; Saunders 2001: 223). The iridescent and reflective quality of obsidian mirrors made them "conveyers of light, sacredness, and brilliance" (Saunders 2003: 238) and because elites wore and used these mirrors as symbols of supernatural power and political authority (Healy and Blainey 2011: 229; Sharer 2006: 180), wearing the mirrors symbolized that these individuals were powerful mystics "through whom, in ritual acts, the power of the supernatural passed into the lives of men" (Schele and Miller 1986:301). The obsidian cache offering can be understood as a mosaic mirror of 190 obsidian pieces arranged as a semi-circular "plaque," with a plan-view diameter of 30 x 35 cm – a diameter not too distant from the 29 cm diameter that is typical of larger mirrors found in the Maya Lowlands. Additionally, if the side-profile of the obsidian cache is taken into account with its depth of 16 cm, its dimensions line up similarly with the average diameter (i.e. 15.1 cm) of Maya mirrors recovered thus far. Consequently, due to their similar dimensions, their similar symbolic properties (re. obsidian as a raw material), and their similar relationship with supernatural worlds in ritual contexts, it is possible that the obsidian core cache was placed at the corner of the structure as a representation of an obsidian mirror. Furthermore, obsidian mirrors are relatively rare artifacts so perhaps a core cache was an acceptable metaphorical substitution.

Duality

Perhaps the most intriguing aspect of the obsidian core cache is its multifaceted duality. Obsidian use throughout Mesoamerica has been proposed as both a basic utilitarian necessity with a wide variety of routine household and domestic uses and as an exclusively elite good used in ceremonial/ritual contexts and as an indicator of wealth and power (Aldenderfer 1991: 139; Aoyama 2007: 24-25; Braswell 2003: 156; Heyden 1988: 217; Rice 1984: 183, 192; Saunders 2001: 221; Sidrys 1976: 449). Rice (1984: 192) addressed this dichotomy when she stated, "obsidian was clearly a special purpose good" because significant quantities of it were removed from commercial circulation whenever it was deposited in dedicatory caches and burials; but at the same time, "it also clearly had utilitarian functions as indicated by tool forms and evidence of use-wear on blade edges, and by the fact that obsidian can be found all over the Maya area in domestic contexts representing the entire range of socioeconomic statuses."

During archaeological investigations throughout the Lowlands, obsidian from ceremonial contexts like burials and caches is found in greater abundance than from domestic refuse, which could indicate that it was primarily imported to bolster elite status and credibility through "conspicuous public consumption by cache deposition, ritual bloodletting, and [its] everyday use in elite households" (Sidrys 1976: 460). Among the Postclassic Maya specifically, prismatic blades of obsidian struck from blade cores were often used as lancets in ceremonial bloodletting rituals as evidenced by scenes from the Madrid Codex and archaeological excavations from Mayapán (Clark 1989: 311, 314; Taube 1991: 66). Clark (1987: 274), a proponent of the idea that obsidian core-blade technology was spread throughout Mesoamerica because of competitive elite behavior, stated that "prismatic blade technology is difficult to learn and requires specialized training" and that the production requirements of core-blade technology would have necessitated "elite sponsorship to finance and coordinate resource procurement from the quarry to workshop;" consequently, the "adoption of prismatic blade technology…is specifically linked to the emergence of chiefdom societies" (Hirth and Flenniken 2002: 124). Hansen (1990:193-197) found evidence of a Late Preclassic obsidian and lithic workshop in the center of the Tigre Complex at El Mirador, suggesting that, at least in the earlier periods of Maya civilization, the elite may have controlled obsidian importation and production. The workshop produced fragments and core shatter with cortex, indicating that early merchants were importing raw nuggets of obsidian and initially working it at the site, implying elite control of importation and distribution in the Preclassic periods. At Aguateca, Aoyama (2007: 24-25) found archaeological evidence (i.e. greater quantities of obsidian in all stages of reduction were found in elite households) indicating that most Maya elites "engaged in artistic creation and craft production" of obsidian. It would seem that obsidian was an "elite-controlled wealth commodity" up until the Late Classic, but with the transition to the Postclassic obsidian was no longer primarily found in ceremonial contexts but in both utilitarian and ritual contexts and in greater quantities throughout the Lowlands (Rice 1984: 192, 194).

Alternately, several scholars (Hirth 2012: 407, 411; Hirth and Flenniken 2002: 123) have argued that obsidian craftsmen were not regarded as elite members of society despite the importance of their goods, and the majority of their manufacturing was conducted in domestic contexts; consequently, "obsidian craft production was first and foremost a commercial venture and thus not necessarily controlled or regulated by political or religious entities." In addition to the routine uses of obsidian like shaving and cutting (Michels 1971:267; Sidrys 1976: 460) obsidian also had medicinal uses where it was ground into a powder and put into cataract-ridden eyes in order to clear up vision and in non-ritual bloodletting to cure headaches, muscle aches, rheumatism, and madness (Clark 1989: 314-216). What then to make of the obsidian core cache? Sidrys (1976: 456) argued that to assign functional values to artifacts (e.g. utilitarian vs. luxury) creates unnecessary ambiguity because an item like obsidian could possess a high value or be associated with elite status "and still retain a useful utilitarian function." Interpreting the obsidian cores as definitively one or the other blurs the varied ways in which the cache served the community of which it was a part. For example, to interpret the obsidian cores as only the leftovers or waste products of blade-core technology, would risk understanding the cores as a pile of trash. Additionally, differentiating between whether the cores were the leftover products from utilitarian prismatic blade production or were the leftovers from the production of blades used in rituals might change the interpretation from a pile of regular trash to a pile of "special" trash. However, regardless of whether the cores produced blades for utilitarian or ritual use, once they were interred as part of the cache, they transformed into ritual items themselves because they were "taken out of daily use and used in ceremony," which made them "pieces of a cosmological map that together with other artifacts and burials served to contextualize the [Maya's] place in the cosmos" (Lucero 2010: 143-144). This transformation is what allows a pile of trash to become treasure.

Transformation

Transformation played a role in several stages of the production of this cache. After acquisition, there was the transformation wrought by skilled artisans who took the raw obsidian and created items whose value was affected by technological skill and political and ideological links with elite power and status (Helms 1993: 16, 115, 196; Rodriguez 1997: 29). This kind of transformation is the result of "productive technology"; but there is another type of transformation that also took place, one Gell (1992: 59) claimed is a result of something he termed "magical technology," or a representation of "the technical domain in enchanted form." Magical technology looks at art as a technical system, meaning that it considers art as a component of technology in that technical processes produce works of art that reflect a "technically achieved level of excellence" (Gell 1992: 43). The obsidian cores would be the works of art that reflect the skilled manipulation of obsidian blade-core artisans. Gell (1992: 44) claimed, "art is orientated towards the production of the social consequences which ensue from the production of these objects"; thus, its power comes from the esoteric technical knowledge required to produce it. In other words, because not everyone had the knowledge and/or skill to manipulate obsidian there is a kind of mystery or magic that the cores embody that gives them a power apart from the political/cosmological/ideological kinds of power already discussed. Gell (1992: 44) succinctly summarizes this idea in the phrase "the technology of enchantment is founded on the enchantment of technology." He further explains that the "technical sophistication involved [in the] radical transformation of materials [is what gives value to works of art, and this value] is conditioned by the fact that it is difficult to get from the materials of which they are composed to the finished product" (Gell 1992: 54). Consequently, the act of transformation may be the central tenet of this cache's significance, perhaps even all caches' significance. The spatial transformation wrought by the procurement stage, the production transformation wrought by the manufacture stage, and the ideological/symbolic transformation wrought by the deposition stage all work together toward a greater transformation that embodies the enchantment of technology. Analyzing the Nojpeten obsidian core cache from different angles revealed that its numerous multifaceted connotations worked together to create something that must have been of great significance to the Itza Maya, and indicated that a comprehensive analytical approach is the best chance at catching a glimpse of what it may have meant to them.

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APPENDIX A – CORE DATA

Artifact #	Source	Lot/Level #	Bag # (1-20)	Completion (C, PF, MF, DF)	Refits To form Complete Core	# of Platforms (1/2)	Main Platform Type (FN/FG, AN/AG, MF)	Main Core Platform Shape (C,O,I)	Length (mm)	Proximal Width (mm) (Max)	Medial Width (mm) (Max)	Distal Width (mm) (Max)	Proximal Width (mm) (Min)	Medial Width (mm) (Min)	Distal Width (mm) (Min)	Max Blade Scar Width (mm)	Min Blade Scar Width (mm)	Weight (g)	# Step Terminations	# Hinge Terminations	# Feather Terminations	Total # of Blade Scars	Main Platform Collapse (Y/N)	Main Platform Constriction (Y/N)	Cortex (Y/N)	End Rejuvenation (DE, PE, N)	# Blades originating from Main Platform	2nd Platform Type (FN/FG, AN/AG, MF)	2nd Core Platform Shape (C,O,I)	2nd Platform Collapse (Y/N)	2nd Platform Constriction (Y/N)	# Blades originating from 2nd Platform	Platform Groove Present	Distal Bulge Present	Black or Grey (B/G)	Matte or Glossy/Glassy (M/G)	Banding: Grey, Clear, None (G/C/N)	Inclusions Present	Core Shape C/HC
F09A.13.64/49	SMJ	13	1	C		1	FG	O	66.61	11.97	12.3	5.05	9.24	12.18	4.12	5.74	2.4	14	0	3	12	15	N	N	N	N	12	\	\	\	\	\			B	M	N		C
F09A.13.64/20	IXT	13	1	C		2	FG	O	83.65	8.26	11.73	5.76	5.57	11.33	2.84	5.89	2.35	14	0	1	10	14	N	Y	N	N	8	FG	O	Y	N	6			B	G	N		C
F09A.13.64/84	IXT	13	1	C		1	FG	O	68.58	8.92	12.65	3.65	3.14	10.2	4.44	5.93	1.42	12	1	2	12	15	Y	N	N	N	15	\	\	\	\	\		Y	B	G	N		C
F09A.13.64/11	SMJ	13	1	C		1	FG	O	78.03	8.05	12.21	5.14	5.56	11.11	3.41	4.86	1.35	15	1	0	16	17	Y	Y	N	N	17	\	\	\	\	\			B	M	N		C
F09A.13.64/92	EC	13	1	C		1	FG	O	64.65	9.42	13.96	4.49	7.19	12.34	3.25	6.17	1.79	15	5	0	13	18	N	Y	N	N	18	\	\	\	\	\			B	G	G		C
F09A.13.64/41	EC	13	1	C		1	FG	O	67.67	19.93	17.18	9.18	14.82	13.26	2.74	9.58	2.62	24	2	4	7	13	Y	N	Y	N	13	\	\	\	\	\		Y	B	M	N		HC
F09A.13.64/103	IXT	13	1	C		1	FG	C	71.45	4.47	11.65	3.83	4.05	11.43	3.79	5.63	1.72	10	1	1	10	12	N	Y	N	N	12	\	\	\	\	\			B	G	N		C
F09A.13.64/76	IXT	13	1	C		1	FG	O	89.16	5.89	10.44	5.52	2.67	10.96	6.05	6.74	1.67	15	1	3	10	14	N	Y	N	N	14	\	\	\	\	\			B	G	N		C
F09A.13.64/8	IXT	13	1	C		1	FG	O	63.84	9.11	10.6	9.32	6.83	9.93	5.79	5.88	1.43	11	0	3	11	14	N	Y	N	DE	14	\	\	\	\	\			B	G	N		C
F09A.13.64/128	IXT	13	1	C		1	FG	O	64.15	6.54	14.65	5.81	3.52	11.36	4.2	7.14	2.23	13	0	0	15	15	Y	Y	N	N	15	\	\	\	\	\			B	G	N		C
F09A.13.64/138	IXT	13	1	C		1	MF	O	78.37	13.98	14.99	6.22	9.55	12.27	2.91	6.32	2.09	21	0	2	12	14	N	N	N	PE	14	\	\	\	\	\			B	G	G		C
F09A.13.64/132	EC	13	1	C		1	FG	O	83.1	12.04	14.87	10.9	9.11	12.33	8.5	6.01	2.12	21	0	8	12	20	N	Y	N	DE	20	\	\	\	\	\			B	M	N		C
F09A.13.64/108	IXT	13	1	C		1	FG	O	77.11	9.84	12.15	5.59	6.26	10.45	4.2	5.69	1.8	13	1	3	11	15	N	Y	N	N	15	\	\	\	\	\			B	G	N		C
F09A.13.64/51	IXT	13	1	C		1	MF	O	71.31	14.59	13.31	8.42	9.87	10.58	5.3	11.94	1.87	18	0	4	12	16	N	N	N	N	16	\	\	\	\	\		Y	B	G	G		C
F09A.13.64/100	SMJ	13	1	C		1	FG	O	65.46	6.96	12.96	6.59	4.7	10.36	4.62	4.65	1.49	11	0	2	11	13	N	Y	N	N	13	\	\	\	\	\			B	M	N		C
F09A.13.64/13	SMJ	13	1	C		2	FG	O	67.88	7.56	12.98	4.05	6.49	13.79	6.86	5.58	1.1	14	0	0	17	17	N	Y	N	DE	9	FG	O	N	Y	8			B	M	N		C
F09A.13.64/82	EC	13	1	C		1	FG	I	64.84	13.64	18.27	8.45	7.24	13.76	6.34	10.04	1.79	21	0	0	18	18	N	Y	Y	N	18	\	\	\	\	\			B	M	G		HC
F09A.13.64/86	IXT	13	1	C		1	FG	O	68.57	7.52	12.31	8.54	4.86	10.37	7.39	5.32	1.37	11	0	1	15	16	N	Y	N	N	16	\	\	\	\	\			B	G	N	Y	C
F09A.13.64/93	IXT	13	1	C		1	FG	O	76.84	10.96	13.94	4.76	5.62	10.95	3.85	6.59	2.03	15	0	2	11	13	N	N	N	N	13	\	\	\	\	\			B	G	N		C
F09A.13.64/90	IXT	13	1	C		1	FG	O	98.21	7.33	14.16	4.89	4.41	11.81	4.31	4.96	1.92	21	3	2	12	17	N	Y	N	N	17	\	\	\	\	\			B	G	G		C
F09A.13.64/9	IXT	13	1	C		1	FG	O	73.94	7.91	12.93	4.49	5.59	13.82	5.45	6.86	1.96	15	0	3	14	17	N	N	Y	DE	17	\	\	\	\	\			B	G	N		C
F09A.13.64/3	SMJ	13	1	C		1	FG	C	64.36	7.69	12.37	6.01	6.49	12.09	6.04	5.37	1.73	11	0	1	13	14	N	Y	N	N	14	\	\	\	\	\			B	M	N		C
F09A.13.64/43	IXT	13	1	C		1	FG	O	72.07	7.59	11.98	6.04	4.91	11.67	7.77	5.61	1.79	12	0	0	15	15	N	Y	N	N	15	\	\	\	\	\			B	G	C		C
F09A.13.64/73	SMJ	13	1	C		1	FG	O	70.82	5.57	12.38	5.93	3.44	11.59	6.49	5.34	1.96	11	0	1	13	14	N	Y	Y	N	14	\	\	\	\	\			B	M	N		C
F09A.13.64/32	EC	13	1	C		2	FG	O	69.52	6.41	17.42	2.21	3.43	9.91	4.99	7.39	1.73	18	0	7	9	16	Y	Y	N	DE	15	FG	O	N	N	1			B	G	G		C
F09A.13.64/61	EC	13	1	C		1	FG	O	82.52	26.53	26.21	19.04	17.24	19.56	5.73	23.52	2.81	70	0	6	8	14	N	N	Y	DE	14	\	\	\	\	\		Y	B	G	C		HC
F09A.13.64/81	UNK	13	1	C		1	FG	O	72.46	6.17	12.52	8.29	4.06	12.69	7.17	6.2	2.04	14	1	1	14	16	N	Y	N	DE	16	\	\	\	\	\			B	M	N		C
F09A.13.64/146	SMJ	13	1	C		1	FG	O	66.77	6.97	12.51	6.42	4.63	12.01	8.07	6.58	1.83	14	0	2	12	14	N	Y	N	N	14	\	\	\	\	\			B	M	N		C
F09A.13.64/14	IXT	13	1	C		2	MF	O	65.11	13.95	17.01	8.82	5.13	11.33	5.97	6.72	2.17	17	0	0	16	16	N	Y	Y	DE	10	FG	O	N	N	6			B	M	N		HC
F09A.13.64/48	IXT	13	1	C		1	FG	O	65.66	9.32	15.15	7.95	5.48	11.3	5.81	6.56	2.56	15	0	2	9	11	N	Y	N	DE	11	\	\	\	\	\		Y	B	G	N		C
F09A.13.64/91	IXT	13	1	C		1	FG	O	80.27	7.22	10.37	6.34	4.71	9.78	4.39	5.08	1.82	11	0	3	12	15	N	Y	N	N	15	\	\	\	\	\			B	G	N		C
F09A.13.64/95	IXT	13	1	C		1	FG	C	69.91	8.87	12.62	6.38	8.1	11.95	6.49	5.83	2.47	14	0	4	9	13	N	Y	N	N	13	\	\	\	\	\		Y	B	G	N		C
F90A.13.64/106	IXT	13	1	C		2	FG	O	71.87	8.04	11.24	10.09	5.14	10.5	12.04	5.05	1.52	13	1	3	12	16	N	Y	N	DE	15	MF	O	N	N	1			B	G	G		C
F09A.13.64/24	SMJ	13	1	C		1	FG	O	73.6	6.18	14.13	9.37	3.54	12.25	5.65	6.31	1.66	15	0	4	11	15	N	Y	N	DE	15	\	\	\	\	\			B	M	N		C
F09A.13.64/40	IXT	13	1	C		1	FG	O	66.55	13.38	12.93	6.68	8.84	11.64	4.33	7.07	2.03	15	0	0	14	14	N	Y	N	N	14	\	\	\	\	\			B	M	G		C
F09A.13.64/2	EC	13	1	C		1	FG	O	73.53	8.48	13.96	5.99	5.44	12.82	4.62	6.24	2.04	16	0	1	14	15	N	Y	N	N	15	\	\	\	\	\		Y	B	M	N		C
F09A.13.64/102	IXT	13	1	C		1	AN	C	75.54	12.39	14.25	5.95	11.2	12.31	5.52	5.51	1.14	18	0	5	11	16	N	N	N	PE	11	\	\	\	\	\			B	G	G		C
F09A.13.64/1	EC	13	1	C		1	FG	O	77.32	13.62	14.45	7.66	11.03	11.91	5.55	8.64	2.27	21	1	7	7	15	N	N	N	N	15	\	\	\	\	\		Y	B	M	N		C
F09A.13.64/18	SMJ	13	1	C		2	AG	O	63.93	13.74	18.24	9.56	8.95	16.79	8.71	8.47	1.91	25	0	1	14	15	N	Y	N	DE	9	FG	O	N	Y	6			B	M	N	Y	C
F09A.13.64/21	EC	13	1	C		1	FG	O	67.25	16.12	16.3	6.75	9.17	12.71	5.01	7.13	2.21	20	0	2	11	13	N	N	Y	N	13	\	\	\	\	\			G	G	N		HC
F09A.13.64/124	IXT	13	1	C		1	FG	O	71.15	4.26	13.39	4.62	3.35	13.56	4.38	6.69	2.36	14	0	1	12	13	N	Y	N	N	13	\	\	\	\	\			B	G	N		C
F09A.13.64/105	UNK	13	2	C		1	FG	O	65.57	8.34	13.85	10.28	5.79	9.98	6.96	5.73	2.68	12	0	1	15	16	N	Y	N	N	16	\	\	\	\	\			B	M	N		C
F09A.13.64/116	IXT	13	2	C		2	FG	O	63.1	10.22	11.59	5.65	3.96	8.73	4.51	7.41	2.04	8	0	0	11	11	N	Y	N	DE	7	AN	O	N	N	4			B	G	N		HC
F09A.13.64/54	IXT	13	2	C		1	FG	O	63.49	7.16	11.77	12.54	4.37	11.42	9.14	5.59	1.79	12	0	0	12	12	N	Y	N	DE	12	\	\	\	\	\			B	G	N		C
F09A.13.64/85	IXT	13	2	C		1	FG	O	61.89	4.82	12.78	7.28	3.65	11.9	4.16	5.35	2.01	10	0	0	13	13	Y	Y	N	N	13	\	\	\	\	\			B	G	N		C
F09A.13.64/66	IXT	13	2	C		1	AN	O	63.25	11.89	13.55	7.03	8.71	12.36	9.67	6.34	1.77	14	0	2	11	13	N	N	N	PE	13	\	\	\	\	\			B	M	N		C
F09A.13.64/133	SMJ	13	2	C		1	FG	O	61.47	6.88	13.82	8.16	4.78	14.48	7.13	5.69	1.59	16	0	1	13	14	N	Y	N	DE	14	\	\	\	\	\			B	M	N		C
F09A.13.64/78	IXT	13	2	C		1	FG	O	62.96	5.47	12.37	4.76	4.73	12.94	3.61	5.44	2.21	12	0	0	14	14	Y	Y	N	N	14	\	\	\	\	\			B	G	N		C
F09A.13.64/34	IXT	13	2	C		2	AG	O	62.59	11.02	14.26	4.46	7.22	10.79	5.36	5.97	1.91	13	0	3	15	18	N	N	N	DE	12	AG	O	N	N	6			B	G	N		HC
F09A.13.64/87	IXT	13	2	C		2	AG	O	61.43	11.99	12.84	4.98	8.6	9.91	7.25	5.98	2.23	12	0	7	6	13	N	N	N	DE	11	FG	O	N	N	2		Y	B	G	G	Y	C
F09A.13.64/29	EC	13	2	C		2	FG	O	61.72	11.17	17.25	13.62	7.12	13.76	8.85	9.18	1.88	20	0	1	12	13	Y	N	N	DE	7	FG	O	N	N	6			B	M	N		HC
F09A.13.64/39	IXT	13	2	C		1	FG	O	66.21	9	11.04	4.01	6.08	10.93	3.81	5.56	1.74	10	0	0	12	12	N	Y	N	N	12	\	\	\	\	\			B	G	N		C
F09A.13.64/33	IXT	13	2	C		1	FG	O	63.96	6.15	10.76	6.21	4.19	10.98	6.46	6.94	2.44	10	0	4	9	13	N	Y	N	DE	13	\	\	\	\	\		Y	B	G	N	Y	C
F09A.13.64/63	SMJ	13	2	C		1	MF	O	61.03	11.37	16.44	7.36	8.17	12.22	6.01	7.13	1.96	18	0	0	18	18	Y	N	N	N	18	\	\	\	\	\			B	M	N		C
F09A.13.64/26	IXT	13	2	C		1	FG	O	62.73	13.55	14.76	7.47	10.14	11.72	4.97	8.92	1.67	17	0	3	14	17	N	N	N	DE	17	\	\	\	\	\			B	G	N		C
F09A.13.64/94	IXT	13	2	C		1	FG	O	63.71	8.58	10.88	6.25	7.09	9.47	5.38	4.98	1.59	9	0	0	12	12	N	Y	N	N	12	\	\	\	\	\			B	G	G		C
F09A.13.64/75	EC	13	2	C		2	FG	C	60.82	10.78	18.77	6.37	10.2	18.68	6.09	11.51	2.57	24	0	3	12	15	N	Y	N	DE	14	AG	O	Y	N	1			B	G	N		HC
F09A.13.64/44	SMJ	13	2	C		1	FG	C	62.58	9.91	11.37	4.19	9.04	10.8	3.92	4.96	2.01	10	0	0	12	12	N	N	N	N	12	\	\	\	\	\			B	M	N		C
F09A.13.64/89	EC	13	2	C		1	FG	O	61.58	20.01	19.32	5.42	7.21	14.98	4.58	6.92	3.28	22	0	1	13	14	Y	N	N	DE	14	\	\	\	\	\			B	G	N		HC
F09A.13.64/107	SMJ	13	2	C		1	FG	O	61.41	15.41	22.7	14.07	7.55	13.14	7.18	7.99	2.13	25	0	0	8	8	N	Y	Y	DE	8	\	\	\	\	\			B	M	N		HC
F09A.13.64/35	IXT	13	2	C		2	FG	O	63.67	8.81	11.86	6.08	6.83	11.64	7.06	6.64	1.62	13	0	2	16	18	Y	N	N	DE	11	FG	O	N	N	7			B	G	C		C
F09A.13.64/140	IXT	13	2	C		1	FG	O	63.05	8.08	13.19	6.64	6.54	14.49	9.73	7.24	2.87	17	0	0	13	13	N	Y	Y	N	13	\	\	\	\	\			B	M	G		C
F09A.13.64/109	SMJ	13	2	C		1	FG	O	61.62	7.77	14.66	7.59	6.07	12.79	5.67	5.41	1.68	15	0	0	19	19	N	Y	N	DE	19	\	\	\	\	\			B	M	N		C
F09A.13.64/25	IXT	13	2	C		2	FG	O	61.42	8.41	11.91	5.09	6.11	12.08	6.87	5.49	1.94	11	0	0	14	14	N	Y	N	DE	7	AG	O	N	Y	7			B	G	N		C

F09A.12.63/15	EC	12	3	C		1	FG	O	61.96	24.64	32.76	18.46	20.52	19.21	4.76	10.89	2.47	52	1	4	11	16	N	Y	Y	DE	16	\	\	\	\	\			B	M	N		HC
F09A.12.63/21	IXT	12	3	C		1	FG	O	44.99	9.84	9.82	6.14	5.59	7.86	5.09	4.73	2.33	5	0	1	9	10	N	Y	N	N	10	\	\	\	\	\			B	G	N		C
F09A.12.63/25	IXT	12	3	C		1	FG	O	39.23	10.85	13	9.26	8.98	10.22	4.07	6.54	1.98	8	0	1	9	10	N	N	Y	N	10	\	\	\	\	\			B	G	N		C
F09A.12.63/31	EC	12	3	C		1	FG	C	32.63	7.53	8.71	4.01	7.44	8.37	6.81	4.61	1.47	3	2	0	8	10	N	Y	N	N	10	\	\	\	\	\			B	M	G		C
F09A.12.63/14	IXT	12	3	PF	N	1	FG	O	26.52	10.16	9.85	10.73	5.08	6.44	8.38	7.54	3.08	3	0	0	7	7	N	Y	N	DE	7	\	\	\	\	\			B	G	G		C
F09A.13.64/119	IXT	13	4	C		1	FG	O	54.23	10.13	10.79	6.99	7.98	10.38	7.11	5.11	1.17	9	0	1	12	13	N	Y	N	N	13	\	\	\	\	\			B	G	N		C
F09A.13.64/179	IXT	13	4	PF	N	2	FG	O	29.72	9.34	11.97	12.95	5.82	10.95	12.19	8.05	1.81	6	0	0	11	11	N	Y	N	Y	10	FN	O	N	N	1			B	G	N		C
F09A.13.64/68	IXT	13	4	C		1	FG	O	48.94	6.13	9.5	3.94	5.52	10.06	4.76	6.76	2.01	6	0	1	10	11	N	Y	N	N	11	\	\	\	\	\			B	G	G		C
F09A.13.64/72	IXT	13	4	C		1	FG	O	57.05	7.81	10.81	5.51	6.51	8.93	6.46	4.54	1.59	7	0	0	10	10	N	Y	N	N	10	\	\	\	\	\			B	G	N		C
F09A.13.64/169	IXT	13	4	DF	N	1	MF	O	30.48	17.8	15.44	6.53	14.86	14.5	5.78	6.26	2.02	10	0	0	13	13	Y	N	N	PE	13	\	\	\	\	\			B	G	N		C
F09A.13.64/170	IXT	13	4	DF	N	1	U	U	34.44	15.53	13.94	5.89	14.62	13.72	8.26	5.59	1.97	9	0	0	14	14	U	U	N	DE	14	\	\	\	\	\			B	M	N		C
F09A.13.64/159	IXT	13	15	PF	N	1	FG	O	48.53	9.05	13.63	13.57	6.47	11.44	12.22	7.21	1.88	11	0	1	12	13	N	Y	N	U	13	\	\	\	\	\			B	G	N		C
F09A.13.64/160	IXT	13	4	PF	N	1	FG	O	36.27	11.83	14.6	14.51	6.75	11.32	11.79	9.42	2.02	9	0	0	12	12	N	Y	N	U	12	\	\	\	\	\			B	M	N		C
F09A.13.64/166	IXT	13	15	PF	Y	2	FG	O	45.39	9.61	13.49	13.33	7.48	11.62	11.13	7.89	2.49	8	0	0	8	8	N	Y	N	DE	7	AN	O	N	N	1		Y	B	G	N		C
F09A.13.64/167	IXT	13	17	PF	Y	1	FG	O	36.31	8.76	14.44	15.49	3.37	11.43	12.47	11.74	2.14	8	0	0	9	9	N	Y	N	U	9	\	\	\	\	\			B	G	N	Y	HC
F09A.13.64/173	IXT	13	4	PF	N	1	FG	O	32.57	11.47	13.61	14.21	9.6	10.32	13.71	6.29	1.98	7	0	1	12	13	N	Y	N	U	13	\	\	\	\	\			B	G	N	Y	C
F09A.13.64/157	IXT	13	4	PF	N	2	FG	O	32.5	9.46	14.1	12.71	8.78	11.29	11.76	6.84	1.33	7	0	0	11	11	N	Y	N	Y	10	U	U	U	U	1			B	M	G		C
F09A.13.64/134	IXT	13	5	C		1	FG	O	51.87	11.58	12.69	7.05	8.62	11.84	6.51	6.39	1.86	10	0	1	11	12	N	N	N	PE	12	\	\	\	\	\			B	G	N		C
F09A.13.64/135	SMJ	13	5	C		1	FG	O	59.48	9.55	12.12	6.13	7.56	11.61	2.99	6.08	1.72	11	0	0	15	15	N	Y	N	N	15	\	\	\	\	\			B	M	N		C
F09A.13.64/136	IXT	13	5	C		1	FG	O	57.86	9.23	12.36	7.91	5.07	11.57	4.45	6.89	2.16	11	0	0	11	11	N	Y	N	PE	11	\	\	\	\	\			B	G	G		C
F09A.13.64/137	IXT	13	5	C		1	FG	O	51.34	7.22	11.26	7.69	5.51	9.87	6.68	4.12	2.07	8	0	0	12	12	N	Y	N	DE	12	\	\	\	\	\			B	G	N		C
F09A.13.64/139	SMJ	13	5	C		1	FG	C	44.3	11.48	12.58	4.91	10.94	12.31	4.89	5.94	1.68	9	0	0	12	12	N	Y	N	N	12	\	\	\	\	\			B	M	N		C
F09A.13.64/141	SMJ	13	5	C		1	FG	O	52.87	10.04	15.09	7.45	7.89	12.27	3.77	6.14	2.23	13	0	0	18	18	N	Y	N	N	18	\	\	\	\	\			B	M	N		C
F09A.13.64/142	SMJ	13	5	C		1	AG	O	53.73	10.05	11.7	3.53	6.42	11.87	4.78	5.21	1.17	10	0	0	15	15	Y	Y	Y	N	15	\	\	\	\	\			B	M	N		C
F09A.13.64/143	IXT	13	5	C		1	MF	O	57.62	9.32	13.39	6.02	5.36	9.86	3.07	4.49	1.64	10	0	0	14	14	Y	Y	N	N	14	\	\	\	\	\			B	G	N		C
F09A.13.64/144	IXT	13	5	C		1	FG	C	49.85	8.19	8.73	3.26	8.11	8.63	2.66	4.41	1.54	6	0	0	13	13	N	Y	N	DE	13	\	\	\	\	\			B	G	N		C
F09A.13.64/42	IXT	13	6	C		1	FG	C	36.14	13.18	12.26	3.59	12.7	12.38	6.92	7.21	2.12	9	0	2	12	14	N	N	N	DE	14	\	\	\	\	\			B	G	G		C
F09A.13.64/46	SMJ	13	6	C		1	FG	O	55.32	9.22	14	5.54	6.33	11.83	4.89	5.62	2.02	11	1	1	13	15	N	Y	N	DE	15	\	\	\	\	\			B	M	N		C
F09A.13.64/47	EC	13	6	C		2	AN	O	51.09	12.55	14.89	13.41	11.03	15.24	13.51	5.85	1.28	17	0	10	9	19	Y	N	N	PE/DE	18	FG	C	N	N	1			B	G	G		C
F09A.13.64/50	SMJ	13	6	C		1	FG	O	50.45	10.18	11.63	2.17	4.02	11.12	4.05	6.57	1.91	9	0	0	13	13	N	N	N	PE	13	\	\	\	\	\			B	M	N		C
F09A.13.64/52	IXT	13	6	C		1	FG	O	58.89	12.91	17.29	14.11	5.14	13.82	7.8	8.25	2.27	19	0	0	13	13	Y	Y	N	DE	13	\	\	\	\	\			B	M	G		HC
F09A.13.64/53	IXT	13	6	C		1	FG	O	58.74	13.17	14.71	8.65	8.06	9.56	2.83	6.42	1.23	12	0	4	12	16	N	Y	N	N	16	\	\	\	\	\			B	G	G		C
F09A.13.64/55	SMJ	13	6	C		1	FG	C	54.48	9.41	12.88	4.4	9.53	13.15	4.81	7.12	1.66	14	0	0	12	12	N	Y	N	DE	12	\	\	\	\	\			B	M	N	Y	C
F09A.13.64/57	SMJ	13	6	C		1	FG	C	48.28	9.59	11.78	6.29	9.11	11.87	9.02	5.89	1.37	9	0	1	12	13	N	Y	N	DE	13	\	\	\	\	\			B	M	N	Y	C
F09A.13.64/80	IXT	13	6	C		1	FG	O	54.23	8.03	15.05	5.85	4.91	10.56	4.44	6.7	1.65	12	0	0	13	13	N	Y	N	DE	13	\	\	\	\	\			B	G	G		C
F09A.13.64/88	IXT	13	6	C		1	FG	O	60.23	6.83	12.9	9.12	3.38	10.09	6.13	5.12	1.55	10	0	0	12	12	N	Y	N	N	12	\	\	\	\	\			B	G	N	Y	C
F09A.13.64/111	SMJ	13	7	C		1	FG	O	46.96	11.81	17.6	6.27	9.55	13.47	7.76	5.01	1.53	13	0	6	11	17	N	Y	N	PE	17	\	\	\	\	\		Y	B	M	N	Y	HC
F09A.13.64/113	EC	13	7	C		1	FG	O	58.79	12.15	19.14	4.86	9.05	12.84	3.85	8.97	2.89	18	0	1	13	14	Y	Y	N	N	14	\	\	\	\	\			B	M	G		HC
F09A.13.64/114	IXT	13	7	C		1	FG	O	57.15	17.51	14.9	4.65	11.34	10.76	3.07	7.55	2.47	15	0	4	8	12	N	Y	N	DE	12	\	\	\	\	\		Y	B	G	G		HC
F09A.13.64/115	IXT	13	7	C		1	FG	O	50.84	23.79	21.55	2.23	10.16	11.49	3.12	10.27	1.93	18	0	0	13	13	N	Y	Y	PE	13	\	\	\	\	\		Y	B	G	G		HC
F09A.13.64/117	IXT	13	7	C		1	FG	O	45.67	18.34	18.01	8.64	8.49	11.24	6.2	7.82	2.26	13	0	0	14	14	N	Y	Y	DE	14	\	\	\	\	\			B	G	G		HC
F09A.13.64/118	IXT	13	7	C		1	AG	O	38.78	10.59	10.29	2.27	9.73	10.66	5.29	4.72	1.71	6	0	1	13	14	N	Y	N	PE	14	\	\	\	\	\			B	G	N		C
F09A.13.64/120	IXT	13	7	C		1	FG	O	38.41	11.97	10.86	5.46	9.48	11.12	9.19	6.62	1.97	8	0	1	12	13	N	Y	N	N	13	\	\	\	\	\			B	G	N		HC
F09A.13.64/121	SMJ	13	7	C		1	FG	O	51.29	24.62	27.82	9.66	16.62	15.65	3.98	8.63	3.29	29	0	1	12	13	Y	N	Y	N	13	\	\	\	\	\			B	M	N		HC
F09A.13.64/122	IXT	13	7	C		1	MF	O	51.85	19.08	17.79	6.08	7.26	12.16	9.14	10.34	1.82	16	0	0	13	13	Y	Y	Y	PE	13	\	\	\	\	\			B	G	G	Y	HC
F09A.13.64/123	IXT	13	8	C		1	FG	O	54.73	17.87	18.01	11.36	10.22	11.34	5.01	8.5	1.62	17	0	1	10	11	N	N	Y	N	11	\	\	\	\	\			B	G	N		HC
F09A.13.64/125	IXT	13	8	C		2	AN	O	59.2	11.16	13.27	9.72	7.62	11.51	7.98	7.16	2.07	13	0	4	14	18	N	N	N	DE	11	FG	O	N	N	7			B	G	N		C
F09A.13.64/126	IXT	13	8	C		1	FG	C	41.17	7.59	10.18	6.17	7.26	10.71	5.78	5.75	1.96	7	0	0	12	12	N	Y	N	DE	12	\	\	\	\	\			B	G	N		C
F09A.13.64/127	IXT	13	8	C		1	FG	O	48.32	7.16	13.79	3.59	4.24	10.16	2.55	6.82	2.82	8	0	0	11	11	N	Y	N	N	11	\	\	\	\	\			B	G	G		C
F09A.13.64/129	SMJ	13	8	C		2	FG	O	60.93	6.69	15.97	13.21	3.28	12.89	10.46	6.57	1.81	17	0	0	20	20	N	Y	N	DE	16	MF	O	N	N	4			B	M	N		C
F09A.13.64/130	IXT	13	8	C		1	FG	O	42.96	14.86	19.74	7.18	12.08	17.87	3.62	10.68	2.38	18	0	0	14	14	N	Y	Y	N	14	\	\	\	\	\			B	G	G		HC
F09A.13.64/131	UNK	13	8	C		1	FG	C	60.81	6.45	10.89	5.26	6.26	10.7	4.76	5.21	1.35	9	0	0	13	13	N	Y	N	DE	13	\	\	\	\	\			B	M	N		C
F09A.13.64/145	IXT	13	8	C		2	AG	O	39.31	15.04	14.34	8.53	11.11	10.38	4.36	9.44	1.72	9	0	0	14	14	N	Y	Y	DE	9	MF	O	N	N	5			B	G	G		HC
F09A.13.64/147	IXT	13	8	C		1	FG	O	39.02	9.27	11.07	5.56	7.88	9.31	2.61	5.95	1.79	6	0	1	11	12	N	Y	N	N	12	\	\	\	\	\			B	G	N		C
F09A.13.64/148	SMJ	13	8	DF	Y	2	AG	C	47.37	10.74	15.33	5.75	10.12	17.84	12.54	13.32	1.98	16	0	0	11	11	N	N	Y	DE	6	MF	O	N	N	5			B	M	N		HC
F09A.13.64/79	EC	13	9	C		1	FG	O	54.28	14.81	13.26	9.49	13.08	12.32	4.85	6.82	2.18	12	3	4	9	16	N	N	N	N	16	\	\	\	\	\			B	G	N	Y	C
F09A.13.64/96	SMJ	13	9	C		1	FG	O	41.69	7.26	10.59	5.07	5.85	9.02	6.27	6.11	1.22	5	0	0	12	12	N	Y	N	N	12	\	\	\	\	\			B	M	N		C
F09A.13.64/97	IXT	13	9	C		1	FG	O	40.32	13.04	13.43	7.85	7.88	10.52	6.97	6.22	1.94	9	0	2	13	15	N	N	Y	DE	15	\	\	\	\	\	Y		B	G	G		C
F09A.13.64/98	EC	13	9	C		1	FG	O	58.42	13.19	14.96	4.21	4.79	12.24	1.69	9.63	2.31	14	0	0	11	11	N	Y	Y	N	11	\	\	\	\	\			B	G	G		C
F09A.13.64/99	IXT	13	9	C		1	FG	C	56.54	8.39	9.61	2.01	8.32	10.45	3.73	4.52	1.47	8	2	2	9	13	N	Y	N	N	13	\	\	\	\	\			B	G	N		C
F09A.13.64/101	IXT	13	9	C		1	AN	O	58.4	16.56	16.05	12.77	14.88	13.25	7.79	9.13	2.03	20	0	3	12	15	N	N	N	Y	15	\	\	\	\	\			B	G	N		C
F09A.13.64/104	IXT	13	9	C		2	AN	O	51.83	8.77	14.52	15.85	4.04	12.43	12.31	6.56	1.52	14	0	1	12	13	N	N	N	DE	12	MF	O	Y	N	1			B	G	N		C
F09A.13.64/19	IXT	13	10	C		2	AG	O	50.38	12.86	19.61	15.37	6.26	15.3	11.03	10.13	2.47	21	0	0	12	12	N	N	N	DE	8	FG	O	N	Y	5			B	G	N	Y	HC
F09A.13.64/22	SMJ	13	8	PF	Y	1	FG	C	44.26	17.51	20.77	5.23	16.09	19.04	2.61	9.88	2.54	20	0	2	12	14	N	Y	Y	DE	14	\	\	\	\	\			B	M	N		HC
F09A.13.64/23	SMJ	13	10	C		2	FG	O	43.25	10.94	14.37	8.43	9.22	12.84	10.95	8.31	1.57	13	0	0	16	16	N	Y	N	DE	12	FG	O	N	Y	4			B	M	N		C
F09A.13.64/27	SMJ	13	10	C		2	FG	O	60.77	11.24	14.6	4.17	5.87	12.56	3.44	6.18	1.91	13	0	0	11	11	N	Y	N	DE	8	FG	O	N	Y	3			B	M	N		C
F09A.13.64/28	IXT	13	10	C		2	MF	C	53.5	9.66	13.92	8.73	9.15	12.59	10.46	8.39	1.94	15	0	2	11	13	N	Y	N	DE	11	FG	O	N	N	2	Y		B	G	G		C
F09A.13.64/30	IXT	13	10	C		2	FG	O	52.34	11.35	14.85	10.66	8.63	11.51	9.17	5.62	2.18	13	0	1	15	16	N	N	N	DE	9	FG	O	Y	N	7			B	G	N	Y	C
F09A.13.64/31	IXT	13	10	C		1	FG	O	42.71	8.61	11.05	3.03	7.75	10.1	2.21	6.16	1.78	6	0	0	9	9	N	Y	N	DE	9	\	\	\	\	\			B	G	G		C
F09A.13.64/36	IXT	13	10	C		1	FG	O	52.06	9.83	12.71	5.23	8.81	11.93	4.84	6.46	1.81	11	0	0	13	13	N	Y	N	DE	13	\	\	\	\	\			G	M	N		C
F09A.13.64/37	SMJ	13	10	C		1	FG	O	55.61	9.47	12.19	2.49	7	11.16	6.16	5.44	2.04	10	0	0	10	10	N	Y	N	DE	10	\	\	\	\	\			B	M	G		C
F09A.13.64/38	EC	13	10	C		1	FG	O	52.58	11.86	14.53	13.84	6.76	11.64	10.33	7.21	1.45	12	0	2	10	12	N	Y	N	DE	12	\	\	\	\	\			B	G	N		C
F09A.13.64/59	IXT	13	10	C		2	FG	O	45.82	11.53	11.04	7.19	8.62	9.48	7.23	4.57	1.39	7	0	5	11	16	N	Y	N	DE	9	MF	C	N	N	7	Y		B	G	N		C
F09A.13.64/64	SMJ	13	11	C		1	FG	O	60.85	9.25	11.14	1.99	8.43	11.17	3.35	5.03	2.51	11	0	0	12	12	N	Y	N	N	12	\	\	\	\	\			B	M	N		C
F09A.13.64/65	IXT	13	11	C		1	FG	O	53.87	15.99	14.18	1.77	10.12	9.94	5.47	9.13	1.86	10	1	1	11	13	N	N	N	N	13	\	\	\	\	\			B	G	G		HC
F09A.13.64/67	SMJ	13	11	C		1	FG	O	58.29	9.71	13.89	4.04	6.26	12.23	2.56	5.72	1.97	11	0	1	15	16	Y	Y	N	N	16	\	\	\	\	\			B	M	N		C
F09A.13.64/69	IXT	13	11	C		1	FG	O	59.84	7.94	13.07	8.76	6.29	10.41	8.46	5.84	2.21	12	0	4	14	18	N	Y	N	DE	18	\	\	\	\	\			B	G	N		C

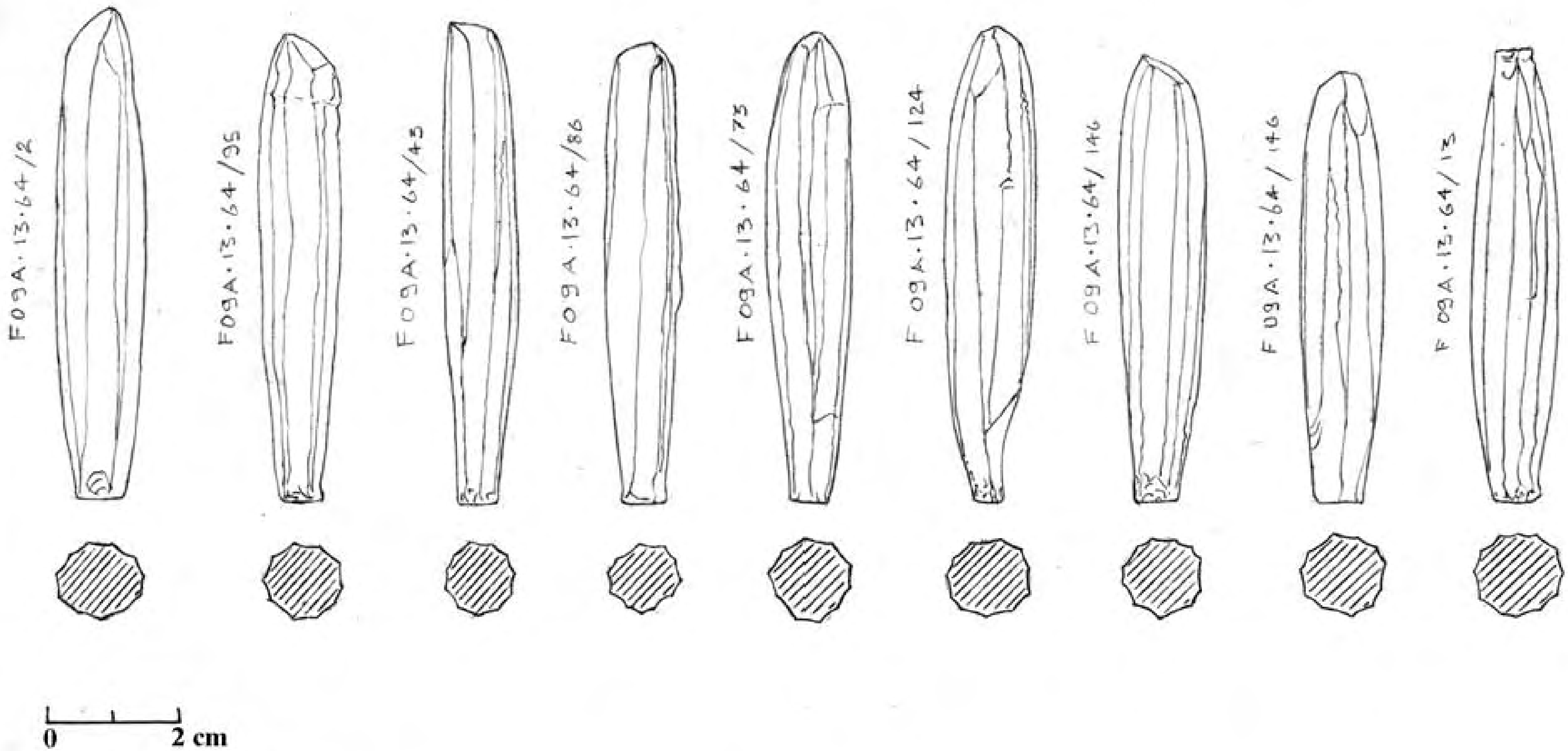
F09A.13.64/70	IXT	13	11	C		1	AG	O	58.9	12.46	11.97	4.21	5.97	10.02	7.59	5.96	2.1	10	1	0	12	13	N	Y	N	N	13	\	\	\	\	\		B	G	N		C
F09A.13.64/71	SMJ	13	11	C		1	FG	O	48.59	6.83	12.79	6.27	5.46	12.29	3.78	6.72	2.16	9	0	1	14	15	N	Y	N	DE	15	\	\	\	\	\		B	M	N		C
F09A.13.64/74	SMJ	13	11	C		1	FG	O	45.59	9.66	11.71	6.32	8.31	11.11	5.48	5.06	1.44	8	0	0	13	13	N	Y	N	DE	13	\	\	\	\	\		B	M	N		C
F09A.13.64/77	SMJ	13	11	C		1	FG	O	56.65	9.76	12.43	3.54	5.97	11.47	5.01	8.36	1.9	10	0	1	13	14	N	Y	N	DE	14	\	\	\	\	\		B	M	N		C
F09A.13.64/56	IXT	13	12	C		1	FG	O	52.36	12.53	15.56	10.74	10.48	14.04	7.94	6.67	2.66	17	0	3	12	15	N	Y	N	DE	15	\	\	\	\	\	Y	B	G	N		C
F09A.13.64/83	IXT	13	12	C		1	FG	O	55.95	9.56	10.21	6.77	3.71	7.49	4.48	5.64	0.86	6	0	2	12	14	Y	N	N	N	14	\	\	\	\	\		B	G	N		C
F09A.13.64/110	EC	13	12	C		1	FG	O	60.34	23.84	27.86	7.92	14.43	19.91	11.18	13.81	2.74	44	0	0	14	14	N	Y	Y	N	14	\	\	\	\	\		B	G	N		HC
F09A.13.64/112	EC	13	12	C		1	FG	O	57.43	29.46	30.94	8.02	11.08	16.69	6.43	10.67	2.56	39	0	0	13	13	N	Y	Y	N	13	\	\	\	\	\		B	G	N		HC
F09A.13.64/155	IXT	13	12	C		1	AN	O	41.66	13.67	13.22	2.85	11.78	12.25	5.34	6.96	2.41	9	0	0	12	12	N	N	N	PE	12	\	\	\	\	\		B	M	N		C
F09A.13.64/168	EC	13	12	DF	N	2	U	U	26.74	18.76	17.12	14.08	17.22	14.98	9.81	7.46	2.06	10	0	0	14	14	U	U	N	DE	11	MF	O	N	N	2		B	M	N		C
F09A.13.64/45	SMJ	13	12	PF	Y	1	FG	O	44.35	7.32	13.7	14.64	3.98	11.46	13.77	6.22	2.28	10	0	0	13	13	N	Y	N	N	13	\	\	\	\	\		B	M	C		C
F09A.13.64/161	SMJ	13	12	DF	Y	1	FG	O	35.83	15.14	12.43	3.81	13.77	11.47	2.79	6.22	2.28	8	0	0	13	13	N	Y	N	N	13	\	\	\	\	\		B	M	C		C
F09A.13.64/4	IXT	13	13	C		1	FG	O	56.32	12.57	18.51	6.24	6.49	12.56	5.92	7.33	1.93	17	0	1	16	17	N	Y	N	DE	17	\	\	\	\	\		B	G	N		C
F09A.13.64/5	EC	13	13	C		1	FG	O	52.68	14.89	15.6	2.73	9.98	12.63	1.98	7.21	2.26	15	0	0	14	14	N	Y	N	N	14	\	\	\	\	\		B	M	N		C
F09A.13.64/6	SMJ	13	13	C		2	FG	O	49.26	9.94	18.59	15.01	6.37	15.88	11.98	8	3.07	19	0	0	11	11	N	Y	N	DE	8	AG	O	N	N	3		B	M	G		C
F09A.13.64/7	SMJ	13	13	C		1	FG	C	49.41	10.17	12.1	6.81	9.21	11.47	9.36	4.77	1.83	9	0	1	11	12	N	Y	N	DE	12	\	\	\	\	\		B	M	N		C
F09A.13.64/10	SMJ	13	13	C		1	FG	O	49.73	10.45	15.14	8.39	8.03	14.58	4.87	7.25	2.03	14	0	0	14	14	N	Y	N	DE	14	\	\	\	\	\		B	M	N		C
F09A.13.64/15	IXT	13	13	C		2	FG	O	59.32	8.84	15.05	8.49	7.28	14.58	6.01	6.48	2.14	15	0	0	12	12	N	Y	N	DE	7	FG	O	N	Y	5		B	G	G		C
F09A.13.64/16	IXT	13	13	C		1	FG	O	58.51	8.5	14.11	13.72	4.26	10.21	10.34	6.73	2.02	12	0	0	11	11	N	Y	N	DE	11	\	\	\	\	\		B	G	N		C
F09A.13.64/17	IXT	13	13	C		2	FG	O	42.56	13.19	17.79	11.51	6.02	12.12	9.31	9.26	1.45	12	0	1	13	14	Y	Y	N	DE	12	FG	O	N	N	2		B	G	G		C
F09A.13.64/58	IXT	13	13	C		1	FG	O	83.18	12.47	16.54	5.19	9.29	12.24	3.67	8.12	1.73	22	1	4	10	15	Y	Y	N	N	15	\	\	\	\	\		B	G	N	Y	C
F09A.13.64/60	IXT	13	13	DF	N	1	U	U	34.72	16.58	15.71	8.13	13.88	13.61	3.42	6.65	2.77	11	0	0	14	14	U	U	N	DE	14	\	\	\	\	\		B	M	N		C
F09A.13.64/62	IXT	13	13	C		2	FG	O	56.28	11.23	14.19	4.32	6.76	9.41	6.52	6.45	1.41	10	0	0	14	14	N	Y	N	DE	11	AN	O	N	N	3		B	G	N		C
F09A.13.64/149	IXT	13	14	C		1	FG	O	54.72	14.98	12.35	6.24	7.87	9.56	3.14	6.99	2.93	11	0	4	12	16	N	Y	Y	N	16	\	\	\	\	\	Y	B	G	N		HC
F09A.13.64/150	SMJ	13	14	C		1	FG	C	56.73	8.98	10.84	3.85	8.26	10.75	4.54	5.02	2.19	10	0	1	11	12	N	Y	N	DE	12	\	\	\	\	\		B	M	N		C
F09A.13.64/151	UNK	13	14	C		1	FG	O	58.74	11.74	12.28	4.92	9.46	11.71	4.68	5.35	1.48	12	0	0	16	16	N	Y	N	DE	16	\	\	\	\	\		G	M	N		C
F09A.13.64/152	IXT	13	14	C		1	FG	O	55.99	11.72	13.33	2.43	7.31	10.07	2.71	6.53	1.77	9	0	1	13	14	N	Y	N	N	14	\	\	\	\	\		B	G	G	Y	C
F09A.13.64/153	IXT	13	14	C		2	AG	O	29.47	11.12	10.01	8.12	9.55	10.05	3	7.51	1.45	4	0	1	8	9	N	Y	N	DE	5	AN	I	N	N	4		B	G	G		C
F09A.13.64/156	IXT	13	14	PF	N	1	FG	O	30.86	13.12	14.93	17.07	11.42	13.46	13.07	9.56	1.59	11	0	1	10	11	N	N	N	U	11	\	\	\	\	\		B	G	N	Y	C
F09A.13.64/158	IXT	13	14	DF	N	1	U	U	42.91	12.34	12.21	7.31	9.23	9.5	7.79	5.09	2.14	8	0	0	10	10	U	U	N	N	10	\	\	\	\	\		B	G	N		C
F09A.13.64/180	EC	13	14	DF	N	1	U	U	16.02	11.75	9.62	7.05	10.32	9.07	2.94	5.48	1.78	2	0	0	10	10	U	U	N	N	10	\	\	\	\	\		B	G	N		C
F09A.13.64/162	IXT	13	15	DF	N	1	AN	O	28.92	15.39	16.63	11.63	14.27	13.51	8.16	7.14	1.92	9	0	0	13	13	N	N	N	DE	13	\	\	\	\	\	Y	B	G	N		C
F09A.13.64/164	EC	13	15	DF	Y	1	AN	I	62.41	6.06	19.2	12.77	5.94	14.11	5.51	7.41	2.42	20	2	1	20	23	Y	N	N	N	23	\	\	\	\	\		G	M	N		HC
F09A.13.64/171	EC	13	15	PF	Y	1	AN	I	62.41	6.06	19.2	12.77	5.94	14.11	5.51	7.41	2.42	20	2	1	20	23	Y	N	N	N	23	\	\	\	\	\		G	M	N		HC
F09A.13.64/165	IXT	13	15	DF	Y	1	U	U	29.85	13.1	13.28	8.39	10.68	11.7	4.64	4.28	2.46	6	0	1	13	14	U	U	Y	DE	14	\	\	\	\	\	Y	B	G	N		C
F09A.13.64/163	SMJ	13	15	DF	Y	1	FG	O	75.7	7.04	13.17	5.24	4.11	12.34	5.89	5.13	1.88	14	0	1	13	14	N	Y	N	DE	14	\	\	\	\	\		B	M	N		C
F09A.13.64/174	SMJ	13	15	PF	Y	1	FG	O	75.7	7.04	13.17	5.24	4.11	12.34	5.89	5.13	1.88	14	0	1	13	14	N	Y	N	DE	14	\	\	\	\	\		B	M	N		C
F09A.13.64/175	IXT	13	15	MF	N	1	U	U	30.73	14.38	14.01	11.08	12.49	11.89	8.26	5.76	1.41	7	0	0	14	14	U	U	N	U	14	\	\	\	\	\		B	G	N		C
F09A.13.64/176	IXT	13	15	MF	N	1	U	U	30.73	14.38	14.01	11.08	12.49	11.89	8.26	5.76	1.41	7	0	0	14	14	U	U	N	U	14	\	\	\	\	\		B	G	N		C
F09A.13.64/177	EC	13	15	DF	N	1	U	U	27.1	8.76	10.39	3.29	3.34	15.37	13.09	7.83	2.26	2	0	0	12	12	U	U	N	N	12	\	\	\	\	\		B	G	N		C
F09A.13.64/172	IXT	13	16	PF	N	1	FG	O	41.81	6.59	12.52	14.89	5.67	10.16	13.02	7.12	1.98	8	0	0	14	14	N	Y	N	U	14	\	\	\	\	\		B	G	N		C
F09A.12.63/1	IXT	12	17	C		2	AN	O	44.89	13.93	14.31	12.06	11.54	14.32	8.34	11.15	2.17	12	0	1	11	12	N	N	N	DE	11	FG	O	N	N	1		B	G	N		C
F09A.12.63/2	IXT	12	17	DF	Y	1	U	U	38.76	16.59	15.87	4.91	14.67	15.41	4.18	10.02	2.09	13	0	0	13	13	U	U	N	N	13	\	\	\	\	\		B	G	N	Y	HC
F09A.12.63/3	IXT	12	17	C		1	FG	O	44	7.11	15.32	15.71	5.37	12.12	14.29	7.68	2.74	11	0	0	12	12	N	Y	N	U	12	\	\	\	\	\		B	G	G		C
F09A.12.63/26	IXT	12	17	C		1	FG	O	50.1	12.84	15.32	5.84	8.61	10.3	6.77	6.91	1.82	11	0	0	15	15	Y	Y	N	N	15	\	\	\	\	\		B	G	N		C
F09A.12.63/28	IXT	12	17	C		1	FG	O	55.49	9.93	12.63	6.93	8.37	11.62	6.23	6.67	1.84	11	0	1	11	12	N	Y	N	N	12	\	\	\	\	\		B	G	N		C
F09A.11.54/1	IXT	11	19	C		1	FG	O	66.54	12.75	17.45	14.69	9.62	12.59	7.96	7.84	1.81	19	0	4	13	17	N	Y	N	DE	17	\	\	\	\	\		B	G	G		C
F09A.11.54/2	IXT	11	19	C		2	AG	O	62.53	21.84	25.25	16.68	11.84	17.33	13.24	14.12	2.51	38	0	1	20	21	N	Y	Y	DE	18	FG	O	N	N	3		B	G	N		HC
F09A.11.54/52	EC	11	B2	MF	N	2	U	U	20.78	12.73	14.12	14.03	6.06	11.42	11.48	8.38	1.75	4	U	U	U	8	U	U	N	U	5	U	U	U	U	3		B	M	N		C

Key

Prismatic Blade Cores

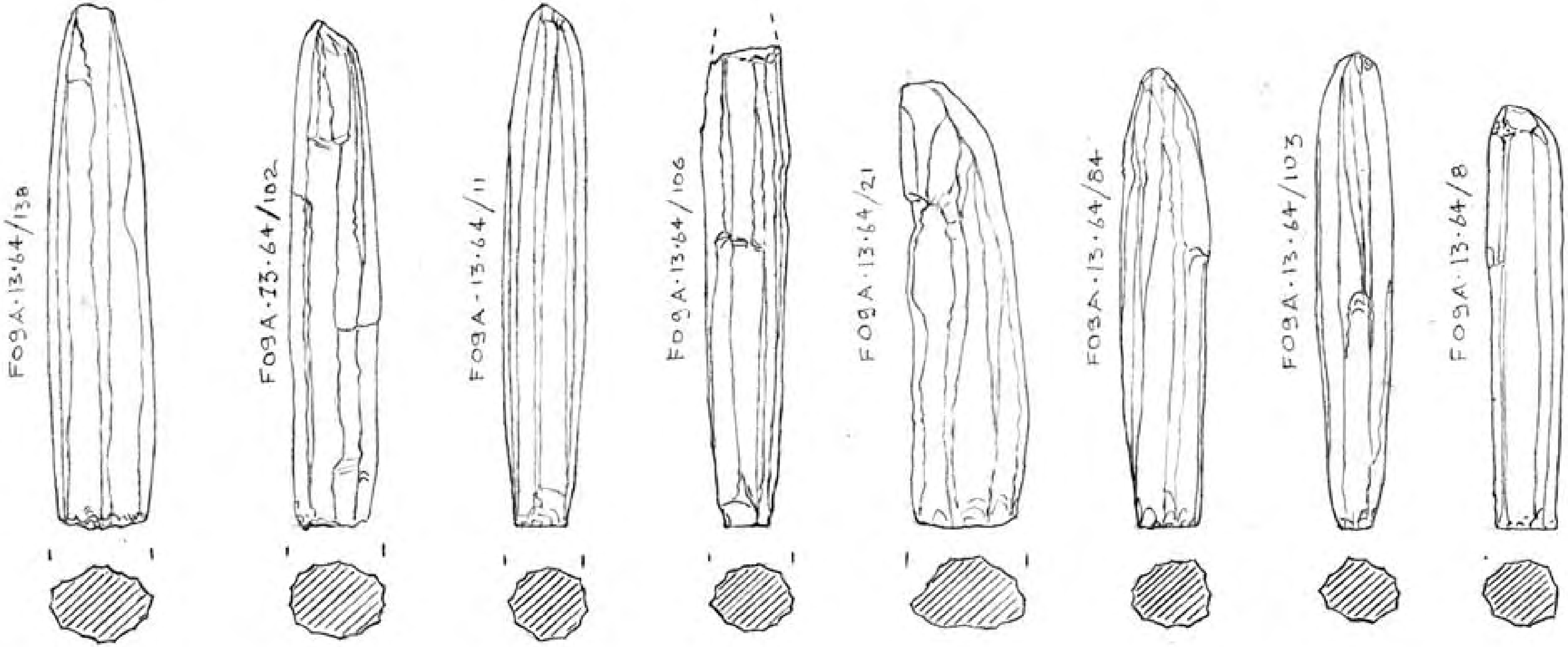
Completion	C	Complete
	PF	Proximal Fragment
	MF	Medial Fragment
	DF	Distal Fragment
Platform Type	FN	Flat Natural
	FG	Flat Ground
	AN	Angled Natural
	AG	Angled Ground
	MF	Multi-Flaked
	Main	Larger Platform, PE
	2nd	Secondary Platform, DE
Main Platform Shape	C	Circular
	O	Oblong
	I	Irregular
Rejuvenation	DE	Distal End
	PE	Proximal End
	N	None
Yes/No	Y	Yes
	N	No
	U	Unknown
Core Shape	C	Cylindrical
	HC	Half-conical

APPENDIX B – CORE DRAWINGS



ISLA DE FLORES
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

BOLSA 1



0 2 cm

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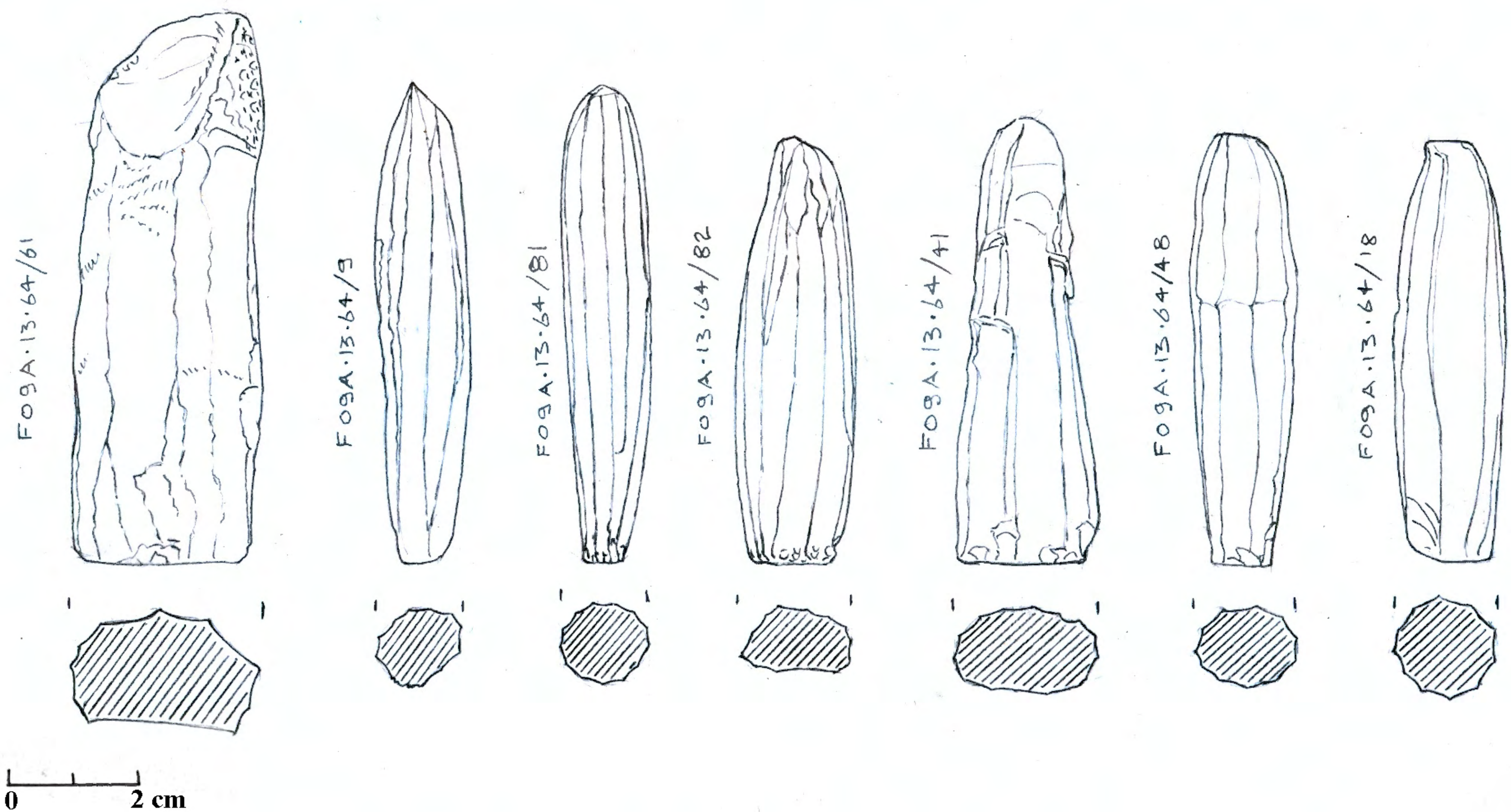
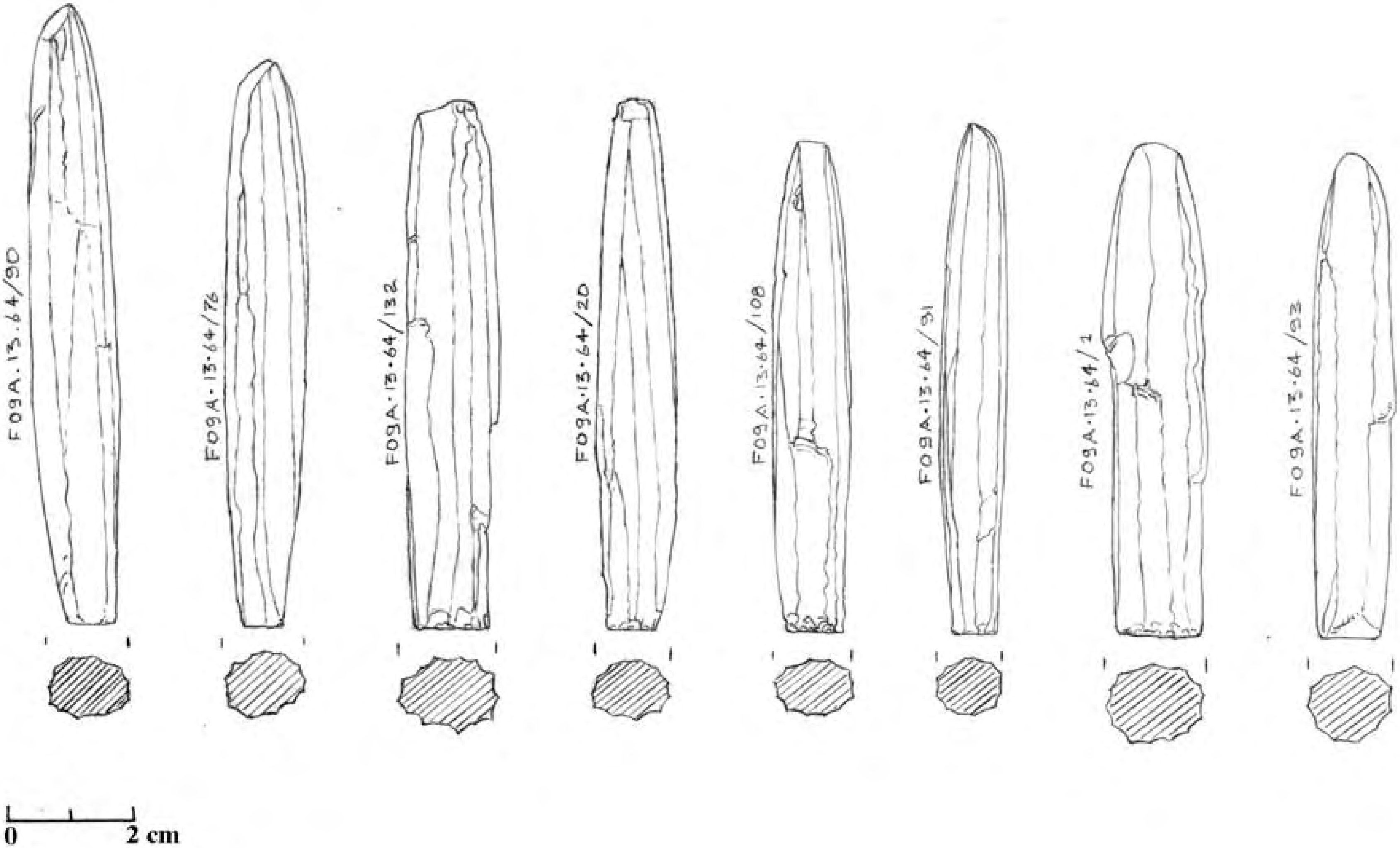
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

BOLSA I



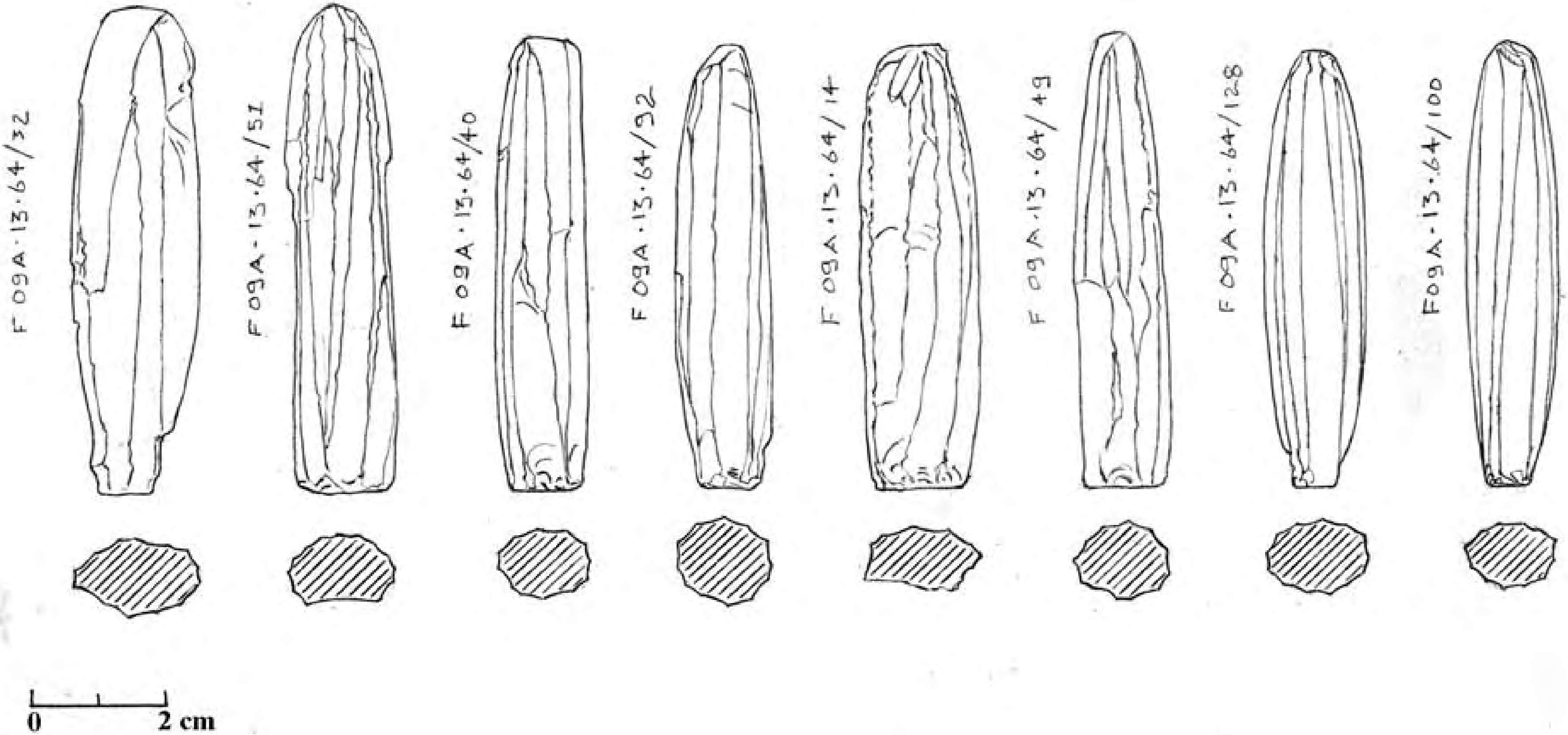
ISLA DE FLORES
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

BOLSA 1



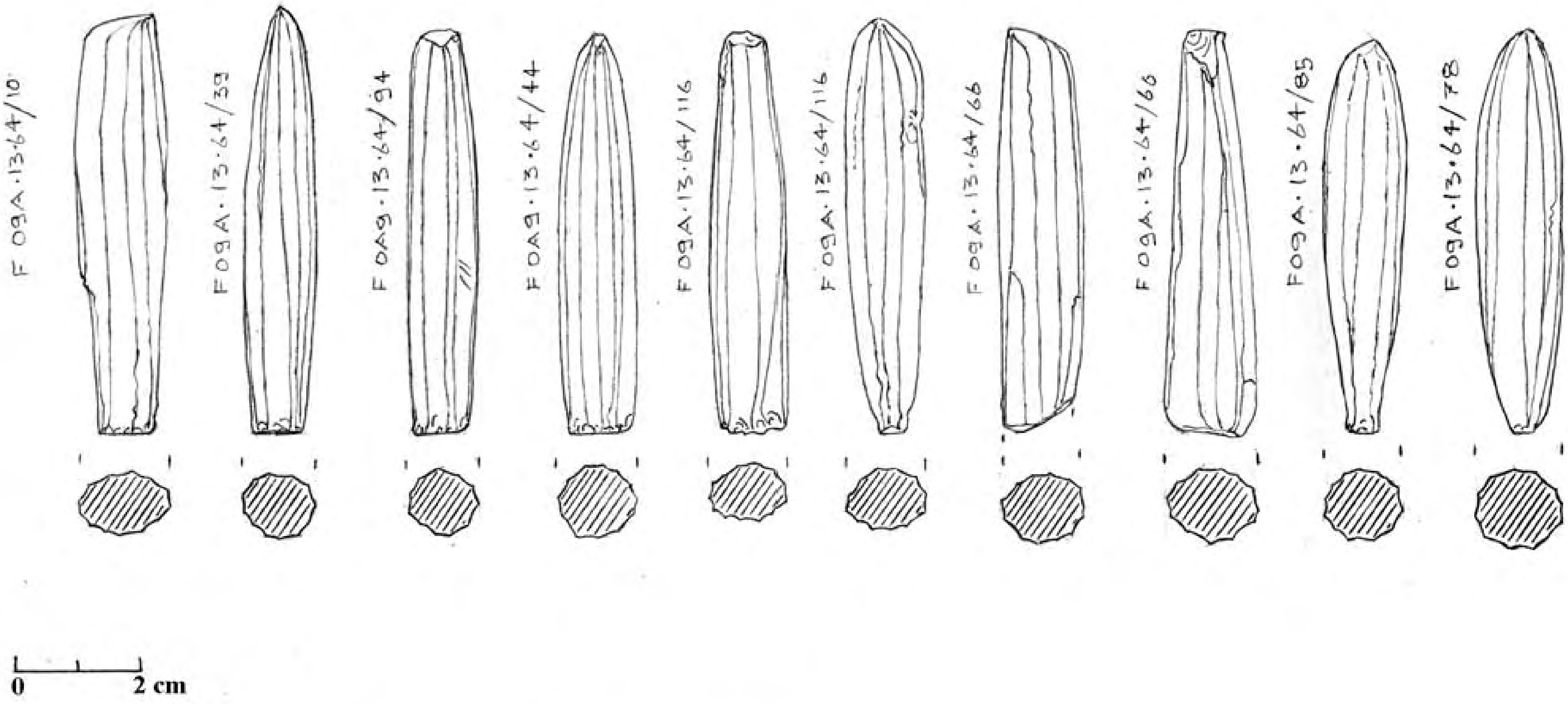
ISLA DE FLORES
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

BOLSA 1



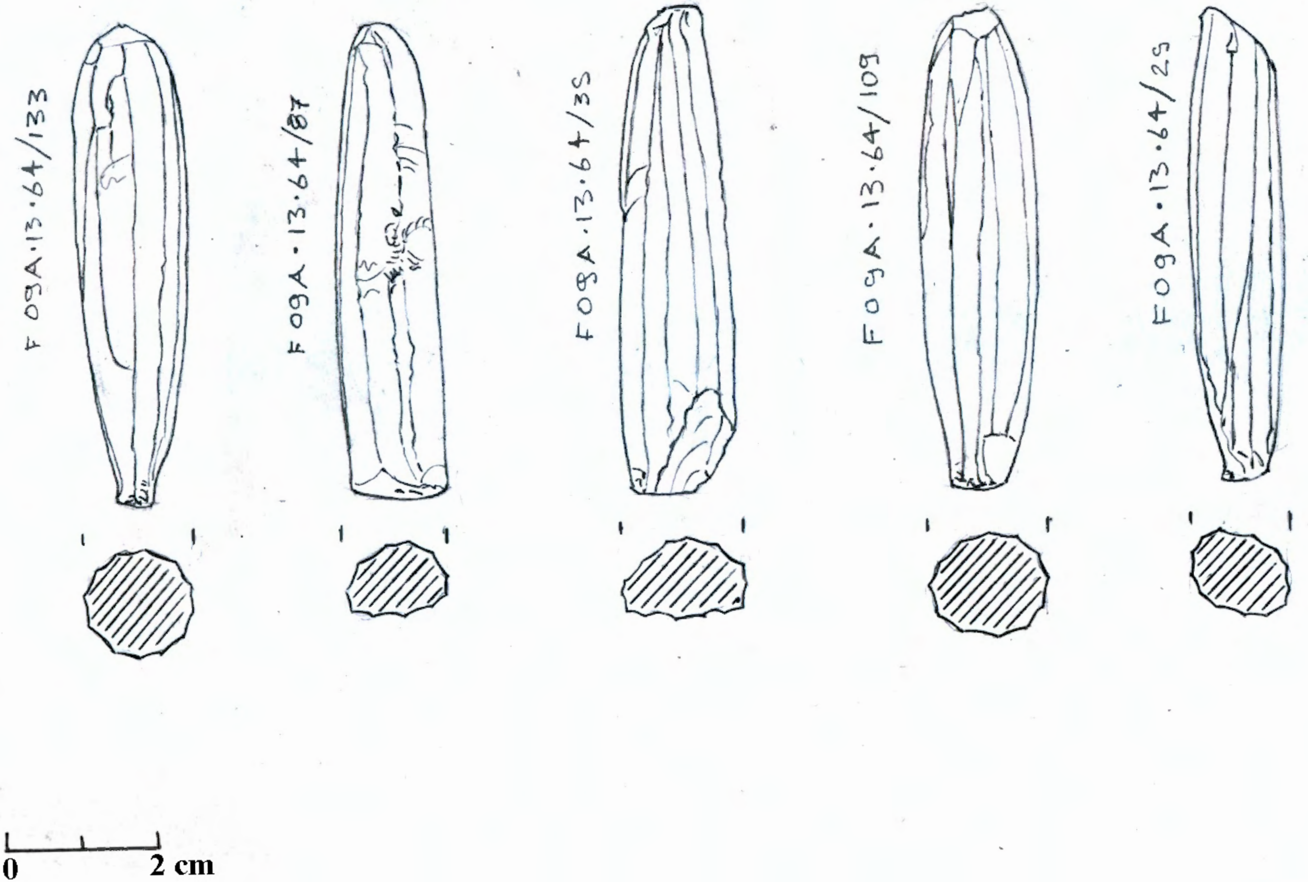
ISLA DE FLORES
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

Bolsa 1



ISLA DE FLORES
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

BOLSA 2



ISLA DE FLORES
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

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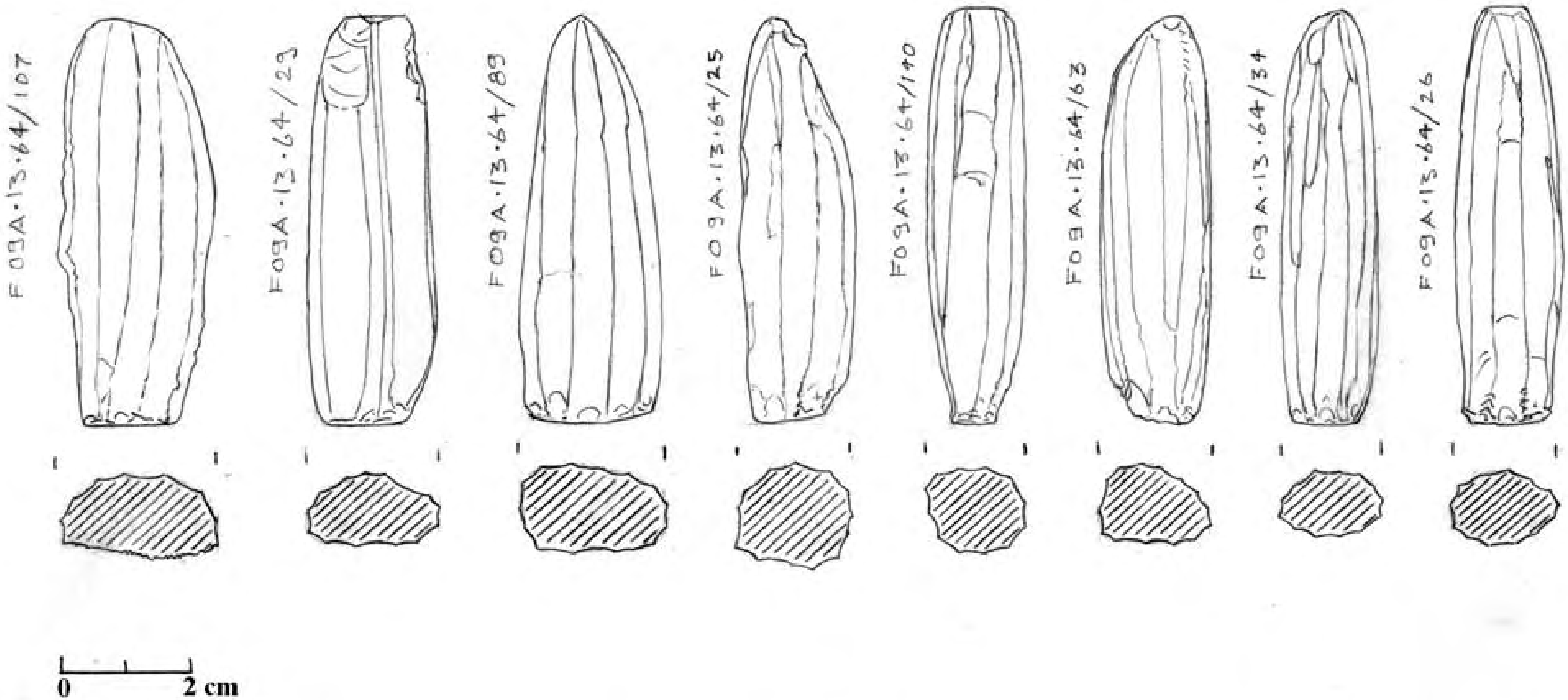
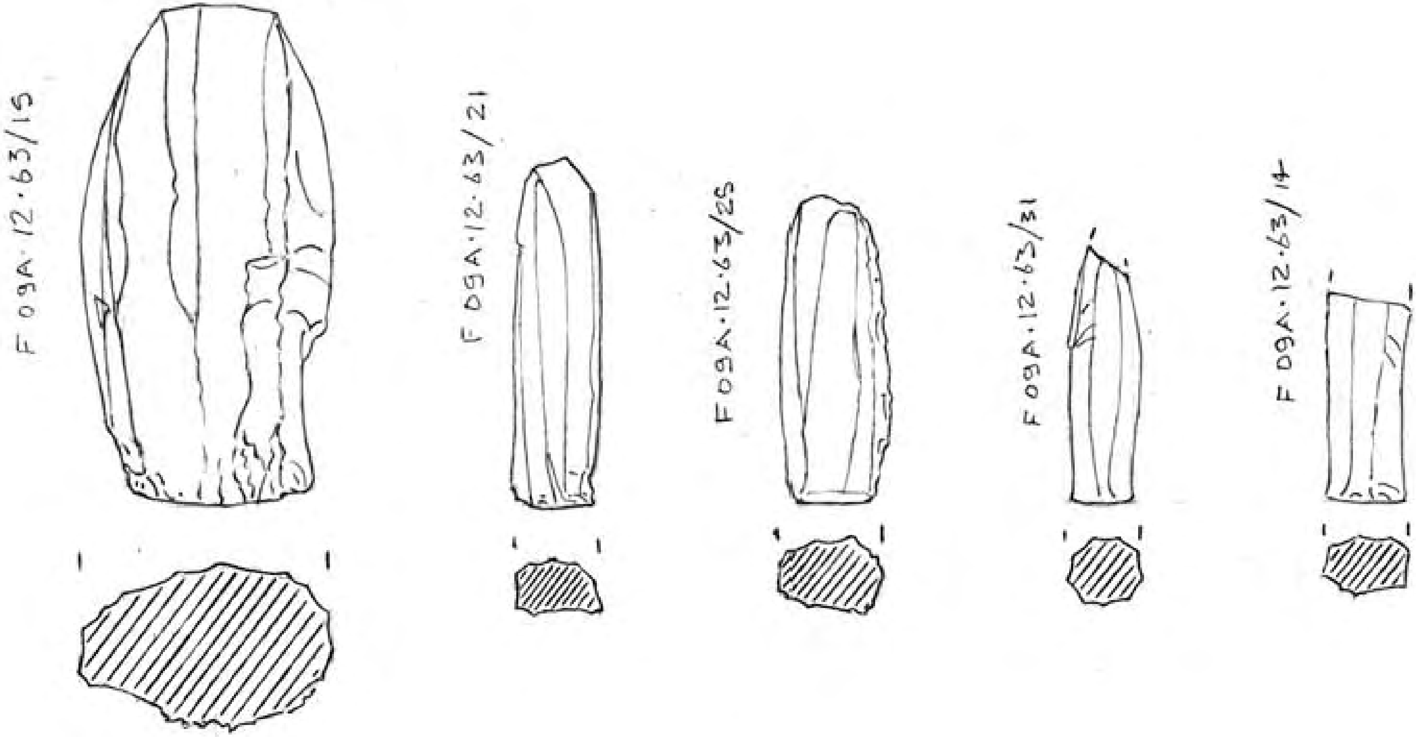


ISLA DE FLORES
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

BOLSA 2

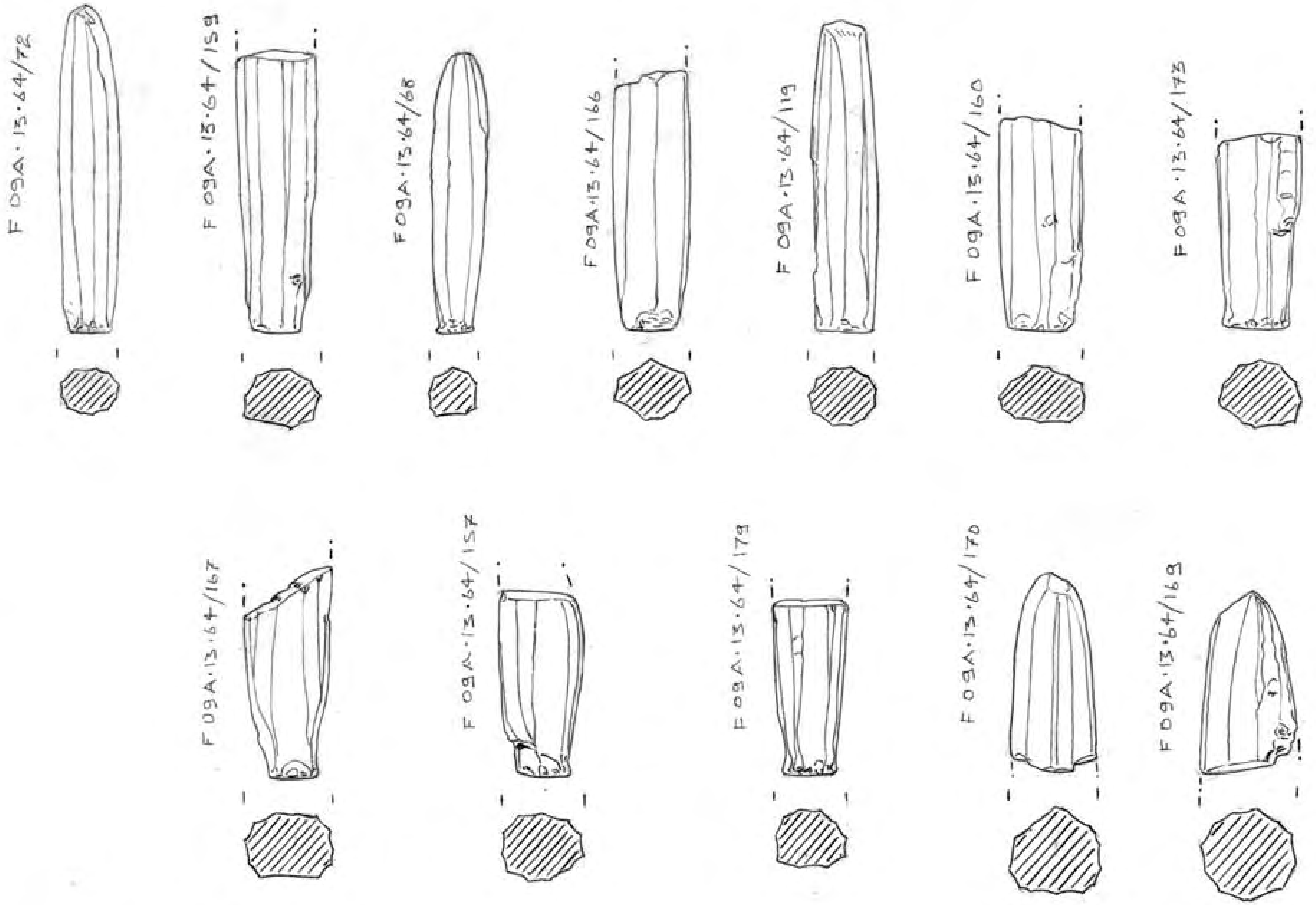


Lascas
B - 11
? X - 9
? x - 10

0 2 cm

ISLA DE FLORES
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

BOLSA 3



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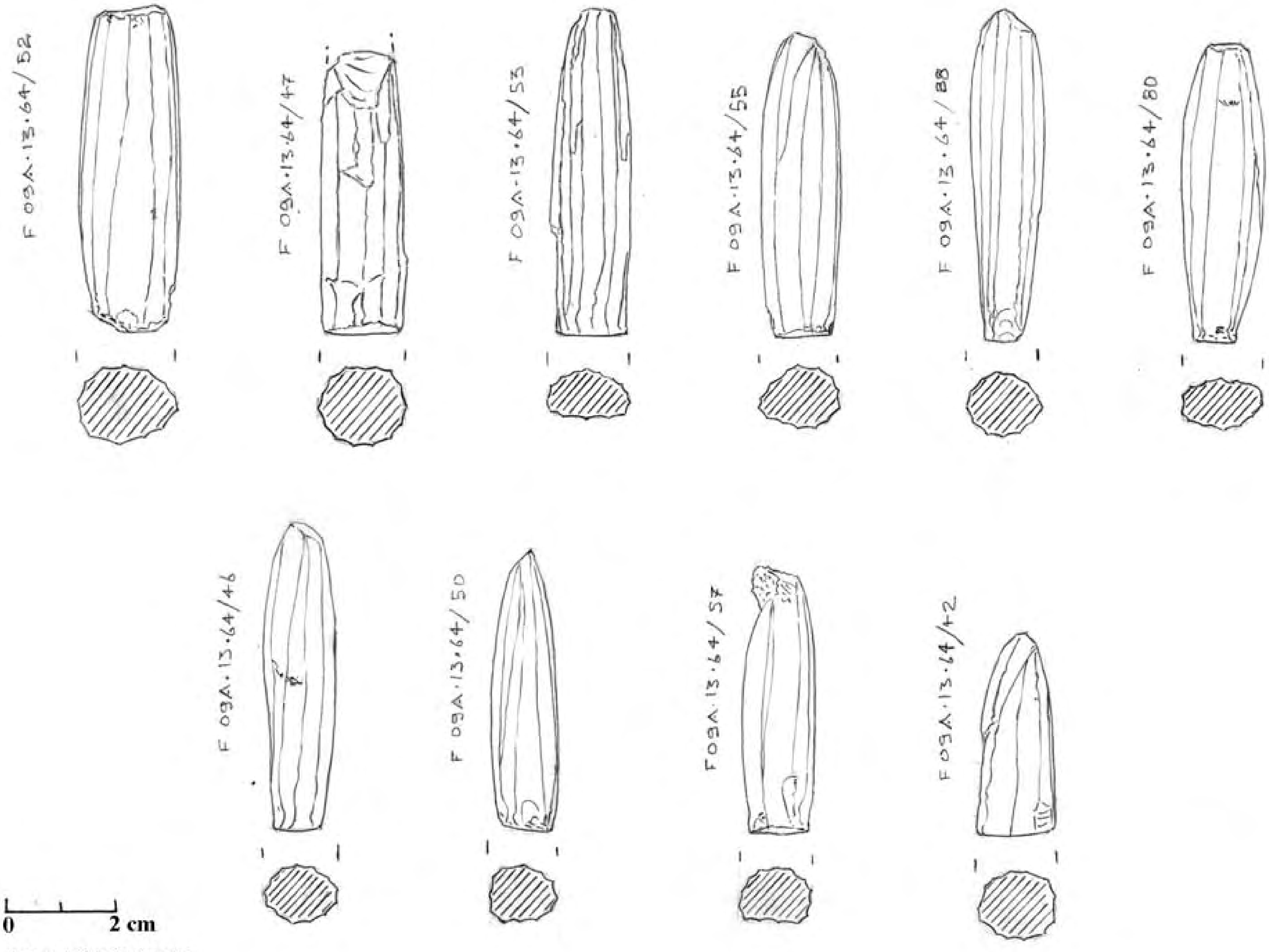
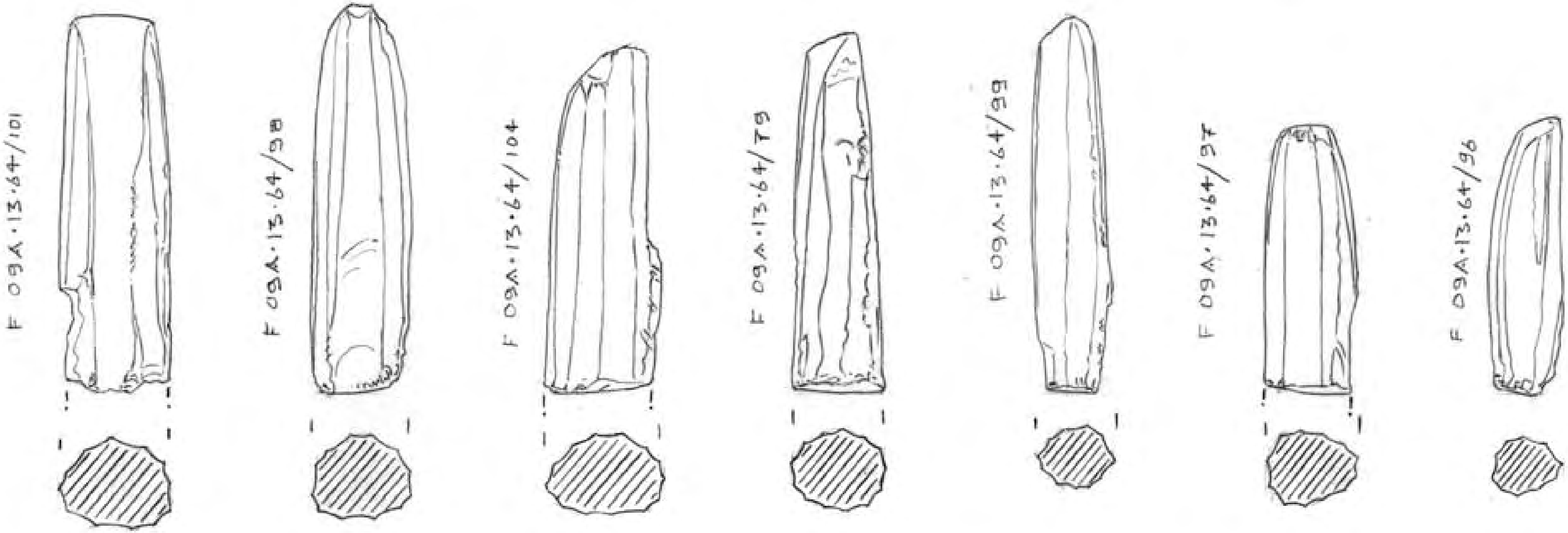
ISLA DE FLORES
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

Bolsa 4



ISLA DE FLORES
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

Bolsa 6



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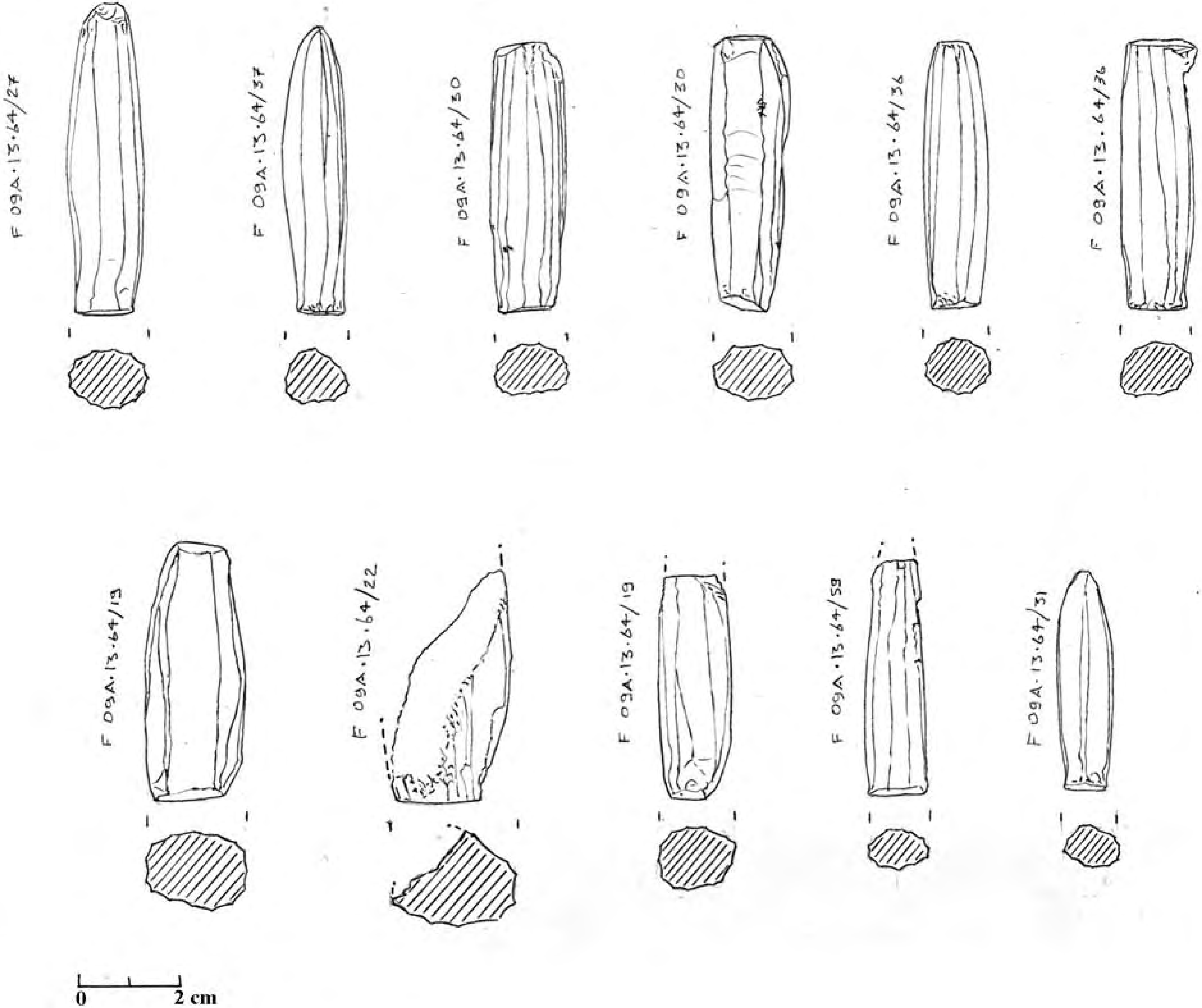
ISLA DE FLORES
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

Bolsa 9



ISLA DE FLORES
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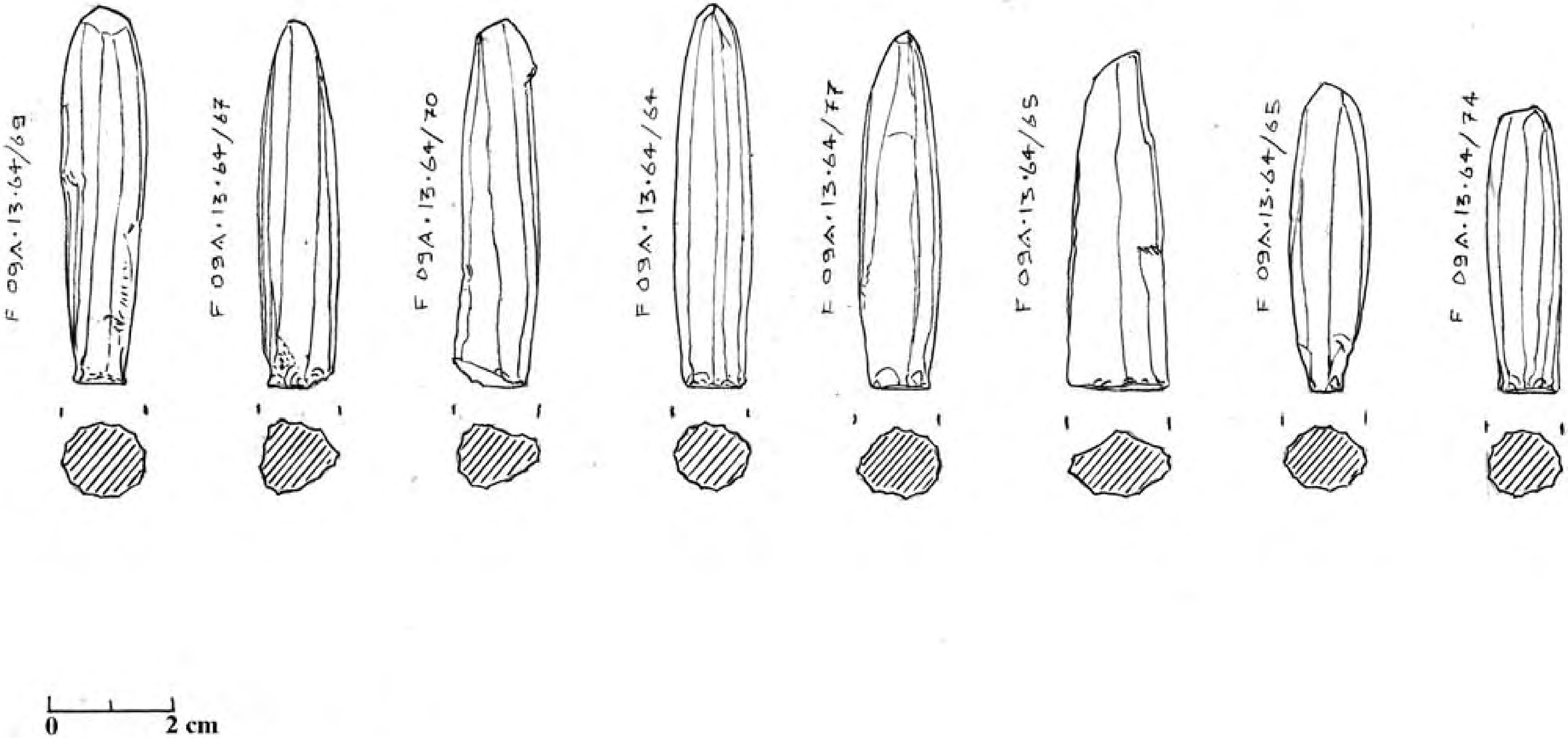
OP.09A, temporada 1992



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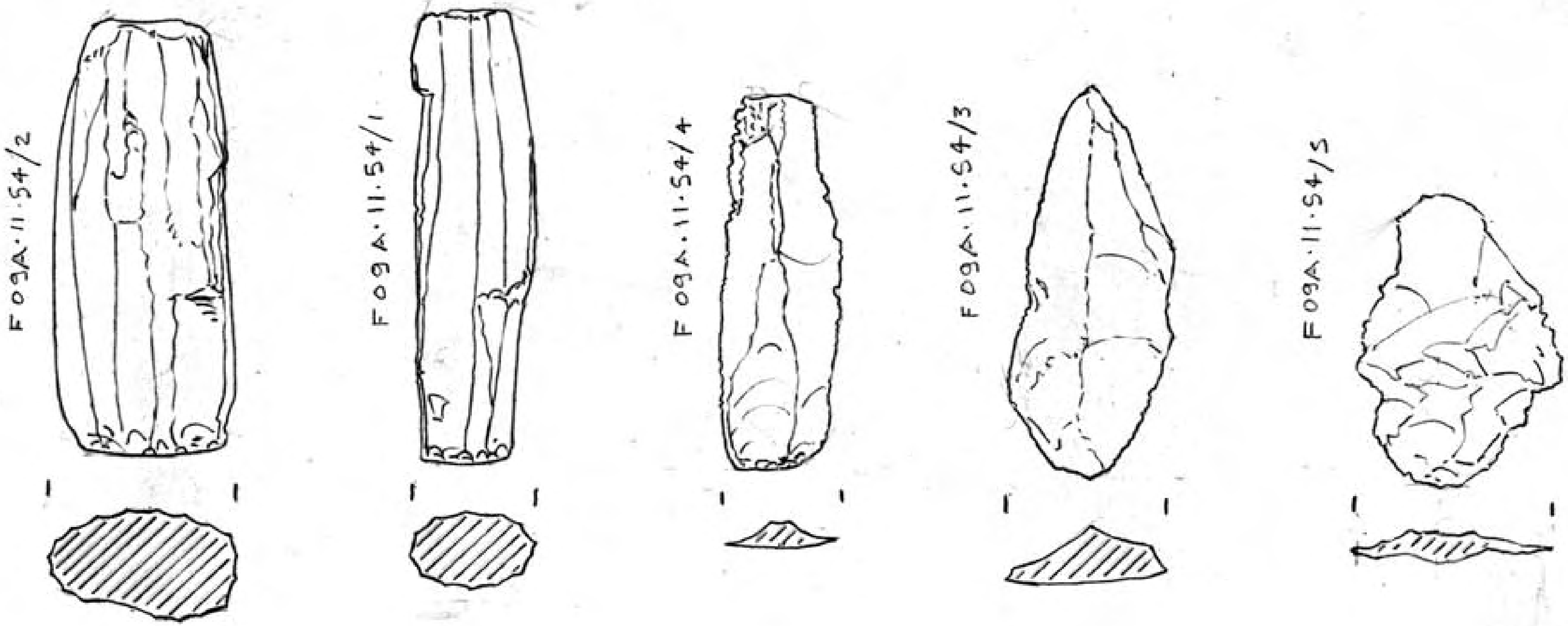
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

Bolsa 11



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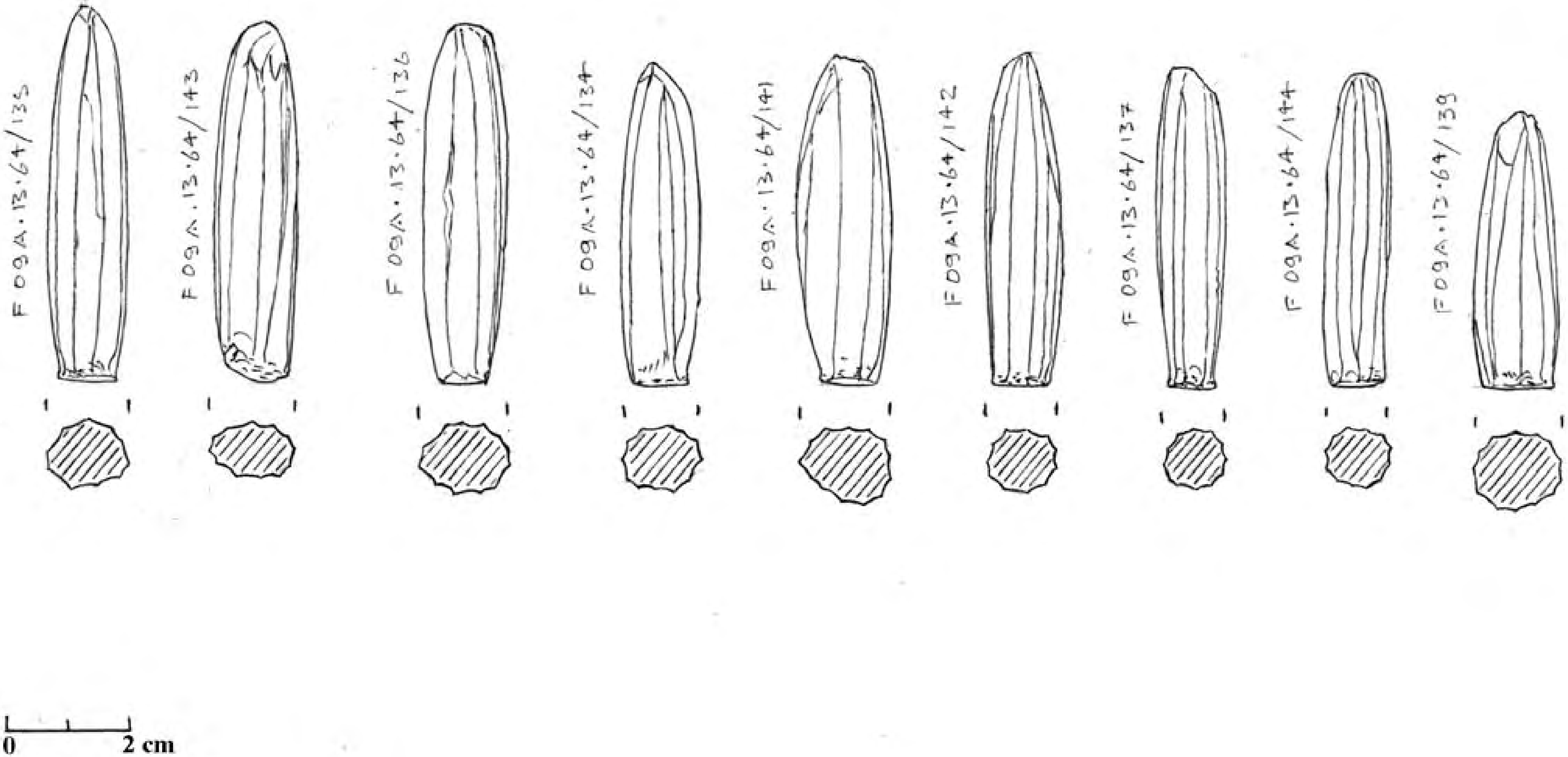
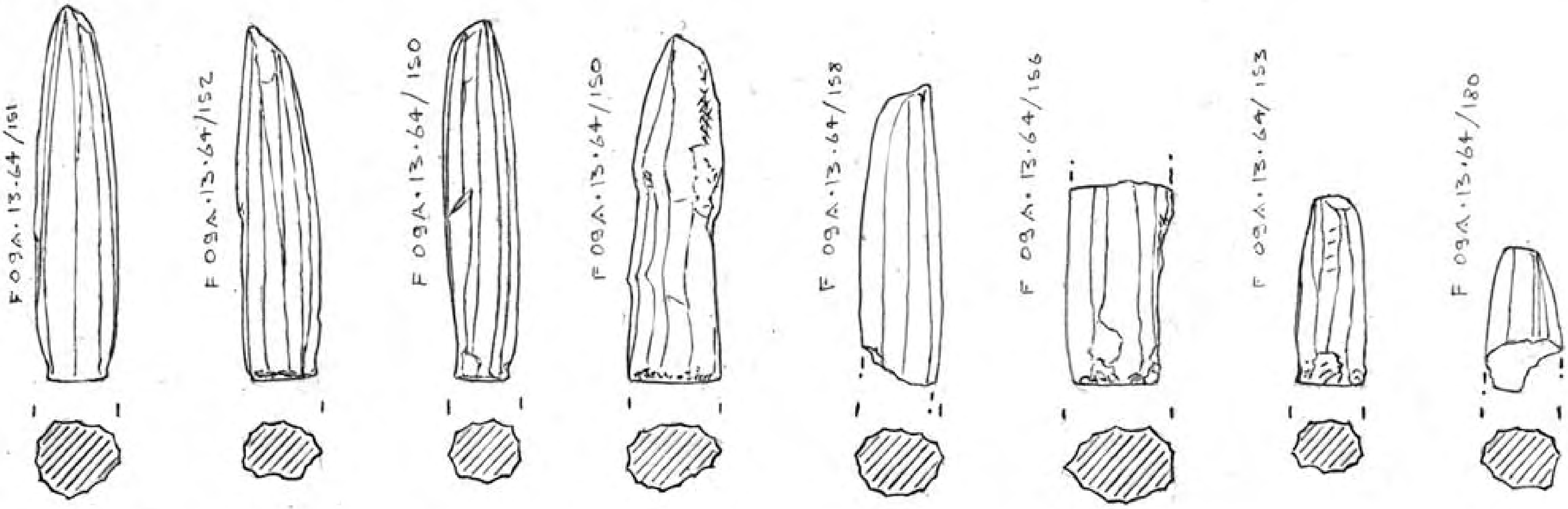
OP.09A, temporada 1992

bolsa 19



ISLA DE FLORES
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

Bolsa 5



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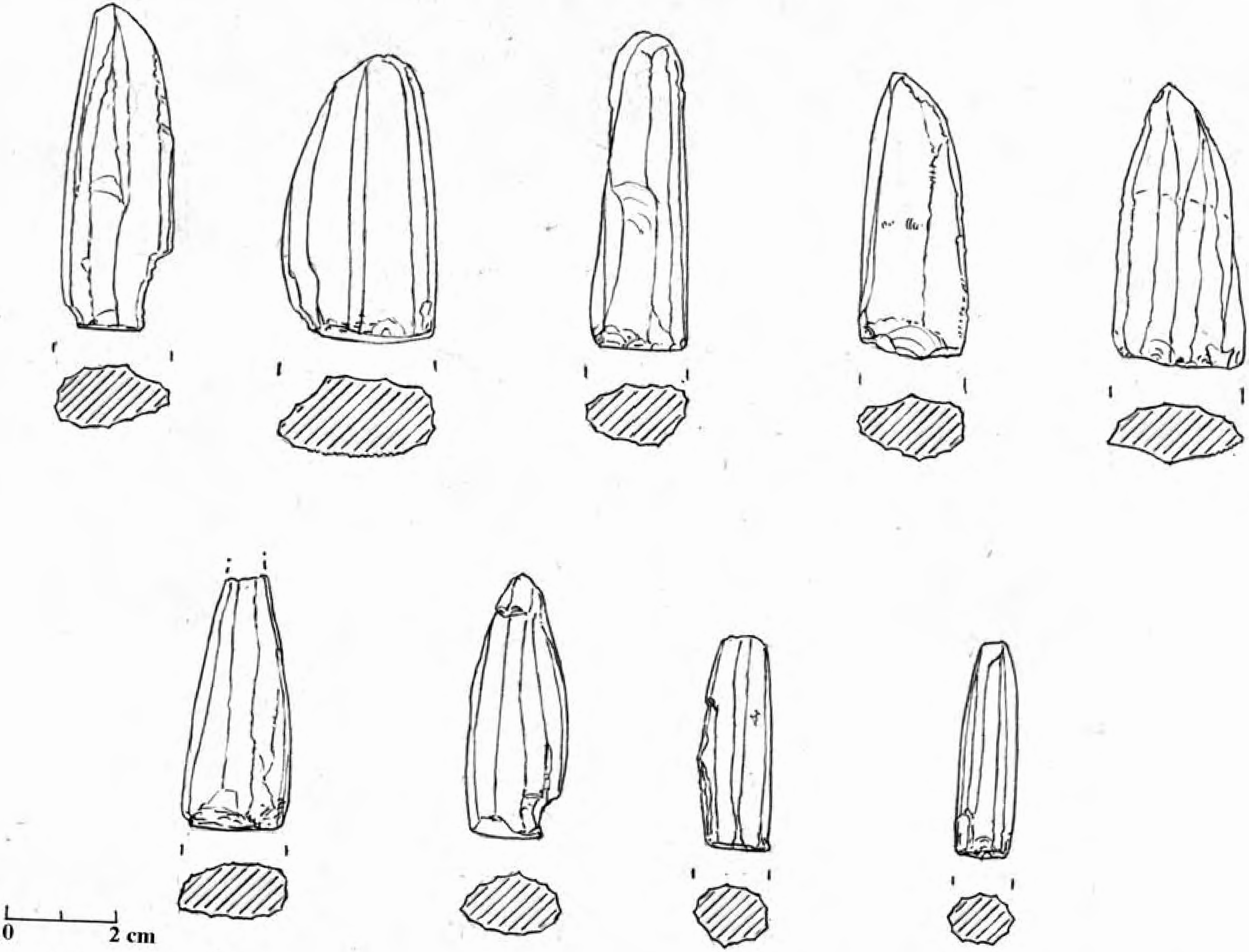
ISLA DE FLORES
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

Bolsa 14



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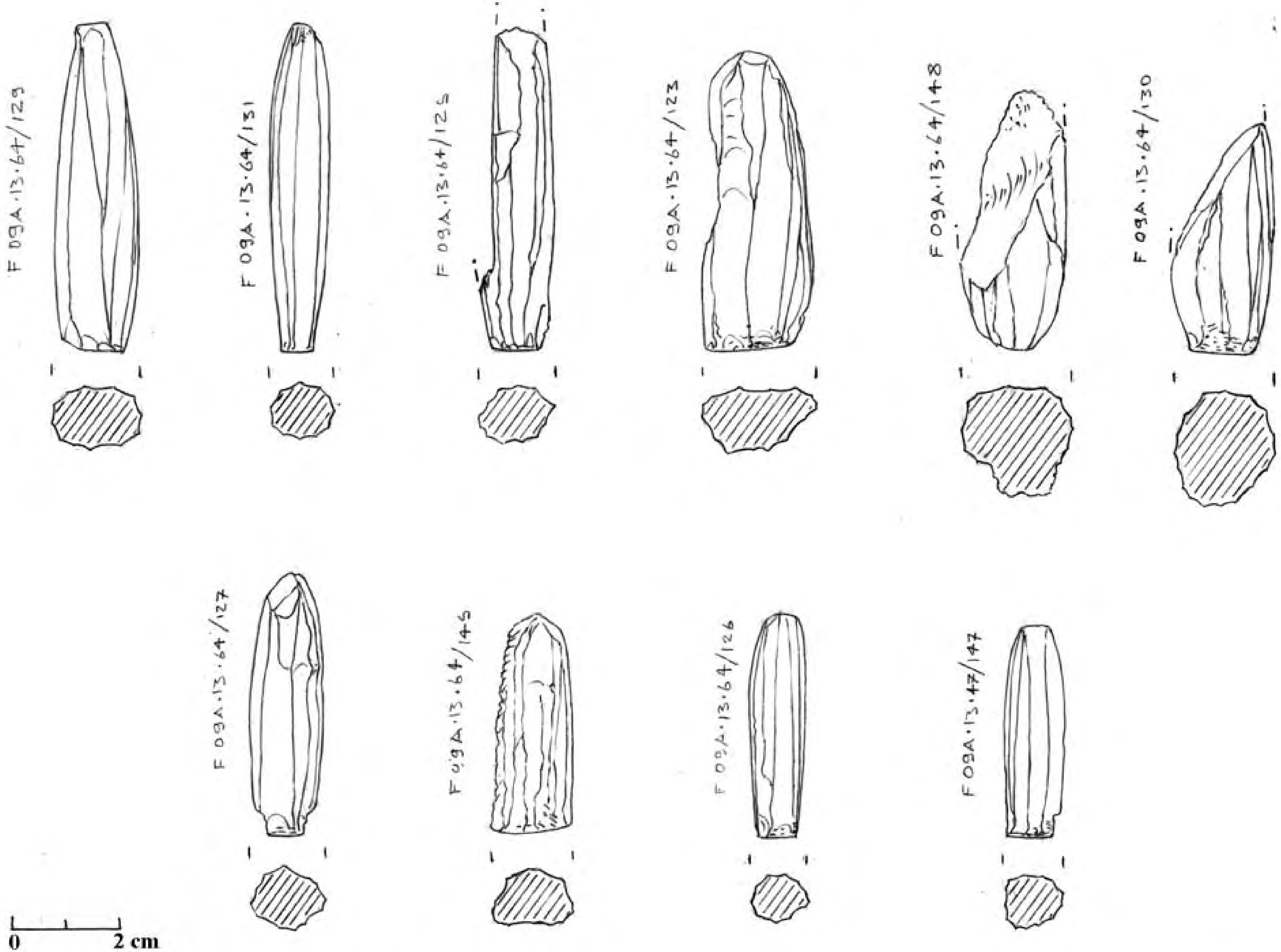
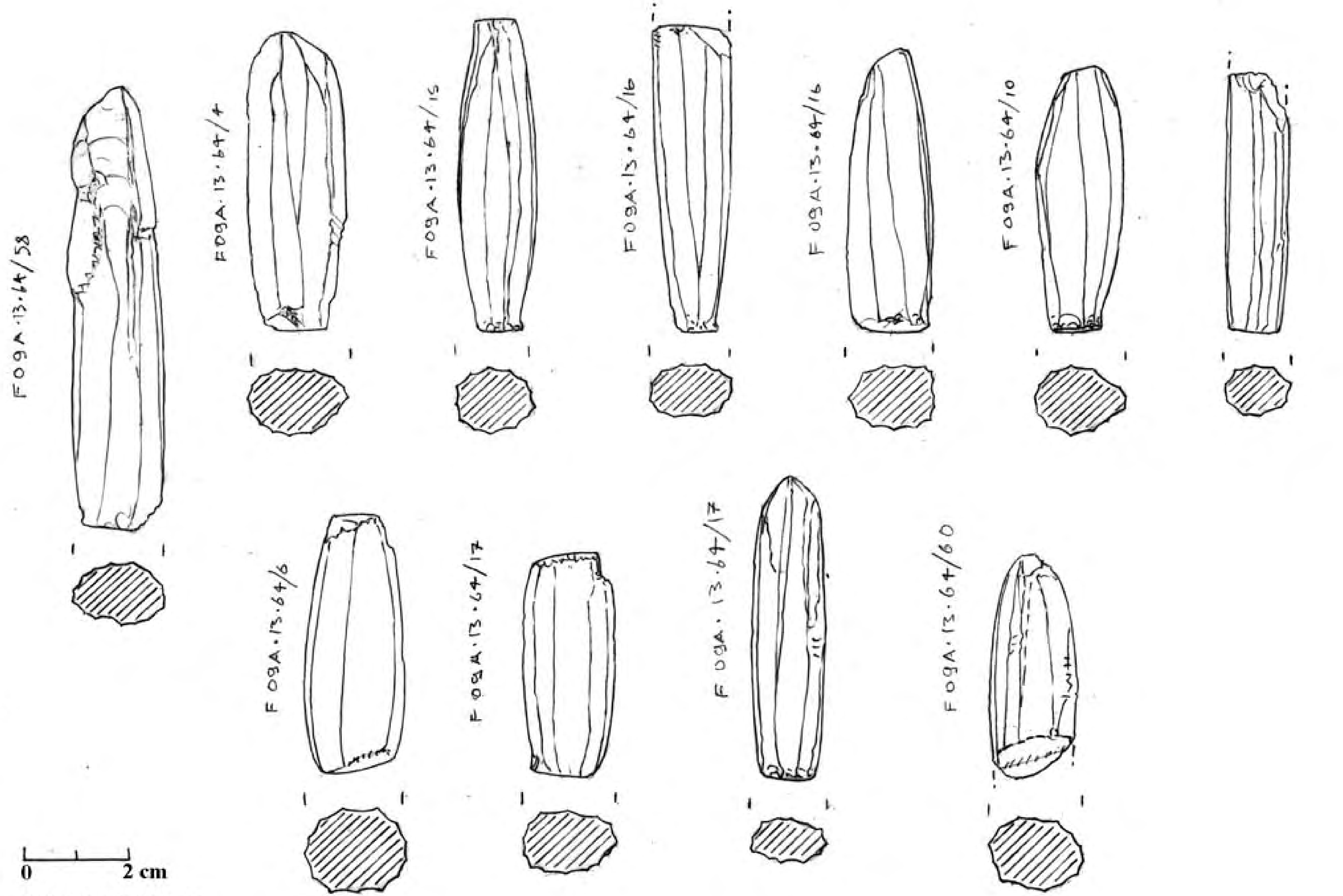
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

Bolsa 7



ISLA DE FLORES
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

Bolsa 80



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Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

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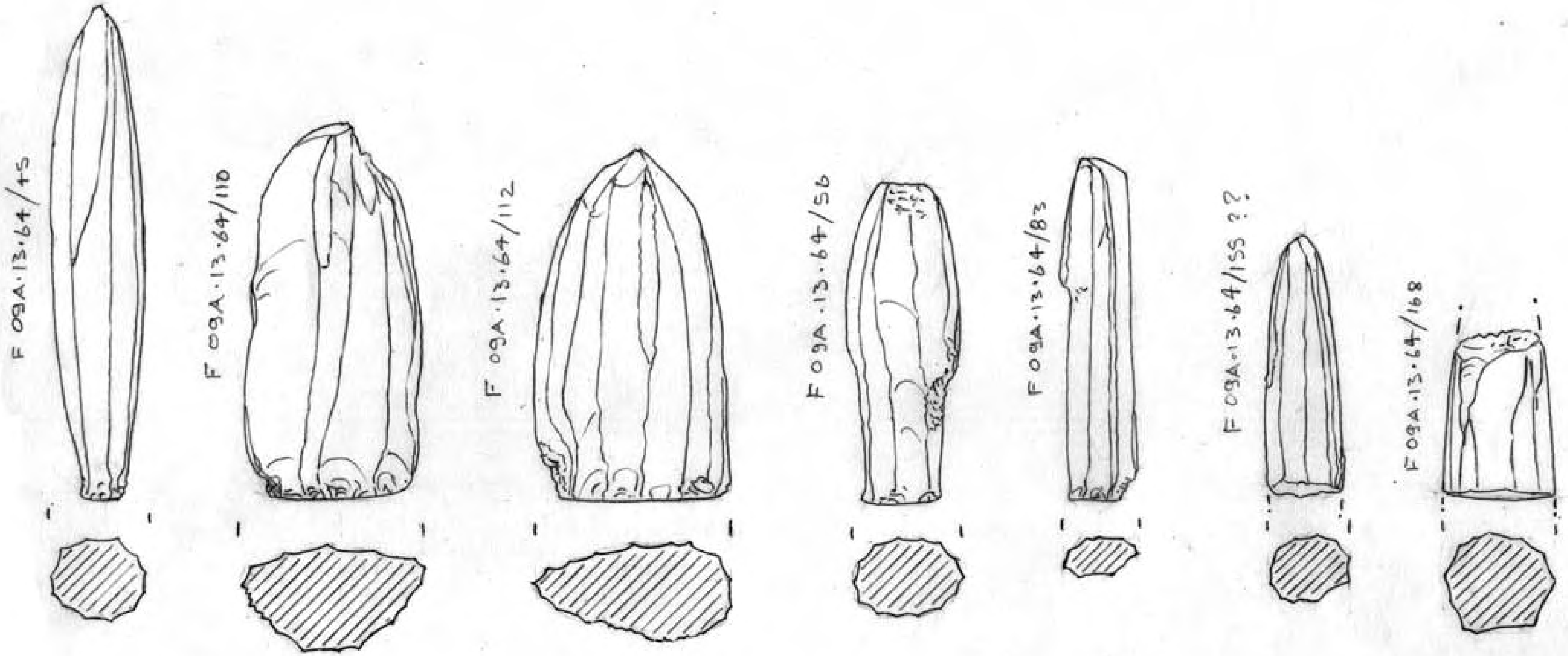

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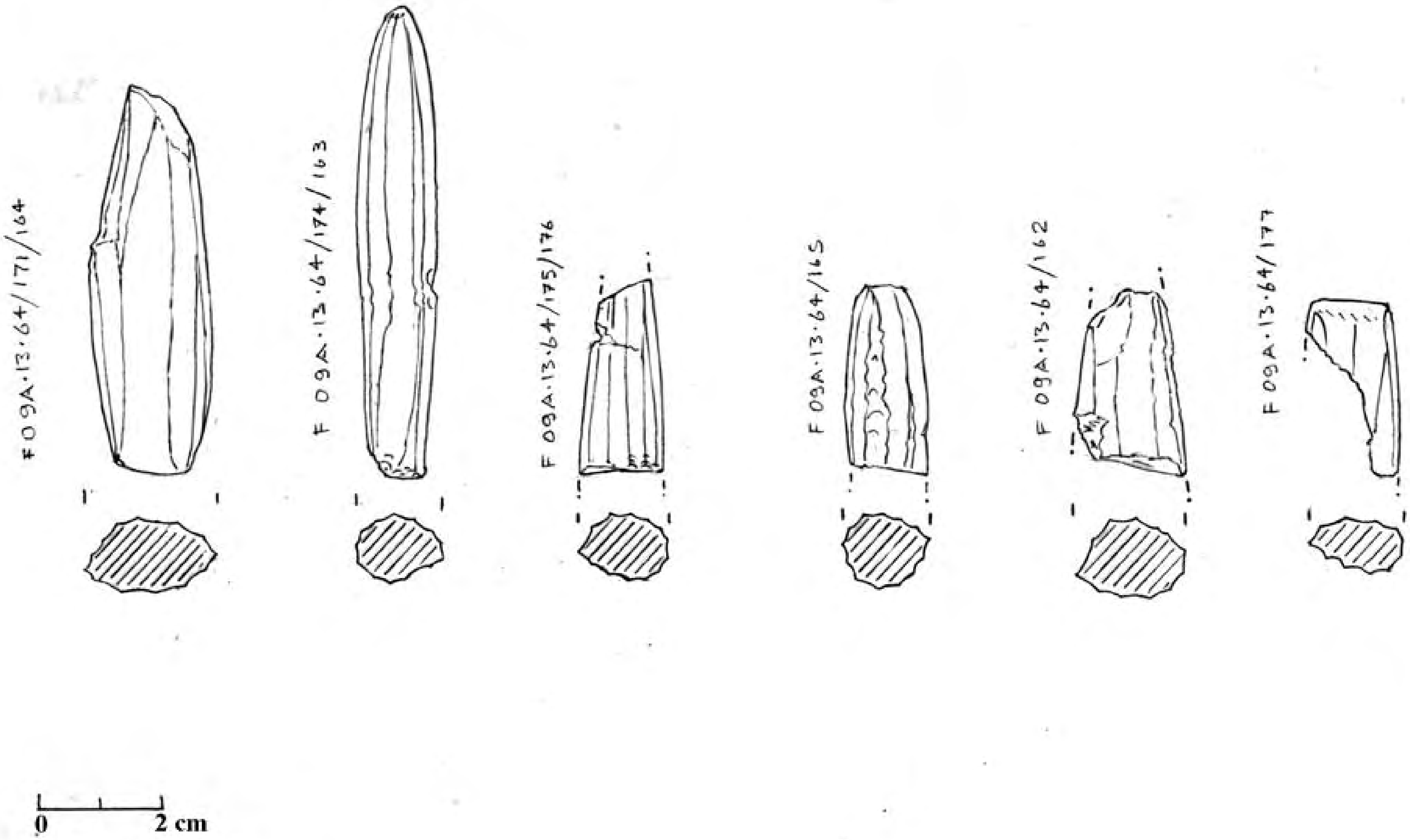
OP.09A, temporada 1992



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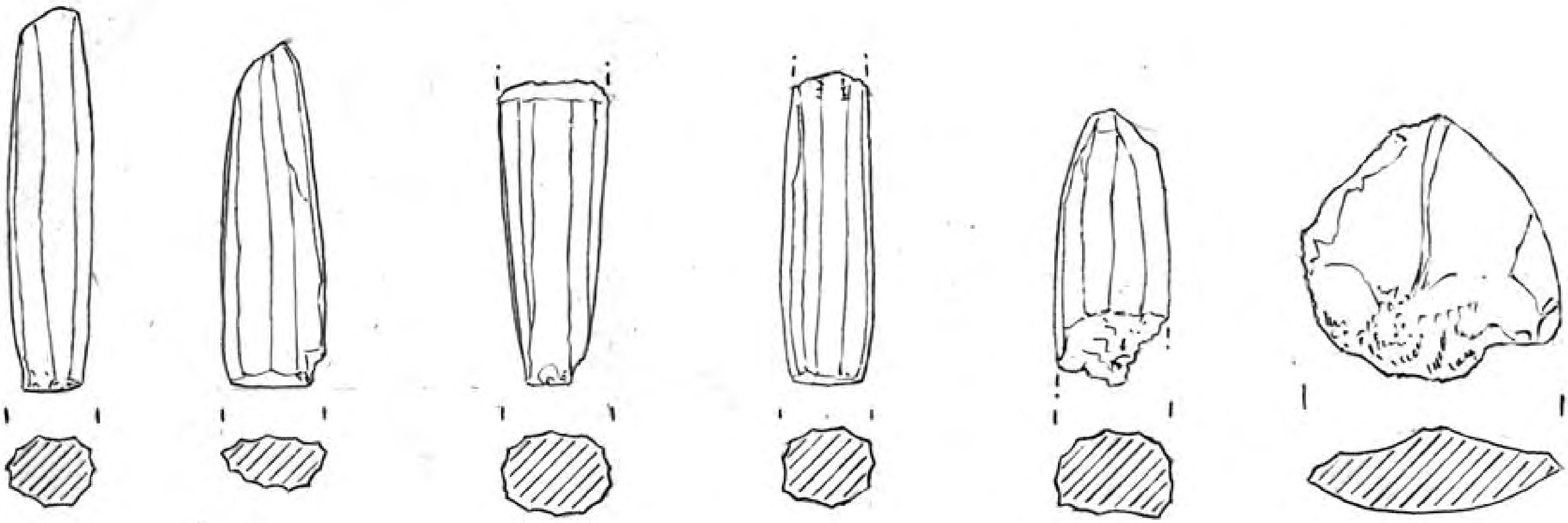
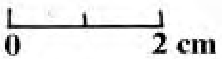
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

bolsa 15





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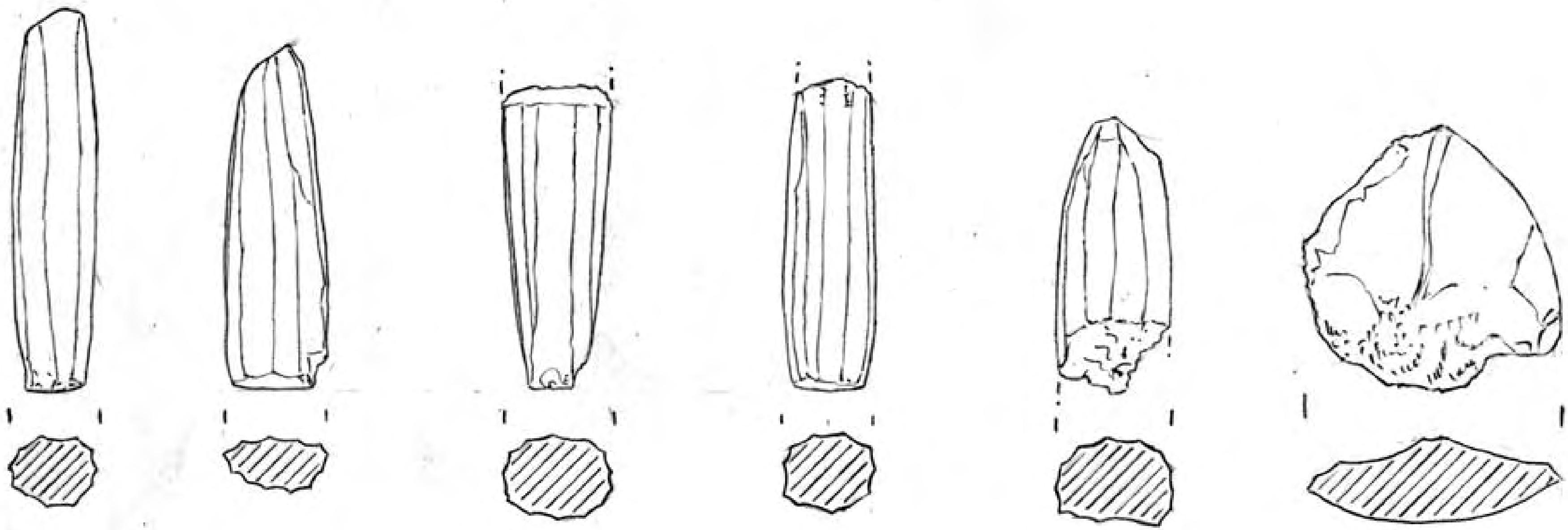
OP.09A, temporada 1992

Bolsa 17



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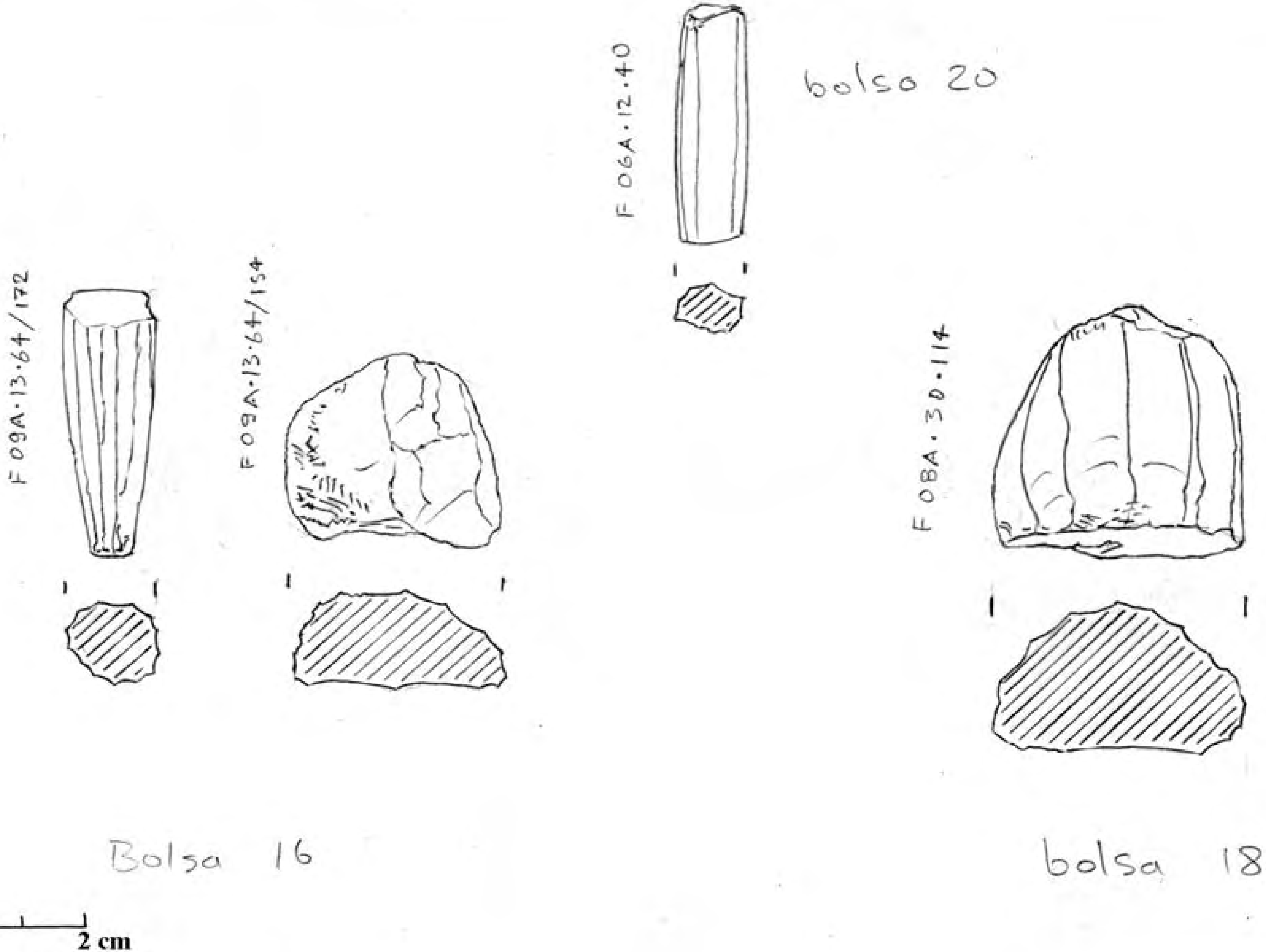
Proyecto PRIAMPEG-RAINPEG
OP.09A, temporada 1992

Bolsa 17



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