Ancient Obsidian Procurement and Production in the Peten Campechano: Uxul and Calakmul During the Early Classic to Terminal Classic Periods

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Abstract: Obsidian, or volcanic glass, was a widely exchanged material used by the ancient Maya to make tools and ornaments. Because there are no obsidian sources within the karstic Maya lowlands, inhabitants of that region had to rely on extensive trade networks stretching hundreds of kilometers. In this study, I compare obsidian procurement and production patterns at Uxul and Calakmul, two extensive and urbanized sites in southern Campeche, Mexico. Hieroglyphic texts demonstrate that Uxul was an independent polity during much of the Early Classic but was absorbed by the powerful regional state centered at Calakmul during the Late Classic period. Study of obsidian artifacts from both sites reveal important differences in procurement and production patterns. The Uxul obsidian collection demonstrates important trade connections – direct or indirect – with Teotihuacan during the Early Classic period, ties that are seen only very weakly at Calakmul itself. Thus it appears that at this early period in its history, Uxul was economically independent of the lords of Calakmul. Finally, the obsidian collection from Uxul is consistent with an early decline and virtual abandonment of the site in the eighth century, long before the final abandonment of Calakmul some time after A.D. 900.

Keywords: Obsidian exchange, Maya, Uxul, Calakmul, southern Campeche, Mexico, Classic period.

Resumen: Obsidiana o vidrio volcánico fue un material ampliamente intercambiado y utilizado por los antiguos mayas para hacer herramientas y adornos. Dado que no hay fuentes de obsidiana en las tierras bajas mayas kársticas, los habitantes de esa región dependieron de redes comerciales que se extendían por cientos de kilómetros. En este estudio comparo las maneras de obtención y de tratamiento de obsidiana en Uxul y Calakmul, dos sitios grandes y urbanizados en el sur de Campeche, México. Los textos jeroglíficos demuestran que Uxul fue una entidad política independiente durante gran parte del Clásico Temprano, pero fue absorbida por el poderoso estado regional centrado en Calakmul durante el Clásico Tardío. La obsidiana es mucho más abundante en Uxul que en Calakmul, especialmente en contextos que datan del período Clásico Temprano. Por otra parte, la colección de obsidiana de Uxul demuestra importantes relaciones comerciales –directas o indirectas– con Teotihuacan en ese período, lo que no parece ser aplicable a Calakmul. Parece que en este primer periodo de su historia, Uxul fue económicamente independiente de los señores de Calakmul. Por último, la colección de obsidiana de Uxul corresponde a una caída temprana y al abandono virtual del sitio en el siglo VIII, mucho antes del abandono definitivo de Calakmul algún tiempo después del año 900 d. C.

Palabras clave: Intercambio de obsidiana, maya, Uxul, Calakmul, Petén Campechano, México, período Clásico.

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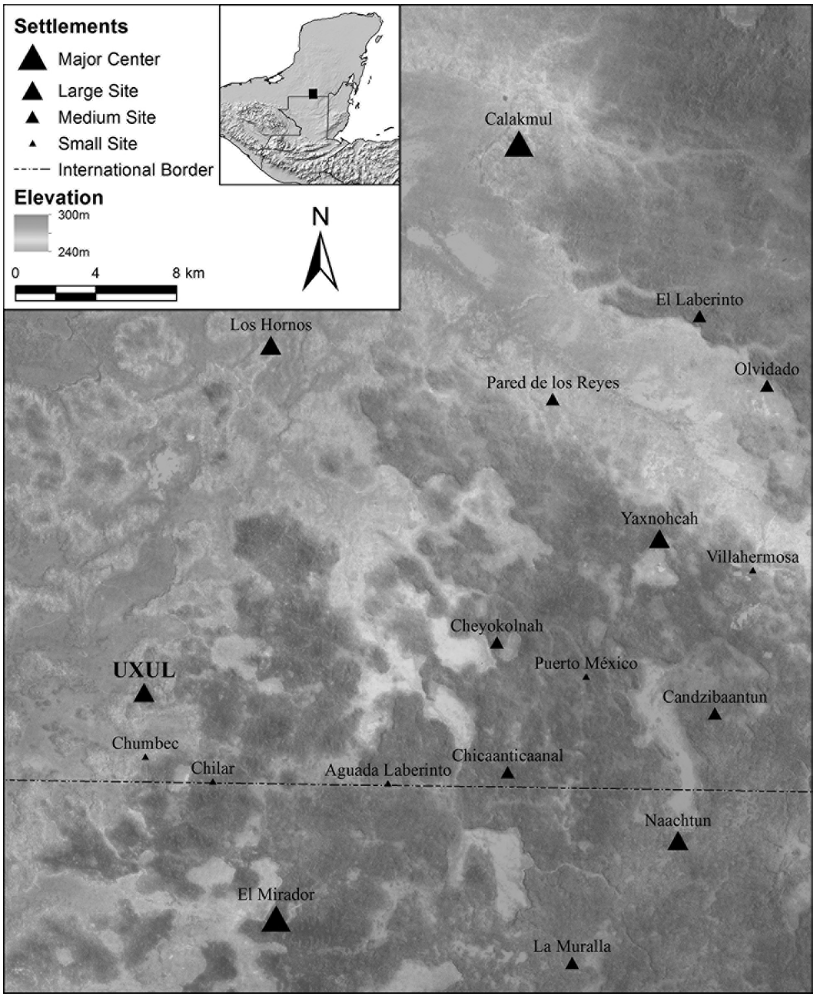

Figure 1. Location of Uxul and Calakmul as well as other sites in northern Guatemala and southern Campeche (prepared by Beniamino Volta; after Braswell 2012: PowerPoint Slide 2; see also Grube et al. 2012: Figure 1).

Many of the largest Preclassic and Classic Maya cities ever built are found in the Peten Campechano and adjoining areas of the northcentral Peten, in an area long called the Mirador Basin (Figure 1). During the Middle Preclassic, Nakbe emerged as the largest and perhaps first urban center in the region. During the Late Preclassic, areas on both sides of the modern international border were dominated by the great city of El Mirador. The collapse of the Late Preclassic political system during the second century A.D. witnessed a demographic decline in much of the southern half of this region, but major sites continued to flourish – and some new ones emerged – in the Peten Campechano. These include the Early to Late Classic city of Uxul and also Calakmul, the largest Maya city in Mexico and what would eventually become the seat of the powerful Snake Head dynasty.

The inhabitants of the Peten Campechano obtained many important resources (such as obsidian, jade, feathers, salt, and even some pottery and ground stone) from outside of the region. Such interregional exchange involved elaborate trade routes and even more complex political relations with neighbors to the north and south. In this paper, I discuss the procurement of obsidian and the production of artifacts made of that material during the Classic period at two of the most important cities of the Peten Campechano: Calakmul and Uxul (Figures 2-4). Artifacts recovered from these sites reveal complex and shifting patterns of trade that fluctuated with the political fortunes of major polities in the Maya lowlands and beyond. Moreover, the distribution and quantity of artifacts indicate that economic boundaries among many Maya polities were closely controlled, forcing individual cities to form their own exchange networks.

Calakmul and secondary cities of the Peten Campechano

Years ago, Joyce Marcus (1976) identified the archaeological site of Calakmul as the location of the Snake Head dynasty during the Late Classic period. Equally prescient, she used geography to argue that seventh century Calakmul administered three zones (Figure 5). The inner zone is defined by Oxpemul to the north, La Muñeca and Altamira to the east, Naachtun and Uxul to the south, and Sasilha to the west (Marcus 2012). A broader and indirectly administered zone of client sites and states extended from southern Campeche and Quintana Roo into northern Guatemala. Finally, Calakmul also influenced an outer political sphere that during certain periods included distant allies such as Dos Pilas, Naranjo, Caracol, and perhaps even Quirigua (see relevant chapters in Martin & Grube 2008).

The origins of the Snake Head polity and the location of its capitals are still a matter of discussion. It is possible that El Mirador was the first seat of Snake Head kings (Grube 2004). More certainly, the Snake Head emblem glyph appeared for the first time at Dzibanche during the early sixth century, that is, towards the end of the Early Classic period. Because no example of the emblem glyph is known at Calakmul

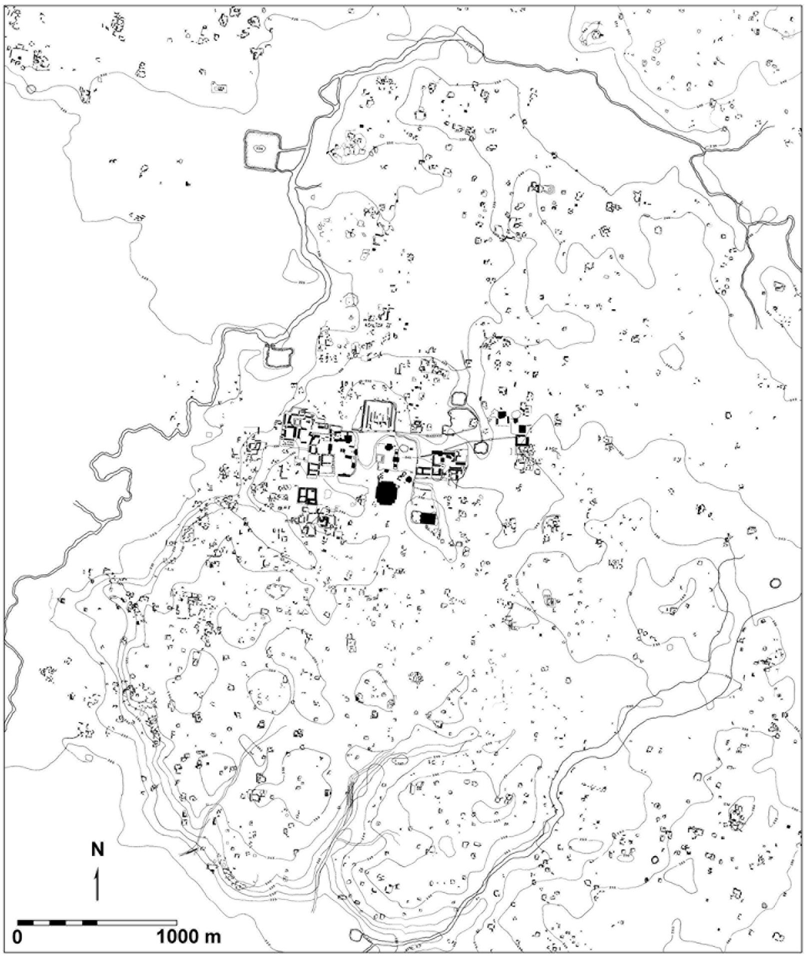

Figure 2. Calakmul, Mexico (after Braswell et al. 2004: Figure 9.2).

at that time, one possibility is that the kingdom was then centered at Dzibanche. The first clear evidence we have that the Snake Head polity was based at Calakmul dates to A.D. 631, when Yuknoom Head, Snake Head Lord of Ux te' Tuun and Lord of Chiik Nahb (two already ancient toponyms referring to the city of Calakmul) conquered Naranjo (Martin & Grube 2008: 108). What is certain is that the ensuing period – A.D. 636 to 695 – represents the high-water mark of Calakmul as a dominant power in Maya political intrigue and, it is reasonable to expect, economic exchange. Although there are still reasonable doubts as to when and why Calakmul began to decline, it seems certain that the eighth and early ninth centuries saw the slow waning of the political influence of Calakmul. Small remnant populations, including individuals who claimed to be kings, stayed in what was left of the great city until the early tenth century (Braswell et al. 2004).

Throughout its long history, how was Calakmul integrated with its neighbors in the inner zone? Nikolai Grube (2005; Grube et al. 2012) has compared the hieroglyphic monuments of several sites to help answer this question. At Uxul, many hieroglyphic monuments date to the period of dominance by the Snake Head kings at Calakmul, that is, the seventh century. There also is ample evidence of Early Classic occupation at Uxul, during which time the site also seems to have been somehow politically deferential or subservient to the local lords (who were not Snake Head kings) of Calakmul. Like Calakmul, Uxul seems to have begun its decline during the early eighth century. In contrast, Oxpemul seems to have had a very different relationship with both the local lords of Calakmul and the Snake Head kings. After erecting an Early Classic monument, Oxpemul would remain subservient to Calakmul until A.D. 731, that is, well into the period of decline, when it was able again to signal its independence of the Snake Head kings (Grube 2005; Robichaux 2010; Robichaux & Pruett 2005).

Throughout the Early and Late Classic periods, times when the Maya did not have fully commercialized or competitive markets (Braswell 2010; Braswell & Glascock 2011), obsidian was an important part of the political economy (Aoyama 2011). Political relationships suggested by hieroglyphic monuments should be reflected in exchange patterns. Moreover, it may be possible to test certain historical narratives using economic data derived from obsidian.

This study describes the analysis of two obsidian collections. The first, from Calakmul, comprises 451 of a total of 515 artifacts collected by members of the Proyecto Calakmul, directed by William Folan of the Universidad Autónoma de Campeche (Braswell & Glascock 2011). The second, from Uxul, consists of 1,200 obsidian artifacts. These were recovered by members of the Proyecto Uxul, directed by Nikolai Grube and Antonio Benavides, in 2009 and the first half of the 2010 season. I am grateful to the participants and directors of both projects for the cordial invitations to conduct research with them.

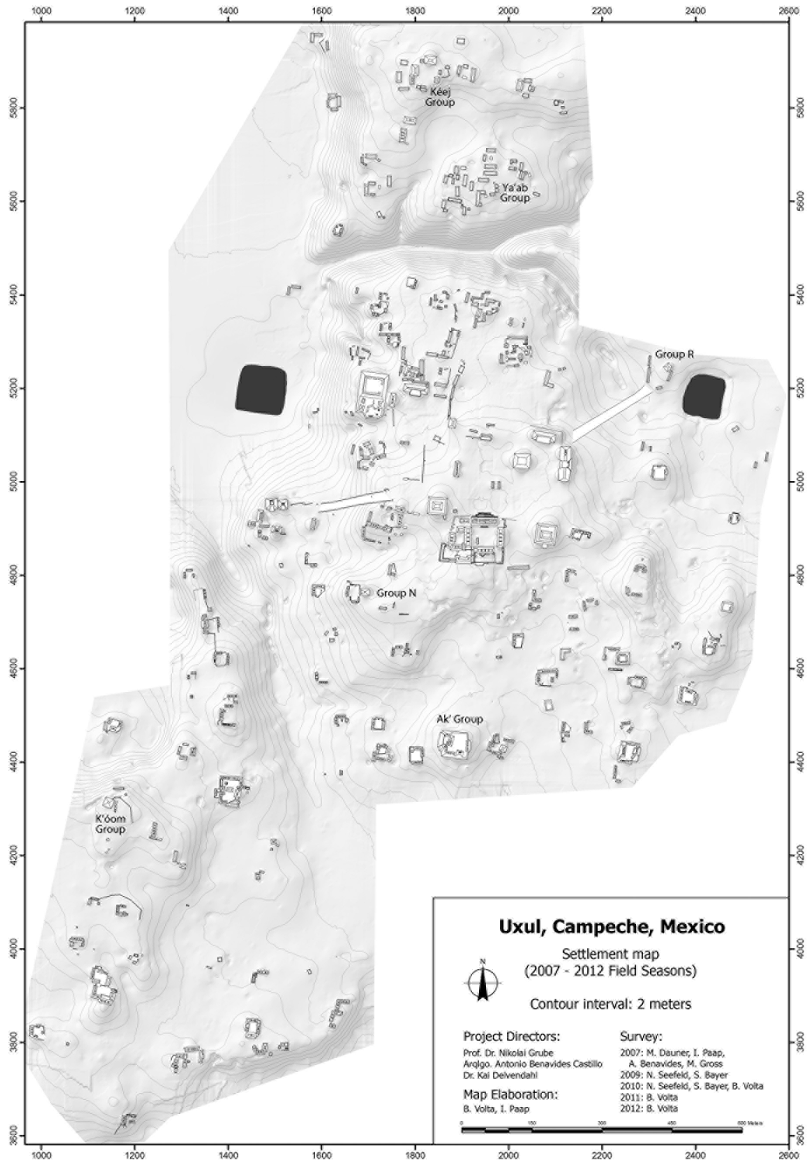

Figure 3. Uxul, Mexico (prepared by Beniamino Volta; after Braswell 2012: PowerPoint Slide 4; see also Grube et al. 2012: Figure 2).

Obsidan sources

Obsidian is a volcanic glass that because of its amorphous structure and hardness is extremely well suited for making chipped stone tools. It is also fragile, which tends to limit the tools made of it to finer cutting, perforating, or scraping activities. Finally, because of its color, luster, and fine texture, it also was occasionally used to make lapidary ornaments such as beads and earflares.

There are more than 50 chemically distinct geological sources of obsidian in Mesoamerica (Figure 6). Most of these either were not exploited in ancient times or were used only on a local or regional level. In central Mexico, the most important sources in prehispanic times were Pachuca (Hidalgo), Ucareo (Michoacan), Zaragoza (Puebla), Otumba (Estado de Mexico), Pico de Orizaba (Veracruz), Paredon (Puebla), and Zacualtipan (Hidalgo). Sources of obsidian are also located in the Maya highlands of Guatemala. These include El Chayal, Ixtepeque, San Martin Jilotepeque, and Tajumulco. The geological sources listed here for each modern country are presented in roughly declining order of the degree to which they were exploited in ancient times. Despite the great distances involved, obsidian from northwest of the Isthmus of Tehuantepec was traded into the Maya area throughout prehistory, especially during the late Early Classic (associated with Teotihuacan trade, ca. A.D. 350-500) and the Terminal Classic to Early Postclassic (a period of great internationalization, ca. A.D. 850-1100). In contrast, very little obsidian from sources in the Maya region was traded westward beyond the Isthmus except during the Preclassic/Formative period (Braswell 2003; Hester, Jack & Heizer 1971; Zeitlin 1982).

Obsidian artifacts are ideally suited for studying long-distance and interregional trade because they can be assigned easily to particular geological sources. This is because the production of obsidian artifacts – unlike ceramic manufacture – is a reductive process, because each source is characterized by a distinct trace element fingerprint, and because material from many sources is visually distinct. Among the most reliable ways to determine the source of obsidian is instrumental neutron activation analysis (INAA). INAA can provide precise, quantified, and comparable compositional data for more than 20 elements, allowing almost all artifacts to be assigned to a single source with near perfect accuracy. Unfortunately, INAA requires a source of high-energy neutrons (typically an experimental reactor), is a destructive technique, and is too time consuming and expensive to be used on large collections. Portable X-ray fluorescence (PXRF) has recently become a financially viable method (Nazaroff, Prufer & Drake 2010; Moholy-Nagy et al. 2013). This technique does not yield accurate quantitative data for distinct elements (although it does provide useful relative data) and is subject to variation and faulty measurements created by the thickness and shape of the artifact. Nonetheless, when properly applied using an adequate reference sample it can yield results that allow about 95% of artifacts to be assigned to a single source (e.g., Nazaroff, Prufer & Drake

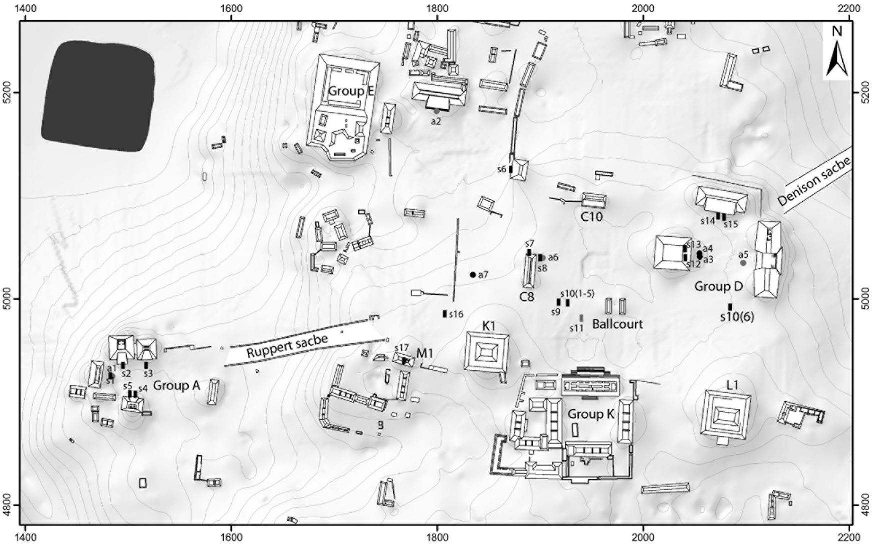

Figure 4. Uxul site center. Scale is in meters from datum (prepared by Beniamino Volta; after Braswell 2012: PowerPoint Slide 4; see also Grube et al. 2012: Figure 3).

2010: Table 4). Moreover, PXRF is less time consuming than INAA (about 100 artifacts can be sourced per day), is nondestructive, and can be conducted on site. Finally, source assignments based solely on visual criteria can also be quite useful, especially with very large collections. Although it is certainly subject to error, visual sourcing often allows a greater proportion of a collection to be unambiguously attributed than does PXRF on its own, is statistically reproducible (Braswell et al. 2000), and is both inexpensive and rapid. I advocate the use of all these techniques together whenever possible. It is particularly important to apply INAA to artifacts that are visually distinctive or anomalous, and to pieces that cannot be attributed to a single source either by PXRF or visual inspection.

Obsidian in the Calakmul sample was sourced using a combined technique of visual sourcing followed by INAA assay of all visual outliers. A random sample from the predominant visual group also was subject to INAA, demonstrating the homogeneity and accuracy of the visual assignments made for that group. Michael D. Glacock of the Missouri University Research Reactor conducted these analyses (Braswell & Glascock 2011). A total of six sources were identified in the Calakmul sample. The Uxul sample was studied during an intense four-day period in the field. All artifacts from that site were assigned to geological sources using visual criteria. Five distinct sources were recognized in the analyzed portion of the Uxul collection. Further testing of the visual categories established for the Uxul sample, either by INAA or PXRF, are needed and the results should be considered preliminary. In particular, I caution that the actual proportion of Ixtepeque obsidian at Uxul might be somewhat higher and that of El Chayal slightly lower than suggested by visual sourcing. Moreover, some of the artifacts tentatively identified as coming from the Ucareo source may be from Zaragoza. Material from these two sources can be particularly difficult to distinguish using visual criteria alone. Source assignments for both collections are shown in Table 1.

	Uxul (N=1,200)		Calakmul (N=451)	
Source	#	%	#	%
El Chayal	1,097	91.4	389	86.3
Ixtepeque	5	0.4	20	4.4
San Martin Jilotepeque	0	0.0	7	1.6
Pachuca	90	7.5	21	4.7
Ucareo	4	0.3	11	2.4
Otumba	2	0.2	0	0.0
Zaragoza	0	0.0	1	0.2
Unsourced	2	0.2	2	0.4

Table 1. Obsidian sources represented in the analyzed Uxul (N=1,200) and Calakmul (N=451) samples. All artifacts were given source assignments using visual criteria; a subset of the Calakmul sample also was sourced using INAA.

Obsidian production, lithic industries, and typology

Two important goals of the lithic analyst are: (1) to identify the exact forms in which obsidian was imported; and (2) to determine the particular production activities conducted at the site. Not all obsidian tools and ornaments are the same, and different reduction activities yield distinct final products and debitage. For this reason, it is important to identify the specific lithic industries practiced at the site, that is, the complete packages of technology, behavior, intermediate products, and byproducts leading to the final desired form.

Attribute and typological analyses of both samples began with the supposition that the obsidian artifacts from Uxul and Calakmul could be assigned to five different lithic industries: the prismatic blade industry, the retouch industry, the casual percussion industry, the bipolar percussion industry, and the lapidary industry. Each industry consists of a series of different production stages and reduction techniques, and each is characterized by distinct initial forms, preforms, debitage, and final products.

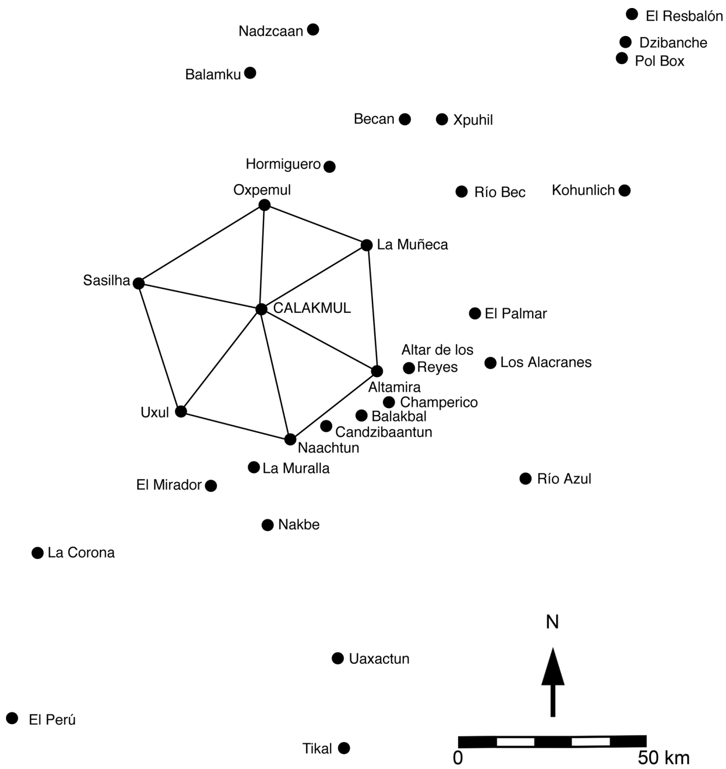

Figure 5. Inner zone (within the hexagon) of the Snake Head polity during the seventh century A.D. (modified from Marcus 2012: Figure 4.3).

Every industry has diagnostic types, but several non-diagnostic forms crosscut some or all industries.

Further complicating lithic studies is the fact that stone tools and debitage often were recycled in different industries. Debitage taxa of one industry could be used as performs in another. Even finished tools were recycled as they broke or became exhausted. For example, a macroblade produced in the prismatic blade industry could be used as a blank for making a large bifacial knife. That knife later might be reworked into a projectile point, which in turn could serve as a casual percussion core after breaking. Finally, small chunks or flakes resulting from casual percussion could be reused as bipolar cores. Thus, a single typological category often cannot capture all the important stages in the life history of a lithic implement. This is particularly true of artifacts made of obsidian that are found in the Maya lowlands, far from their points of geological origin. My solution is to identify primary and (if necessary) secondary types for the same artifact. Typological assignments for Uxul and Calakmul artifacts are presented in Tables 2 and 3. Tables 4 and 5 summarize these data by distinct lithic industry. The final column presents normalized percents that account for artifacts assigned to multiple lithic industries.

Primary Type (Secondary Type)	#
Thinning/retouch flakes	13
Casual percussion flakes	128
Bipolar flakes	5
Macroblades (handheld bifaces)	1
Macroblades (small bifaces)	2
Small percussion blades (small bifaces)	1
Prismatic blades	1021
Prismatic blade (projectile point)	1
Exhausted polyhedral core	2
Chunk (bipolar core)	4
Chunks	22

Table 2. Typology of Uxul obsidian artifacts. Secondary typological assignments shown in parentheses; most artifacts are fragmentary rather than complete.

Primary Type (Secondary Type)	#
Thinning/retouch flakes	4
Casual percussion flakes	23
Macroblades (handheld bifaces)	2
Small percussion blades	8
Small percussion blades (small bifaces)	2
Prismatic blades	376
Prismatic blade (biface point)	1
Prismatic blade (sculptural inlay)	1
Exhausted polyhedral core	22
Chunk (bipolar core)	1
Chunks (casual percussion core)	6
Chunks	4
Earspool/lapidary ornament	1

Table 3. Typology of Calakmul obsidian artifacts. Secondary typological assignments shown in parentheses; most artifacts are fragmentary rather than complete.

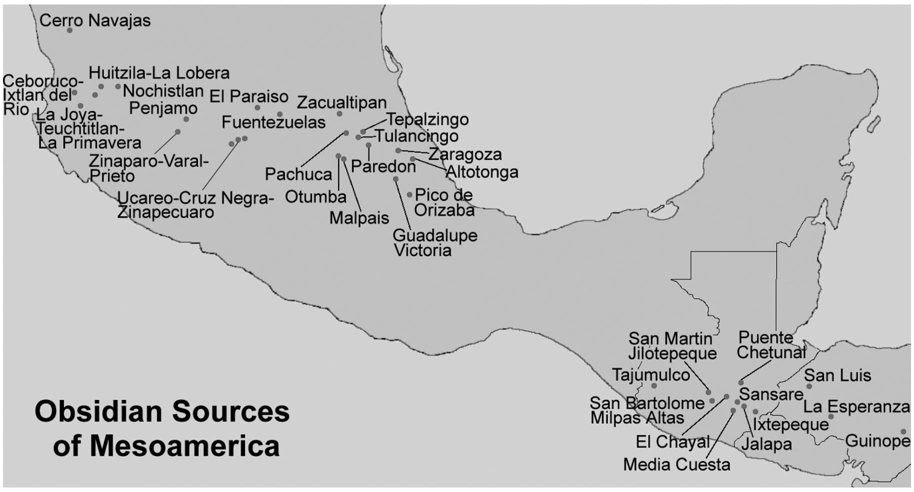

Figure 6. Important obsidian sources of Mesoamerica (prepared by the author).

Industry	#	%	Adjusted %
Prismatic Blade	1,038	86.5	85.1
Retouch	21	1.8	1.7
Bipolar Percussion	11	0.9	0.9
Casual Percussion	128	10.7	10.5
Lapidary	0	0.0	0.0
Undetermined Percussion	22	1.8	1.8

Table 4. Lithic industries represented by Uxul obsidian artifacts. The final column adjusts percents in order to account for pieces assigned to more than one industry.

Industry	#	%	Adjusted %
Prismatic Blade	426	94.5	88.2
Retouch	19	4.2	3.9
Bipolar Percussion	1	0.2	0.2
Casual Percussion	36	8.0	7.5
Lapidary	1	0.2	0.2

Table 5. Lithic industries represented by Calakmul obsidian artifacts. The final column adjusts percents in order to account for pieces assigned to more than one industry.

The prismatic blade industry

The most commonly practiced obsidian industry in the Maya lowlands was prismatic blade production. In part, this is because it is an exceptionally efficient means of making tools using a limited quantity of material. Moreover, obsidian blades are highly standardized and well suited for making composite tools. A blade can be snapped into several sections, each of which can be mounted into a wooden, bone, or antler handle. Prismatic blade production is a multi-stage process that generally involved different craftsmen working in different sites. The first stages most often were conducted in the highlands at or near the obsidian sources. There, nodules of volcanic glass were transformed into macrocores using freehand percussion. After most of the cortex was stripped and the basic form established through the removal of macroflakes and macroblades, final trimming by removing small percussion blades was conducted. The most common forms of export from the highlands of Guatemala were the trimmed macrocore and large polyhedral core.

After arriving in the lowlands, blades would be removed from a core using a pressure tool (Clark 1982; Crabtree 1968). As blades were removed, the core would be slowly rotated removing them in a series of rings or as a spiral. The first such blades – called initial series blades – are short and show scars from earlier removed percussion blades. The second series generally run the full length of the core and have scars from percussion blades only on their distal halves. Both first and second series blades are usable but are not the most desirable form. Final series blades come from the third and all subsequent rings until the core is exhausted.

It is easy for the bit of a pressure tool to slip on the platform of a blade core and the force needed to initiate a fracture can be considerably less than that required to propagate it. For these reasons, the Classic Maya modified the platforms of most prismatic blade cores. During reduction, the outer edge of the platform was scratched. Platform scratching was repeated as needed. Craftsmen also turned the cores on their sides and removed accumulated overhang by abrading the edge of the platform on a stone. Beginning at about A.D. 800, cores with pecked and ground platforms began to appear in the Maya lowlands. This technological shift is an exceptionally important temporal marker. The earliest examples are made of central Mexican obsidian. Pecking and grinding was conducted only once in the production process, but probably not at the obsidian source itself (Healan 1997). It could have been a rejuvenation technique designed to extend the usable life of a core. It should be noted that there is strong evidence that many cores reached lowland Maya sites in a reduced state. Although 200 or more blades can be made from a single good-sized macrocore, there is evidence that cores traded into the Peten Campechano arrived in a nearly exhausted condition.

Retouch industry

A second important obsidian industry practiced in the Maya lowlands was the production of retouched artifacts using hard hammers and soft billets. Such retouched tools include simple unifacially worked scrapers as well as more specialized bifacial implements such as handheld knives and projectile points. Preforms for this industry included large macroblades and macroflakes as well as smaller percussion flakes and blades. Debitage consists of characteristic thinning flakes. Most larger bifaces made of obsidian from the Maya highlands were made on macroblade blanks from the Ixtepeque source (Moholy-Nagy, Asaro & Stross 1984), but El Chayal obsidian also was used to a lesser degree. It is probable that many such bifaces were manufactured outside of the lowlands proper and then traded as finished artifacts. Nonetheless, the number of refurbishing flakes found at lowland sites indicates that knappers constantly resharpened and reworked bifaces. Bifaces made on central Mexican obsidian also were imported in finished form – often with characteristic non-Maya patterned flaking – and were refurbished as needed.

The manufacture of some bifacial artifacts requires very little retouch. These include notched prismatic blades that were mounted and served as perforators, prismatic blade points, and small round inlays made on prismatic blade fragments. Sequins (inlays with central holes) also are occasionally found, but most are made of green Pachuca obsidian and date to the late Early Classic. They probably were brought to Maya sites as items sewn onto large ritual objects such as headdresses.

Casual percussion industry

A third common practice was the production of simple percussion flakes. This casual percussion industry required no skill and little training, and hence, probably was practiced by non-specialists. In the Maya lowlands, broken or exhausted artifacts – especially prismatic blade cores and bifaces – were used as cores for making ad hoc flake tools using hard hammer percussion. Debitage types include percussion cores and chunks.

Bipolar percussion

Small broken artifacts were sometimes recycled using bipolar percussion, which yields tiny but usable flakes with characteristic attributes. Bipolar percussion was practiced by placing a core on an anvil and smashing it. From the Middle Preclassic period onward, this technique was most important in areas where obsidian was rare.

Lapidary industry

Obsidian also could be ground and polished in order to make ornaments such as earflares, labrettes, and tubular beads (often in a spiral shape and always made of Ucareo obsidian). Lapidary work using obsidian was most commonly practiced in highland

Mexico. In the Late Postclassic period the highland Maya also began to practice this industry.

Attribute analysis

In addition to assigning each obsidian artifact to one or more type and lithic industry, I recorded a wide range of metric and non-metric attributes. These include condition (whole artifact versus proximal, medial, distal, or longitudinal fragment), the quantity of cortex present, the number of dorsal ridges, blade series (for prismatic blades only), the presence of unifacial or bifacial retouch, signs of grinding, platform preparation technique (blades only), total cutting edge, length, width, thickness, mass, and geological source. In this report, these attributes are discussed only when relevant.

Obsidian of Uxul

A total of 1,200 artifacts from Uxul were analyzed in 2010; 955 were collected in 2009 and 245 in 2010. Because the 2010 season was still ongoing when I conducted the analysis, only about half the material recovered that year was studied at that dime. During the ensuing two years after I studied the sample, the total amount of obsidian recovered by the Proyecto Uxul increased to more than 4,000 pieces (Antonio Benavides, personal communication 2012). The first thing that stands out about the Uxul collection is that it is numerically very large. In four years, the Uxul project recovered roughly eight times as many obsidian artifacts as the entire Universidad Autónoma de Campeche project at Calakmul (N=515). In fact, if we also consider the ongoing INAH (Instituto Nacional de Arqueología e Historia) project at Calakmul (N=605; Andrieu 2009), the quantity of obsidian artifacts from Uxul is roughly four times that recovered at Calakmul over a 25-year period of investigation.

Uxul – at least during the Early Classic period – had much greater access to obsidian than did Calakmul. Nonetheless, this observation should not be overstated. The total mass of obsidian that I analyzed from Uxul was not great, just 484 g. In contrast, the 451 pieces I studied from the UACAM (Universidad Autónoma de Campeche) project at Calakmul have a mass of 895 g. Put another way, the average piece of obsidian recovered from Calakmul is nearly five times as massive as that collected at Uxul. This is probably caused by two factors. First, recovery techniques at both sites differ. Second, most of the artifacts collected at Uxul in 2009, that is, most of those that I analyzed, come from a single context that dates to the Early Classic period: the plaza floor of Group M.

Obsidian sources at Uxul

By far the most common source represented in the Uxul collection is El Chayal (91.4%; Table 1). This is typical for Early and Late Classic lowland Maya sites, except those in the southeastern Maya periphery (Braswell 2003; Daniels & Braswell 2013). Five blade fragments appear to come from Ixtepeque; the only proximal fragment from that source has a pecked-and-ground platform and probably was manufactured during the Terminal Classic period.

Pachuca obsidian, with its diagnostic gold-green color, also is surprisingly frequent (7.5%) in the analyzed sample. Eight of the 90 artifacts from that central Mexican source are proximal fragments of prismatic blades. Six of these have completely plain, smooth facet platforms. A seventh has a smooth platform with very limited scratching. Another has a very small and broken platform. What is significant here is that no pecked-and-ground platforms are present. This dates the Pachuca blades to sometime before the Terminal Classic period, probably the late Early Classic when the southern Maya lowlands engaged in trade with Teotihuacan. Virtually all prismatic blades at Teotihuacan that are made of Pachuca obsidian have smooth platforms.

Two additional artifacts – both bifaces – have been assigned to the Otumba source, and one of these has patterned flake scarring diagnostic of central Mexican manufacture. These two probably came to Uxul from the Teotihuacan region during the late Early Classic. Finally, four more artifacts are very tentatively assigned to the Ucareo source (in each case, I have noted a second possible source) and two more remain without a visual assignment. Given that only 13 artifacts – just 1% of the sample – were given a visual assignment to a source other than El Chayal or Pachuca, they should all be chemically sourced. Moreover, a random sample from the El Chayal visual group also should be tested in order to determine the accuracy of assignments made to that group.

Obsidian industries at Uxul

The obsidian artifacts from Uxul were assigned to four lithic industries: the prismatic blade industry, the retouch industry, the bipolar industry, and the casual percussion industry. Twenty-two artifacts were assigned to an undetermined percussion industry, that is, they were not sufficiently diagnostic to assign to either the bipolar or casual percussion industry. Debitage types indicate – at some level – the practice of all four of these industries at Uxul. In particular, there is evidence that prismatic blades were produced from imported polyhedral blade cores from the El Chayal, Guatemala source. This evidence consists of exhausted polyhedral fragments, three blades with bad overshoot terminations, five complete but stunted blades (either errors or part of the repair process), two repair blades from reversed cores, and a crested blade designed to remove an error scar from a core.

There is no clear evidence that bifaces were manufactured at the site. Most bifaces, and certainly all made of exotic obsidian from Otumba and Pachuca, arrived at Uxul as finished artifacts. Thirteen flakes attest to the resharpening of existing bifaces made of obsidian from three sources (El Chayal, Pachuca, and Ucareo), and whole or fragmentary bifaces were found made of El Chayal, Pachuca, and Otumba obsidian.

Exhausted polyhedral cores and broken bifaces were recycled by both bipolar and freehand percussion in order to make ad hoc flake tools. Although only two exhausted polyhedral core fragments were recovered (compared to 22 in the much smaller sample from Calakmul), numerous casual percussion flakes and chunks are derived from such cores. These show that recycling of exhausted polyhedral cores was very common at Uxul.

The Group M plaza

The most intriguing concentration of obsidian came from the plaza of Group M (Figure 7). In 2009, excavators recovered more than 900 pieces of obsidian from the patio of this group. As originally reported, this included 334 prismatic blade fragments and more than 600 pieces of prismatic blade debitage (Grube & Paap 2010: 11). In reality, nearly all pieces are prismatic blade fragments, but errors and corrective blades are among these. Somewhat surprising is the presence of cortex on 16 obsidian artifacts (1.3%), all but one of which comes from the El Chayal source (the remaining piece was not given a source assignment). In contrast, none of the 451 artifacts from Calakmul that I have studied or the 605 discussed by Andrieu (2009) have cortex. The collection from the Group M plaza, therefore, reflects the local production of prismatic blades from imported cores made of El Chayal obsidian. Moreover, those cores reached the site at a fairly early stage of reduction when some cortex was still present.

Also present in the Group M collection are a significant number of obsidian blades and other artifacts from central Mexico, including Early Classic obsidian blades from the Pachuca source. These – with their smooth platforms – suggest that the context dates primarily to the late Early Classic period. Only one pecked-and-ground platform (the Ixtepeque blade discussed above) was found among the 188 whole blades and proximal fragments. Most have scratched, plain, or very small platforms consistent with an Early Classic date.

Why was so much Early Classic obsidian found on the Group M patio? Nearby are three large holes, two of which are in the patio itself. Grube & Paap (2010: 11) have suggested that these were excavated during the Early Classic for fill used in the construction of Structure M1. The obsidian on the surface of the patio may have been removed as this fill was dug. If so, this would help date the construction of Structure M1. In particular, it must date to the late Early Classic, that is, after the period of interaction with Teotihuacan. Nonetheless, it is somewhat difficult for me to imagine that the

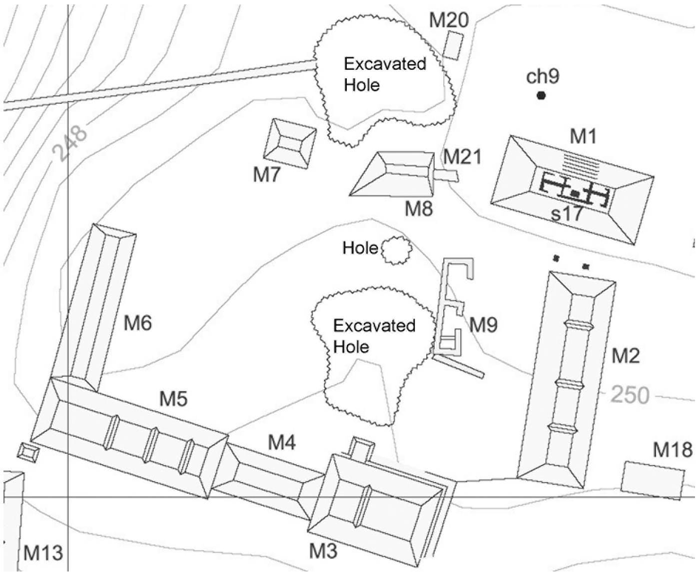

Figure 7. Group M, Uxul. Oriented north-south; see Figure 4 for scale (prepared by Beniamino Volta; after Braswell 2012: PowerPoint Slide 6).

holes in the Group M plaza were left open during the ensuing centuries of occupation. I therefore wonder if they – and the obsidian scatter on the surface of the final patio – represent even later scavenging activity. By the Terminal Classic period, it is certain that very little new obsidian was traded to Uxul. Instead, the most important source would have been deposits of used or discarded and already ancient artifacts. It could be that scavenging of an earlier midden associated with both blade production and use took place in the Terminal Classic period during the occupancy of Structure M9.

Obsidian of Calakmul

I have studied a total of 451 of the 515 obsidian artifacts recovered by the Proyecto Calakmul of the Universidad Autónoma de Campeche (UACAM), directed by William Folan. The 64 remaining pieces (complete prismatic blades from a burial in Structure 7) are on display at the Baluarte San Miguel in Campeche and were not available for study. Moreover, I also had the opportunity to analyze 127 obsidian artifacts collected in 1994 and 1995 by the INAH Proyecto Calakmul directed by Ramón Carrasco. Since then, Chloé Andrieu (2009) has reanalyzed these artifacts as well as most of the obsidian collected by the INAH project during the next 14 years (N=605). For this reason, I concentrate here on the first data set rather than the INAH materials.

The most startling aspect of the Calakmul sample is its very small size in both count and total mass. I have argued that obsidian did not reach Calakmul except in trace amounts during its seventh century peak because of the nearness of Tikal and the closed nature of that polity's economic system (Braswell & Glasock 2011; Braswell 2010). Calakmul did have access to other important and imported resources, such as jade. In fact, much more jade has been recovered from Calakmul than obsidian. The ruler-to-ruler gifting or tribute through which jade circulated in the Peten Campechano was not subject to the same kinds of limitations as obsidian trade, implying that very different exchange mechanisms were in place for the two materials.

Sources of obsidian at Calakmul

The relative frequencies of the sources of obsidian consumed in the Calakmul sample are different from those at Uxul. The relative quantity of Ixtepeque obsidian is ten times greater at Calakmul than at the other site. Moreover, although some obsidian from the Ucareo source is found at Uxul, it is seven times more frequent – relatively speaking – at Calakmul. Two sources, Zaragoza and San Martin Jilotepeque, that are unknown at Uxul are found at Calakmul. Although there are no clear examples of obsidian from the Otumba source in the UACAM Calakmul sample, at least two pieces (one chemically sourced) were identified in the INAH sample that I studied. One of these was part of an Early Classic offering, the other was found on the surface of the same structure.

The differences in source procurement strategies seen at the two sites largely reflect temporal distinctions. Much of the San Martin Jilotepeque obsidian found at Calakmul probably arrived at the site in the Middle to Late Preclassic or during the Terminal Classic period. Uxul does have a Late Preclassic occupation, but it was not particularly strong and limited to areas near the *aguada* (Grube et al. 2012: 27, 44). Moreover, there is little evidence for a Terminal Classic occupation beyond Structure M9 (Grube et al. 2012: 37). The Ucareo and Zaragoza obsidian at Calakmul also comes from Terminal Classic deposits. So, too, does the Pachuca obsidian recovered by the UACAM project. The only proximal blade fragment made of Pachuca obsidian found at Calakmul has a pecked-and-ground platform, demonstrating that it was produced no earlier than the Terminal Classic period. Thus, while the vast majority of exotic obsidian found at Uxul comes from the Pachuca source and dates to the Early Classic period, there is relatively little evidence of such trade in Mexican obsidian at that time at Calakmul. Instead, Calakmul received most of its non-El Chayal obsidian during the Terminal Classic period, and only some of that was from Pachuca.

Obsidian industries at Calakmul

Typological analysis reveals that, as at Uxul, most obsidian artifacts from Calakmul can be assigned to the prismatic blade industry. Blades made of El Chayal obsidian were produced using already reduced – in fact, almost exhausted – prismatic blade cores. The average prismatic blade core consumed at the site had a mass of just 160 g and measured 105 mm by 53 mm by 49 mm (Braswell & Glascock 2011). This is very small for a polyhedral core. No artifacts contain cortex, reflecting the reduced state of obsidian that reached the site. As mentioned above, Andrieu (2009) also found no cortex on her somewhat larger sample from Calakmul. In contrast, cortex was found on 16 artifacts (1.3%) at Uxul.

Compared to Uxul, there is much more evidence for the use of retouched artifacts, especially bifaces, at Calakmul. This is probably a function of chronology; many of the artifacts recovered from Calakmul – especially those from floor contexts – date to the Terminal Classic period. At that time, the relative abundance of bifaces increased dramatically across the Maya lowlands. This may be a function of increased warfare or, alternatively, it may reflect shifting food procurement practices during a period of demographic decline and agricultural instability. The casual percussion industry and bipolar industries also were practiced at Calakmul, and there is even evidence for the consumption – but not production – of lapidary items made of obsidian. Throughout the Maya region, obsidian lapidary work was imported from central or west Mexico.

Conclusions

Comparison of obsidian collected from Uxul and Calakmul reveals some similarities and other important differences. First, although it is hard to quantify, obsidian seems to have been much more abundant at Uxul during the Early Classic than at Calakmul at any time in the history of that site. This suggests that Early Classic Uxul was dependent on neither redistribution from Calakmul, nor the presence of a central market at that city. In other words, despite the fact that Uxul was both of lesser importance and apparently friendly towards Calakmul during the Early Classic, there is little reason to argue for a subordinate economic role. Instead, Uxul had its own obsidian procurement network, one that seems to have been more efficient than that of Calakmul itself.

We might even wonder if Uxul enjoyed relatively benign relations with Tikal during the Early Classic period. Obsidian is orders of magnitude more common at Tikal than at Calakmul, and it may be that Uxul received some of its obsidian via the large polity to the southeast. A hypothesis for further testing is that obsidian independence changed during the era of the Snake Head kings, that is, Uxul became more economically dependent on Calakmul as it became more politically linked to it.

Also of interest is the relatively large quantity of central Mexican obsidian at Uxul that dates to the Early Classic period. This material could have been brought directly from Teotihuacan or – much more likely – was gifted or traded by an intermediary. During the Early Classic period, green obsidian from Pachuca and bifaces of Otumba obsidian were in no way commodified. Instead, they were subject to strict sumptuary rules of distribution. Almost always such objects are limited to palace contexts. At Copan, for example, green obsidian is absent outside of the Main Group. This implies that connections between the rulers of Uxul and some other polity were close. The evidence is negative, but it does not seem likely that this material flowed through Calakmul. Early Classic Mexican obsidian is quite uncommon there (Andrieu 2009: Tableau 45). In fact, most Mexican obsidian known from Calakmul dates to the Terminal Classic period (Andrieu 2009: Tableau 45; Braswell & Glascock 2012: Tables 10.3 and 10.4). Moreover, there are very few other indications of ties, direct or indirect, between Calakmul and Teotihuacan. Thus Uxul seems to have been more independent from Calakmul during the Early Classic than our historical narratives imply. It is even possible that interaction between Uxul and Teotihuacan was mediated by Tikal, another site where exotic Mexican obsidian was abundant during the Early Classic period (Moholy-Nagy et al. 2013).

Finally, the obsidian artifacts from Calakmul, as well as many other sources of data, demonstrate a continuing occupation at that site throughout the collapse period and even into the tenth century. There are a few obsidian artifacts at Uxul consistent with a Terminal Classic date, but not many. Structure M9 at Uxul was built during the Terminal Classic (Grube & Paap 2010), but there is little reason to suspect significant occupation during the ninth century A.D. In contrast to Calakmul, the obsidian artifacts from Uxul suggest that the site was all but abandoned during the late eighth century A.D. This supports the early collapse model proposed by Grube et al. (2012).

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