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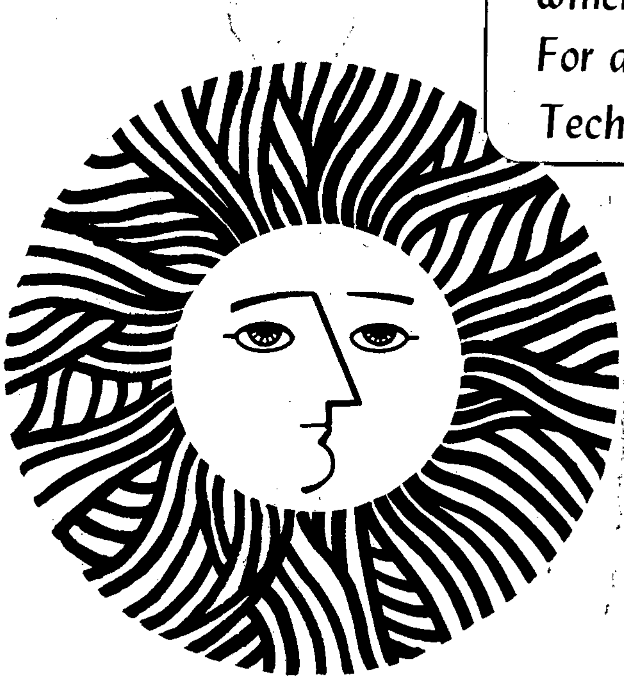

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ABSTRACT

The results of a recent source analysis of a small series of secondarily worked obsidian artifacts from Tikal, Guatemala, showed a high proportion of Central Mexican obsidian among point-knives, most of which occur in residential contexts. On the other hand, obsidian used for prismatic blades and for ceremonial deposits came predominantly from closer sources in Highland Guatemala.

Source analysis by physical-chemical methods is most useful for testing hypotheses about prehistoric obsidian utilization when it can be combined with behavioral typology. Also important are identification of the functional contexts of different obsidian artifact types and the study of the obsidian industry from any one site as a behaviorally-integrated whole.

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Tikal, in the Lowland Maya area of Guatemala (Fig. 1), appears to have imported obsidian throughout its long period of occupation (Table 1). It is clear from the proportions of obsidian artifact types present that the most desired ones were prismatic blades, also called flake-blades (Kidder 1947: 4), fine blades (Spence and Parsons 1972: 11), core blades (Hester 1972), or just blades. From at least the beginning of the Late Preclassic Period, most obsidian seems to have been brought into Tikal as macrocores or large polyhedral cores (Fig. 2). Macrocores are large, roughly conical blade cores formed by percussion and often bearing patches of cortex (Hester 1972). Macrocores may be further reduced by percussion to form large polyhedral cores, from which prismatic blades can be produced by pressure (Clark 1977). Although no macrocores or large polyhedral cores have been found at Tikal, Classic Period macroblades and large core platforms worked into locally distinctive eccentrics and incised obsidians, as well as rare, small cortical flakes from nearly all periods, may be taken as evidence of their former presence.

Although most obsidian found at Tikal is grey or black, a small proportion, estimated at about 1% of the recorded total, is green. Green obsidian is consistently present after the beginning of the Classic Period, with the highest frequency occurring during the Early Classic. Green obsidian occurs as prismatic blades (440+ fragments), point-knives, i.e., "projectile points or knives" (78, mostly incomplete), and rare eccentrics and other forms (12), core fragments (c. 4), and small flakes and percussion blades (c. 15). Source analyses carried out on Mesoamerican obsidian since the late 1960s (e.g., Stross et al 1968) strongly suggest that all green obsidian found in the Maya area came from quarries in the vicinity of Pachuca, Hidalgo, in Central Mexico (Fig. 1). Nearly all of the grey obsidian used by the Maya came from several sources in the Highlands of Guatemala.

The model of local manufacture of prismatic blades from imported macrocores or large polyhedral cores probably also holds for blades of green obsidian, even though there are differences in artifact distributions and morphology.

Evidence of green obsidian blade manufacture, such as small flakes, chips, or percussion blades, or fragments of exhausted blade cores (Clark and Lee 1979) is scarce at Tikal. It is rarely reported for the few Maya area sites where green prismatic blades have been found, although it must be noted that early excavations were not designed to recover such evidence.

In addition, somewhat different manufacturing methods have produced morphological differences in the proximal ends of the blades. Nearly all of the green prismatic blades have noticeable platforms, which given them a squarish plan. Most of the grey blades have tiny platforms and are rounded in plan, due to a careful trimming of the edge of the core platform before pressing off the blade (Rovner 1974). However, this is not an absolute division at Tikal and green blades with rounded ends and grey blades with square ones also occur occasionally.

A near absence of green blade debitage and cores and different manufacturing procedures might suggest that green prismatic blades were produced in Central Mexico and imported ready-made into the Maya area. However, obsidian blades are fragile. There would have been problems in transporting them over a thousand-kilometer network that went overland for much or most of its length. It seems more likely that the green obsidian blades found at Tikal were produced there from imported large polyhedral cores that produced little waste other than the exhausted core (Clark 1977; Clark and Lee 1979). In effect, in contrast to finished blades, large polyhedral cores can be considered an easily transported, high value, relatively low bulk commodity. To date, small fragments comprising about four green obsidian prismatic blade cores have been recovered from Tikal. Based upon data from experiments in blade replication, four cores would be more than enough to account for the green obsidian blades found at Tikal so far (Sheets and Muto 1972; Sheets, personal communication 1979; Clark, personal communication 1980).

Obsidian workers at Tikal had been producing prismatic blades for centuries, so green blade production would not have posed problems for them. The difference in shape of the proximal ends of green and grey blades noted above might then be attributable to the superior flaking qualities of the green obsidian (D. Crabtree, personal communication 1976; A. Benfer, personal communication 1978), which may not have demanded as careful platform trimming as did Highland Guatemalan grey obsidian.

On the other hand, point-knives and eccentrics are not indigenous to the Maya Lowlands, but were introduced during the Early Classic Period. Therefore, point-knives and eccentrics of Central Mexican obsidian and Central Mexican form are here regarded as Central Mexican products. Their transportation may have posed less of a problem than prismatc blades insofar as they are not as fragile. The point-knives, at least, may have been hafted and sheathed.

The apparent or real lack of evidence for green prismatic blade manufacture at Lowland sites that have produced green blades may reflect Classic Period economic and political conditions. Although the long distance transportation of prismatic blades from Central Mexico to the Maya Lowlands would have been impractical, movement of small quantities of prismatic blades over the much shorter distances within the Lowland area may not have been. Green blades manufactured at a major center like Tikal may occasionally have been carried to smaller, subordinate sites.

PREVIOUS ANALYSES

Because in many cases physical-chemical analysis permits the assignment of obsidian to geological source, a number of Tikal obsidian artifacts have been analyzed in the hope of shedding light upon ancient procurement and utilization. Two early source analyses were carried out on a total of 203 primary artifacts (Moholy-Nagy 1975: Table I), that is, on grey and green prismatic blades and grey blade core fragments and small flakes thought to be prismatic blade production debitage. Both analyses suggested procurement of grey obsidian from several sources in the Highlands of Guatemala, with a heavy dependence upon stone from El Chayal (Fig. 1) during the Early and Middle Classic Periods (Stross et al 1968; Moholy-Nagy 1975). The analyzed green obsidian prismatic blades were either assigned to Pachuca, Hidalgo, or could not be assigned to any source.

Although these findings fit well with other evidence and have not been contradicted by the latest source analysis to be discussed below, they should nevertheless be considered tentative. The first analysis was carried out during the development of the X-ray fluorescence (XRF) method. The second was carried out in 1971 by neutron activation analysis (NAA) using only two elements, sodium and manganese (Pires-Ferreira 1972). Therefore, while these two analyses are probably reliable in the attribution of the optically and chemically distinctive green obsidian to Hidalgo, there may be poor discrimination between various sources of grey obsidian.

During the Early Classic Period, contemporary with the widespread occurrence of green obsidian prismatic blades, a number of secondarily-worked obsidian artifact types appear at Tikal. The most numerically important are eccentric obsidians and point-knives, both of which are more common in chert. Incised obsidians appear somewhat later during the Middle Classic. Ground obsidian artifacts, all of grey stone, are also known from Classic Period contexts but are too rare to discern regularities in their function or use. Up to 1978 no examples of secondarily-worked artifacts from Tikal had been analyzed to determine the source of the obsidian.

Source analysis by XRF and NAA provides an opportunity to confirm or discard hypotheses about sources suggested by other data such as differences in artifact form, color of the obsidian, manufacturing technique, or archaeological context (Clark 1979). Incised obsidians seem to have been a Middle and Late Classic Tikal specialty. They are large macroblades, macroblade fragments, or core platforms with an incised drawing on the ventral surface (Kidder 1947: Fig. 70-72; Coe 1967: 103). All 360+ known examples are of grey obsidian. Virtually all of the 825+ known obsidian eccentrics are of grey obsidian and of forms characteristic of the Central Peten. Nine recorded exceptions of green obsidian are of Teotihuacan types (cf. Millon _et al_ 1965: Fig. 94, right part of top row and bottom two rows; Rubin de la Borbolla 1947: Fig. 9, top of bottom row and bottom of middle row) and are surely ready-made imports. It should also be noted that green obsidian eccentrics do not occur in the same contexts as grey ones at Tikal. Grey eccentrics on exhausted prismatic blade cores (cf. Kidder 1947: Fig. 9) may be the most common form during the Classic Period. During the Middle and early Late Classic Periods, some eccentrics were also made on macroblades, core platforms, and prismatic blades. All obsidian eccentrics disappear well before the end of the Late Classic, while flint eccentrics and incised obsidians continued to be produced until the end of the Period.

Except for a few strays, incised obsidians have only been found in caches associated with stelae and temples. The same is generally true of grey obsidian eccentrics.

Point-knives occur from the Early through the Terminal

Classic Periods. Of the 262 recorded examples of obsidian, 182 are grey or black, 78 are green, and 2 are black mottled with brownish-red. The high proportion of green examples, almost 30%, is noteworthy. Characteristic of Tikal obsidian point-knives is their incomplete, often reworked condition (Fig. 3; cf. also Kidder 1947: Fig. 64, a), which makes classification difficult. Nevertheless, most of the stemmed examples can be fitted into Tolstoy's typology for Central Mexico (Tolstoy 1971: Fig. 2, 3).

Grey and green obsidian point-knives, like grey and green obsidian prismatic blades, are found predominantly in construction fill and middens associated with structures thought to have been residences (Moholy-Nagy 1976, 1981). They occur in structure groups tentatively associated with all social classes present at Tikal, although elite residences have proportionately more point-knives in their obsidian assemblages than do middle-range residences, and lower-class residences have the smallest proportion of all (Moholy-Nagy 1981: Table 2, parts 1 and 2). Point-knives also occur in some Early Classic burials of problematical nature that include other Central Mexican traits such as rare green obsidian eccentrics, tripod metates of vesicular basalt, and Teotihuacan-style ceramic vessels and censers.

Before the latest obsidian analysis carried out in 1978, it was felt that grey obsidian eccentrics and incised obsidians were probably locally manufactured directly or ultimately from Highland Guatemalan macrocores or large polyhedral cores that had been imported for the production of prismatic blades (Fig. 2). Green obsidian point-knives were thought to have been imported as finished products from Central Mexico, along with rare green obsidian eccentrics and other forms and a few green obsidian polyhedral cores. Grey point-knives might either have been imported or locally made of Highland Guatemalan obsidian in imitation of Central Mexican types.

THE 1978 ANALYSIS

Samples taken from 28 incomplete artifacts were examined by Frank Asaro and Fred H. Stross of the Lawrence Berkeley Laboratory using more accurate XRF methods and NAA than in the two previous analyses mentioned above. Altogether 14 point-knives, 4 obsidian eccentrics, 2 incised obsidians, a ground obsidian earspool, 3 prismatic blades, and 2 cortical flakes from Tikal, and 2 flakes from Tetitla, Teotihuacan, Mexico, were analyzed (Table 2).

The secondarily-worked point-knives, eccentrics, and incised obsidians were the main focus of the analysis, since none of these types had been analyzed before. The ground earspool of grey obsidian was submitted because of its uniqueness at Tikal. At the time of its discovery it was regarded as additional evidence of influence from Central Mexico. The prismatic blades, two grey and one opaque brown-green, were chosen for their unusual optical properties. The two small grey cortical flakes seemed to be debitage and might therefore support the hypothesis that Highland Guatemalan obsidian arrived in Tikal as macrocores. The two waste flakes from Tetitla were submitted for comparison with the Tikal materials.

The source of the obsidian was first determined by XRF

(Table 3). These measurements were of a relatively inexpensive type. This type has a good precision but only moderate accuracy (e.g., 25% for Zr). The XRF sourcing was then confirmed by a high precision and accurate, abbreviated NAA on a representative sample from each provenience group (Table 4). Any artifacts still unassigned by the abbreviated NAA were submitted to a more intensive, high precision and accurate NAA measurement that might involve twenty to thirty elements. This procedure was successful in assigning the obsidian used for all artifacts except two point-knives (68I-45/2, TIKL-10, Fig. 3,j and 77A-17/7, TIKL-11, Fig. 3,k). The detailed analysis of these two opaque black specimens is given on Table 5. The stone used for one of them, 77A-17/7, is similar to obsidian from Zinapecuaro, Michoacan, Mexico.

No transparent or translucent green obsidian point-knives were submitted for analysis because it was assumed that the source of this kind of stone was Pachuca. However, the tip fragment of an unusual, opaque, silvery-green obsidian point knife (45G-11/7, TIKL-6, Fig. 3,f) was analyzed and also proved to be from the Pachuca area. Of the 13 other grey and black point-knives, 9 were made of Mexican obsidian, 7 of these of stone from Otumba (Table 2 and Fig. 3). Two point-knives were of obsidian from the Highland Guatemalan source of Ixtepeque. Two, as noted above, could not be assigned to a source. The high barium content of the artifacts attributed to Otumba establishes the obsidian as from Otumba, and not from the Paredon source, as cautioned by Charlton _et al_ (1978).

Although somewhat flawed by the small size of the sample, the results of the 1978 analysis generally support the hypothesis that obsidian eccentrics and incised obsidians were locally manufactured from macrocores or large polyhedral cores from Highland Guatemala. The circumstance that these ceremonial artifacts were of El Chayal obsidian reinforces the relationship between ceremonial use of obsidian and predominantly utilitarian prismatic blade manufacture already suggested by a behavioral typology (Fig. 2) and the two, previous, less accurate source analyses.

Furthermore, viewing the obsidian industry of Tikal as a product of manufacturing behavior reveals a shift of priorities. The earliest eccentrics were usually made on exhausted cores, the end-prodcts of the prismatic blade manufacturing process. But later eccentrics and incised obsidians were usually made on macroblades and other large pieces, which diverted a certain amount of obsidian from prismatic blade production. The socioeconomic causes of this shift should be investigated.

The results of analysis also indicate that most of the grey obsidian point-knives found at Tikal are not local imitations of Central Mexican types but rather Central Mexican products. Together with the presence of green obsidian and other imported objects, an exchange network is suggested that extended all the way to Central Mexico. Throughout the Early and Middle Classic Periods this network brought a tiny yet constant proportion of obsidian into Tikal. The identification of Central Mexican grey obsidian also supports observations of specialized workshops in the Basin of Mexico. Workshops in the vicinity of the grey obsidian quarries at Otumba (T.A. 79) and in Teotihuacan itself are interpreted as having specialized in the production of bifaces such as point-knives and in the production of scrapers (Spence 1967; Spence and Parsons 1972: 120-124; Clark 1979). It would now seem that such secondarily-worked artifact specialization was well established by the Early Classic Period.

The fourteen analyzed point-knives show a general correspondence between typology and source (Fig. 3). Of the four examples not assigned to Central Mexican sources, two (Fig. 3, j and 3, m) are too fragmentary to classify. However, the two with intact bases (Fig. 3, k and 3, l) do not fit well into Tolstoy's classification. Of these, one (Fig. 3, l) is of Ixtepeque obsidian, while the other (Fig. 3, l) could not be assigned to a source.

At present the place of manufacture of the Ixtepeque obsidian point-knives (Fig. 3, k and 3, l) is uncertain. They might have been made at Tikal from imported macrocores or imported macroblades. It ought to be possible to test this idea by sourcing small-sized debitage that might be the result of biface manufacture. However, only special deposits were routinely screened at Tikal, so no sample of such debitage is available at present. On the other hand, some workshops found at Papalhuapa near the Volcan Ixtepeque showed evidence of point-knife production, as well as the production of macroblades and point-knife blanks that may well have been intended for export (Graham and Heizer 1968: 104).

If the two cortical flakes attributed to El Chayal did come from macrocores, they could be considered support for the earlier finding, achieved with less precise methods, that Classic Period Tikal relied heavily upon El Chayal for its macrocores. It is possible that some El Chayal obsidian reached Tikal unworked in nodular form. However, present evidence from examined Mesoamerican quarries indicates that raw obsidian was rarely transported any distance, particularly after the Late Preclassic (Sheets, personal communication 1980). To avoid transporting waste, preliminary working into macrocores or macroblades took place in workshops near the quarries (Holmes 1919: 217-225; Spence and Parsons 1967, 1972; Graham and Heizer 1968; Sheets 1975). In any case, flakes or small percussion blades bearing cortex are rare at Tikal.

We can only speculate about the use of El Chayal stone for the ground earspool. This fragment occurred in mixed debris that included mostly Early Classic ceramics with some Middle and Late Classic sherds. It is the only example from Tikal made of obsidian, although in size and shape it is similar to the small, heavy flares of jade known from both the Maya area (e.g., Kidder 1947: Fig. 26) and Central Mexico (e.g., Rubin de la Borbolla 1947: Fig. 16, bottom) during the Early Classic. It is possible that this earspool was made in the Guatemalan Highlands, perhaps at Kaminaljuyu, which was close to the El Chayal source and which was producing similar artifacts of jade at that time (Kidder, Jennings, Shook 1946: 124).

CONCLUDING COMMENTS

The 1978 analysis of a sample of secondarily-worked artifacts confirmed the tentative results of two earlier source analyses achieved by less accurate methods. Tikal imported most of its obsidian from Highland Guatemala, apparently as macrocores or large polyhedral cores. During the Classic Period, it also received a very small proportion of obsidian from Central Mexico, as finished point-knives, green obsidian polyhedral cores, and rare eccentrics and other forms. The inception as well as the high point of this latter obsidian exchange network coincides with the time of maximum Teotihuacan influence in other aspects of Tikal material culture during the Early Classic.

Although the presence at Tikal of Central Mexican green obsidian has been known for a number of years, the presence of Central Mexican grey obsidian was discovered by analyzing point-knives. Therefore, in attempting to trace obsidian procurement networks for any particular site or region (e.g., Hammond 1972), samples should be taken from as many different types of artifacts present as possible. In assessing the properties of materials, ancient artisans made fine distinctions between them that are now lost to us or that we are just beginning to discover via experimentation. Available evidence demonstrates that obsidian from different sources was preferred for different types of artifacts (Spence 1967; Spence and Parsons 1972: 25; Clark 1979).

Keeping this in mind, it is clear that the distance over which material is imported cannot be regarded as a good indicator of the function of the material at its destination. At Tikal, artifacts of grey and green Mexican obsidian occur predominantly in apparently residential contexts of all social classes. Sometimes these artifacts are found in primary middens. Usually, like most of the artifacts from Tikal, they occur in occupation debris redeposited as construction fill. They are rare in ceremonial contexts. Most of the ceremonially-deposited obsidian appears to have come from closer sources in the Highlands of Guatemala.

Nearly all of the ceremonial obsidian artifacts seem to derive directly or ultimately from Highland Guatemalan macrocores or large polyhedral cores imported from the production of prismatic blades. That such a connection can be made between utilitarian and ceremonial obsidian usage demonstrates the usefulness of a behavioral typology such as Sheets' (1975). Furthermore, it shows that unless the utilitarian and ceremonial artifacts from any particular site are studied as a whole, such interrelationships of procurement, technology, and function can never come to light.

Recent developments in method permit increased precision in the sourcing of obsidian by XRF and NAA. Yet the reporting of the results of source analysis often overlooks the ancients' interest in obsidian in the first place. It is not sufficient to describe an analyzed object as an "artifact" as though the type of artifact and the way it was manufactured and used did not matter. They do.

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Fig. 1. Sources and sites mentioned (based on Hester <u>et al</u> 1971: Map 4 and Sidrys 1976: Fig. 1).

1 Tikal

2 El Chayal, Kaminaljuyu

3 San Martin Jilotepeque (Rio Pixcaya, Aldea Chatalun)

4 Ixtepeque, Papalhuapa

5 Teotihuacan, Otumba

6 Cerro de las Navajas (Cruz del Milagro),Pachuca

7 Zaragoza

8 Zinapecuaro, Ucareo

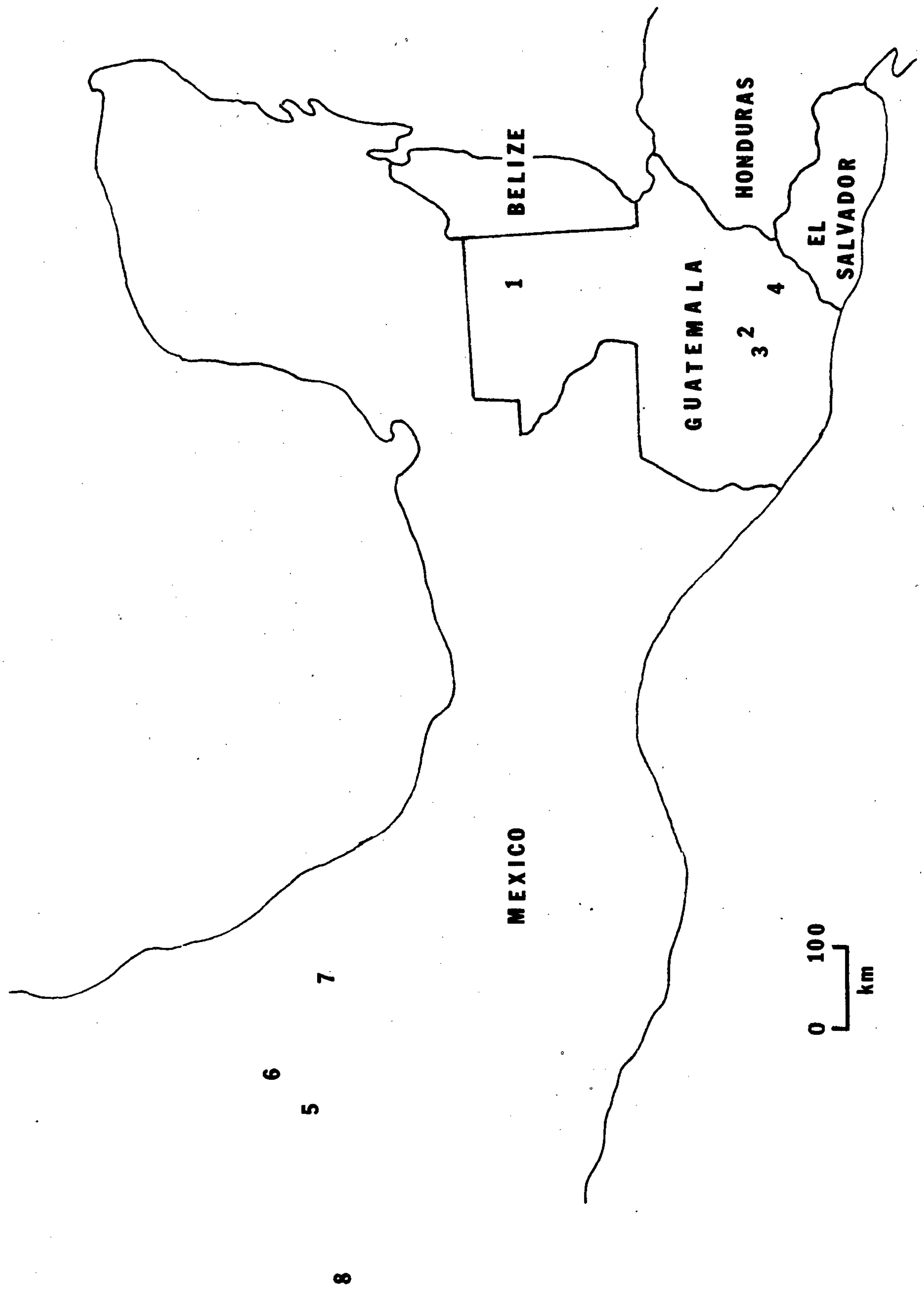
BELIZE
HONDURAS
EL SALVADOR
GUATEMALA
MEXICO
1
2
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Fig. 2. A behavioral typology of the Tikal obsidian industry (after Sheets 1975 and Clark and Lee 1979). * - hypothesized.

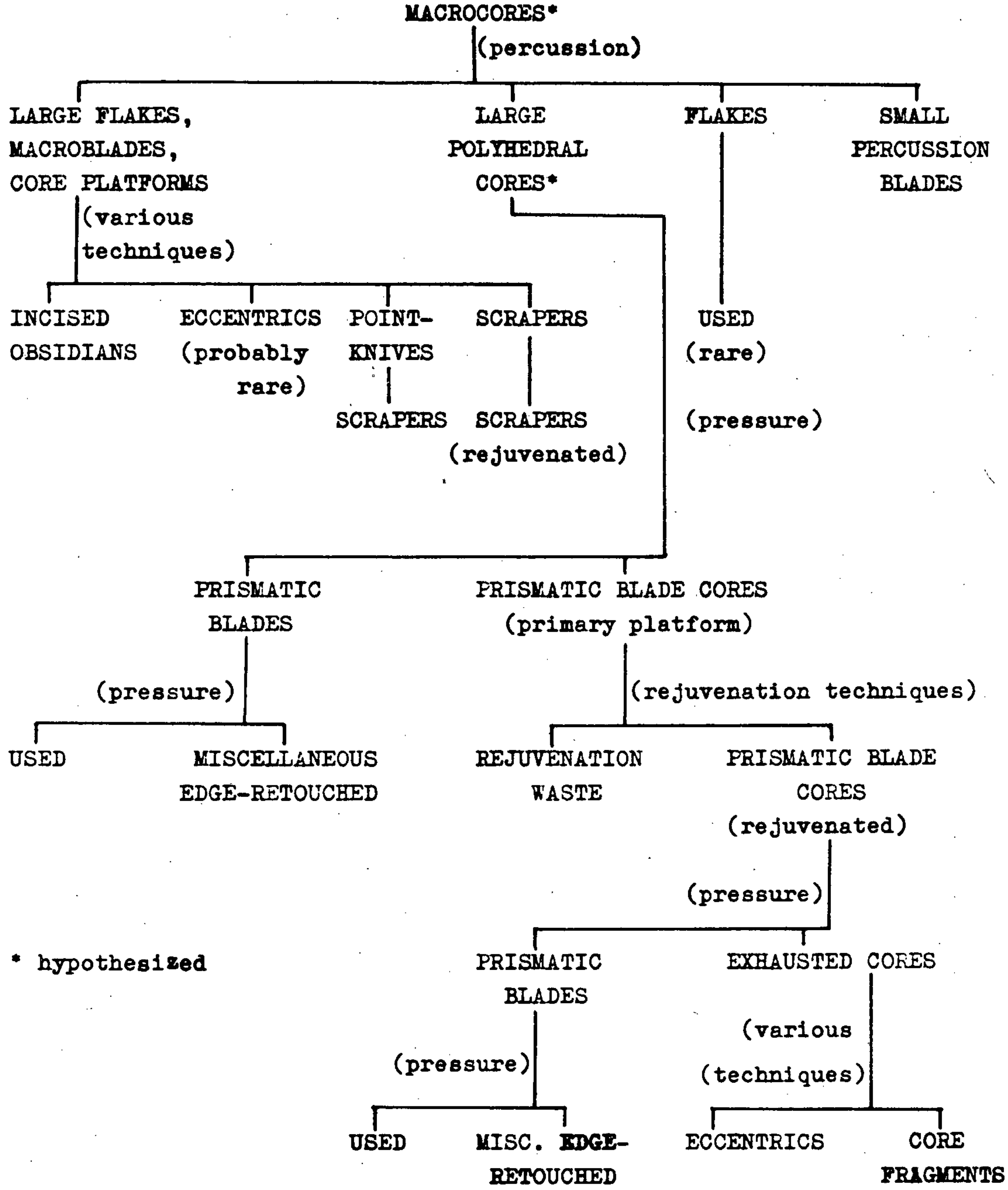
MACROCORES*
(percussion)
LARGE FLAKES,
MACROBLADES,
CORE PLATFORMS
LARGE
POLYHEDRAL
CORES*
FLAKES
SMALL
PERCUSSION
BLADES
(various
techniques)
INCISED
OBSIDIANS
ECCENTRICS
(probably
rare)
POINT-
KNIVES
SCRAPERS
SCRAPERS
SCRAPERS
SCRAPERS
(rejuvenated)
USED
(rare)
(pressure)
PRISMATIC
BLADES
PRISMATIC BLADE CORES
(primary platform)
(pressure)
USED
MISCELLANEOUS
EDGE-RETOUCHED
(rejuvenation techniques)
REJUVENATION
WASTE
PRISMATIC BLADE
CORES
(rejuvenated)
(pressure)
* hypothesized
PRISMATIC
BLADES
EXHAUSTED CORES
(pressure)
(various
(techniques)
USED
MISC. EDGE-
RETOUCHED
ECCENTRICS
CORE
FRAGMENTS

Fig. 3. Fourteen analyzed obsidian point-knives from from Tikal, Guatemala. Tentative classification after Tolstoy (1971). Drawings by W.R. Coe. All to same scale. Length of J is 12.3 cm.

A: 20A-731/74. Otumba. Gary Large (Fig. 2, u).

B: 20B-119/45. Otumba. Shumla (Fig. 2, z).

C: 20D-168/15. Zaragoza. Livermore-like (Fig. 3, d).

D: 26B-6/1. Ucareo type. Livermore-like (Fig. 3, d).

E: 43F-110/23. Otumba. Livermore-like (Fig. 3, d).

F: 45G-11/7. Pachuca. Tip fragment.

G: 66H-27/12. Otumba. Shumla (Fig. 2, z).

H: 67A-137/53. Otumba. Gary Typical (Fig. 2, r).

I: 67A-184/58. Otumba. Shumla (Fig. 2, z).

J: 68I-45/20. Not assigned to a source. Stemless.

K: 77A-17/7. Not assigned to a source. Very broad stem.

L: 78M-15/18. Ixtepeque. Very broad stem.

M: 98F-17/6. Ixtepeque. Stemless.

N: 128E-13/7. Otumba. Kent (Fig. 3, k).

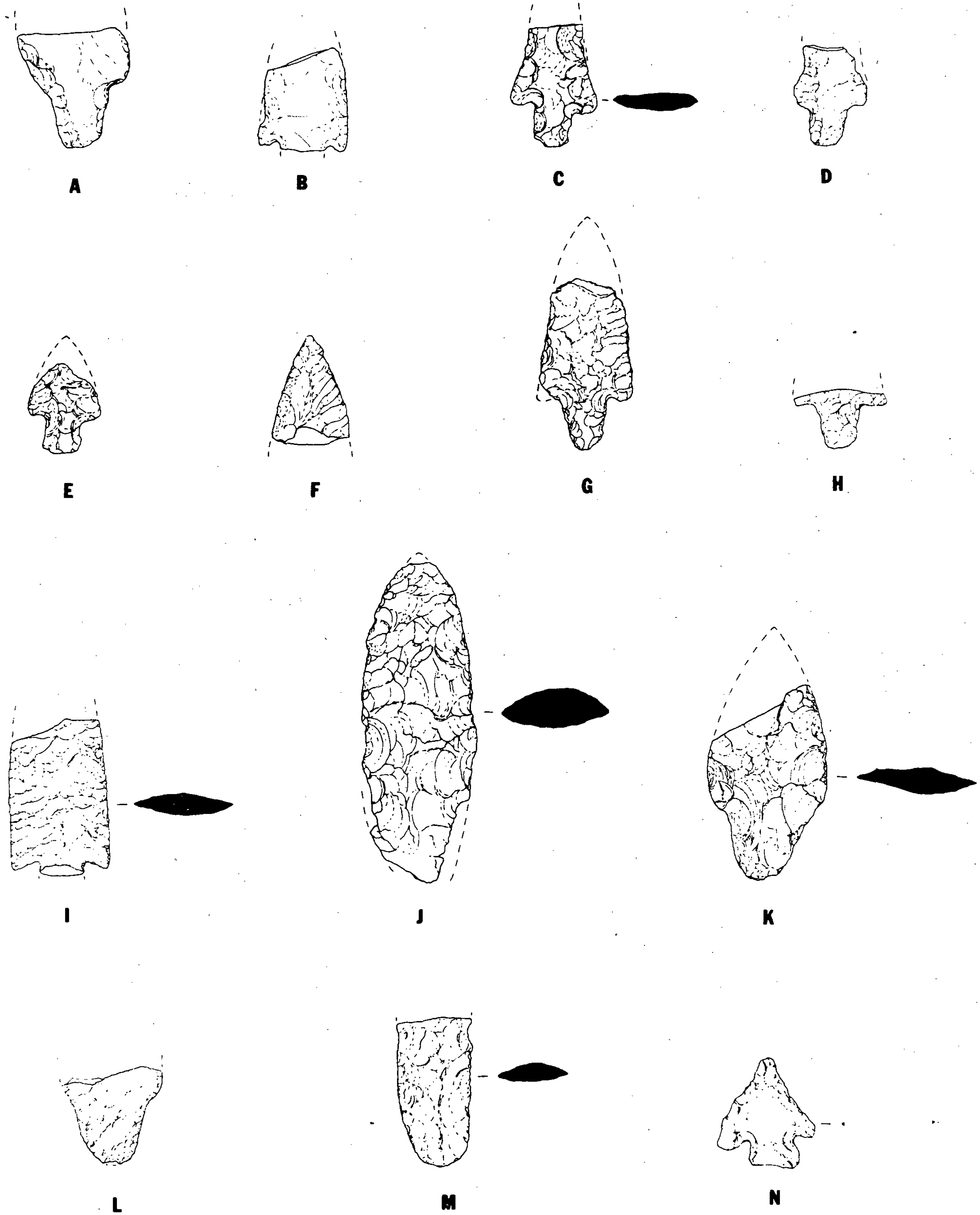
A
B
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Table 1. Tikal and Teotihuacan chronologies (after Willey and Smith 1969 and Sanders, Parsons, and Santley 1979).

Tikal periods	Ceramic complexes		Date	Teotihuacan phases
Terminal Classic			1000	Mazapan
	Eznab			
			900	
10.2.0.0.0				Xometla
			800	
Late Classic	Imix			
				Oxtotipac
9.14.0.0.0			700	Metepec
Middle Classic	Ik			
				Late Xolalpan
9.8.0.0.0			600	
		Late		
				Early Xolalpan
			500	
Early				
	Manik	Middle		Late Tlamimilolpa
Classic			400	
				Early Tlamimilolpa
		Early	300	
8.10.0.0.0				
				Miccaotli
			200	
	Cauac-Cimi			
				Apetlac
Late			100	
				Teopan
Preclassic				
	Cauac		0	
				Oxtotla
			100	
	Chuen			Patlachique
			200	
				Tezoyuca
			300	
	Tzec			
Middle				
			400	Late Cuanalan
Preclassic				
	Eb		500	
			600	Early Cuanalan

Table 2. Obsidian artifacts from Tikal and Tetitla analyzed in 1978. Note: C - cache, P - burial of problematical nature. Approximate dates of ceramic complexes are given on Table 1.

Tikal catalogue and lot number	Artifact type	Date	Description	LBL sample no.	XRF no.	NAA no.
GUATEMALA PROVENIENCE						
<u>El Chayal-La Joya Area</u>						
9B-1j/6(C115)	Eccentric	Middle Classic	translucent grey	TIKL-15	8075-R 8079-L	1055H
11D-36p/10(C11)	Eccentric	Middle Classic	translucent grey, hazy bands	TIKL-16	8075-S	
12B-69f/14(C41)	Eccentric	Early Classic	translucent grey, hazy streaks	TIKL-17	8075-T	
12J-147t/22(C120)	Eccentric	Early Classic	translucent grey, hazy bands	TIKL-18	8075-U	
11D-216/37(C42)	Incised	Late Classic	translucent grey, hazy dark spots	TIKL-19	8075-V	
12C-210i/10(C14C)	Incised	Middle Classic	translucent grey, fine hazy streaks	TIKL-20	8075-W	
36U-7/18	Earspool	Manik through Imix	translucent grey, hazy banding	TIKL-21	8075-X	1055Z

(more)

Tikal catalogue and lot number	Artifact type	Date	Description	LBL sample no.	XRF no.	NAA no.
66D/29	Cortical flake	Cauac	translucent grey, cloudy banding	TIKL-25	8075-1	
67L/11	Cortical flake	Manik or earlier	translucent grey, cloudy banding	TIKL-26	8075-2	
Ixtepeque (Sidrys' source 2-1)						
78M-15/18	Point-knife	Imix, some Cauac	clear brown-grey, faint hazy streaks	TIKL-12	8075-0	1075G
98F-17/6	Point-knife	Eznab	clear brown-grey, faint hazy streaks	TIKL-13	8075-P	
20H-6/3	Prismatic blade	Ik through Eznab	clear grey	TIKL-23	8075-Z	
Rio Pixcaya (San Martin Jilotepeque)						
12W-10/8	Prismatic blade	Late Preclassic	translucent grey,"dusty" inclusions	TIKL-22	8075-Y 8079-J	1057J

(more)

Tikal catalogue and lot number	Artifact type	Date	Description	LBL sample no.	XRF no.	NAA no.
MEXICO PROVENIENCE						
<u>Otumba, Mexico</u>						
20A-731/74	Point-knife	Ik, Imix	opaque grey	TIKL-1	8075-D	1055X
20B-119/45	Point-knife	Ik, Ik-Imix transition	translucent grey, fine hazy streaks	TIKL-2	8075-E 8079-D	
43F-110/23	Point-knife	Manik, Ik	opaque grey	TIKL-5	8075-H 8079-E	1057F
66H-27/12(P231)	Point-knife	Late Manik	opaque grey	TIKL-7	8075-J	
67A-137/53	Point-knife	Late Manik	opaque grey	TIKL-8	8075-K	
67A-184/58	Point-knife	Late Manik	opaque grey	TIKL-9	8075-L	
128E-13/7	Point-knife	Manik, Ik, Imix	opaque grey	TIKL-14A,B	8079-G,H	
Tetitla	Flake		opaque black	TETI-1	8075-3	
Tetitla	Flake		translucent grey, dense hazy banding	TETI-2	8075-4	

(more)

Tikal catalogue and lot number	Artifact type	Date	Description	LBL sample no.	XRF no.	NAA no.
<u>Pachuca, Hidalgo</u>						
45G-11/7	Point-knife	Manik, some later Classic	opaque silver-green	TIKL-6	8075-I	
78L-10/2	Prismatic blade	Manik, mostly Imix	opaque brown-green	TIKL-24	8079-K 8078-D	1057K
<u>Zaragoza, Puebla</u>						
20D-168/15	Point-knife	Early Imix	opaque grey	TIKL-3	8075-F,Q	1055Y
<u>Ucareo type, Michoacan</u>						
26B-6/1	Point-knife	Cauac-Cimi, Manik, Ik	opaque black	TIKL-4	8075-G	1037E
UNKNOWN PROVENIENCE						
68I-45/20	Point-knife	Manik, some Late Preclassic	opaque black	TIKL-10	8075-M 8079-F	1036Y
77A-17/7	Point-knife	Manik through Imix	opaque black	TIKL-11	8075-N	1036X

Table 3. Results of X-ray fluorescence analyses (abundances in ppm).

Notes to Table 3.

[1] Uncertainty in the Ba measurement, except for Pachuca results, is about 4%.

[2] Assignment confirmed by NAA (see Table 4).

[3] NAA (see Table 4) confirmed the El Chayal-La Joya assignment of the artifact and indicated that the slight deviation from the group averages is due to statistical or measurement fluctuation.

[4] The "391 ppm Mn" type with which the representative samples, TIKL-1 and TIKL-5, agree in the NAA measurements, corresponds closely in chemical composition to the Otumba, Mexico, obsidian as given by Stross et al (1976) for elements measured in common. The entire chemical composition of the "391 ppm Mn" type as measured at LBL is therefore assumed to be the chemical composition of Otumba source obsidian.

[5] The assignment of the sample to the LBL "252 ppm Mn" type was confirmed by a NAA measurement. This type corresponds closely in chemical composition to the Zaragoza source obsidian as given by Stross et al (1976) for the elements measured in common. The entire chemical composition of the "252 ppm Mn" type is therefore assumed to be the chemical composition of the Zaragoza source obsidian.

Designation	Ba[1]	Ce	Rb/Zr	Sr/Zr
<u>Artifacts assigned to El Chayal-La Joya-Cornelia Dome (Guatemala) source</u>				
TIKL-16	918	52 ± 8	1.32 ± .08	1.33 ± .06
TIKL-17	932	50 ± 8	1.23	1.37
TIKL-18	906	59 ± 9	1.25	1.29
TIKL-19	893	54 ± 9	1.21	1.34
TIKL-20	895	45 ± 9	1.13	1.31
TIKL-21[2]	874	49 ± 8	1.13	1.35
TIKL-25	885	54 ± 8	1.29	1.37
TIKL-26	870	50 ± 8	1.28	1.25
TIKL-15[2, 3]	896	48 ± 6	.99	1.25
Mean (first 8)	897	51.6	1.23	1.33
RMSD (first 8)	21	4.2	.07	.04
Reference group	943	47.4	1.24	1.29
<u>Artifacts assigned to Ixtepeque (Jutiapa) source (R. Sidrys 2-1 source)</u>				
TIKL-12[2]	1022	43 ± 7	.59 ± .05	.88 ± .04
TIKL-13	990	51 ± 9	.55	.85
TIKL-23	1018	44 ± 8	.54	.92
Mean	1010	46	.56	.88
RMSD	17	4.4	.03	.04
Reference group	1030	43.3	.57	.90

(more)

Designation	Ba	Ce	Rb/Zr	Sr/Zr
Artifact assigned to San Martin Jilotepeque area (Chimaltenango) (Rio Pixcaya type)				
TIKL-22[2]	1051	47 ± 4	.85 ± .05	1.66 ± .06
Reference group	1103	47.4	.95	1.64
Artifact designated as Ucareo (Michoacan) type				
TIKL-4[2]	159	74 ± 6	1.18 ± .07	.08 ± .02
Reference group	138±19	71 ± 2	1.24	.11
Artifacts assigned to Otumba (Mexico) source[4]				
TIKL-1[2]	716	63 ± 6	.92 ± .05	.94 ± .03
TIKL-2	786	65 ± 6	.81	.88
TIKL-5[2]	735	55 ± 4	.97	.82
TIKL-7	784	65 ± 6	.81	.87
TIKL-8	732	57 ± 6	.82	.84
TIKL-9	733	56 ± 6	.82	.90
TIKL-14	734	54 ± 6	.72	.79
TETI-1	745	54 ± 6	.85	.89
TETI-2	795	64 ± 6	.79	.91
Mean	751	59	.83	.87
RMSD	29	6	.07	.05
Reference groups				
Stross *et al* 1976	800-1000	60-65	~1.0	~1.0
Asaro *et al* n.d.	806 ± 26	54.9±.8		
Artifacts assigned to Pachuca (Hidalgo) source				
TIKL-6	9	106 ± 15	.22 ± .01	< .004
TIKL-24[2]	23	97 ± 7	.20	< .008
Mean	16	102	.21	< .008
RMSD	10	6	.01	
Reference groups				
Stross *et al* 1976	0-10	110-115	.25	< .006
Asaro *et al* n.d.		96.4±1.9		

(more)

Designation	Ba	Ce	Rb/Zr	Sr/Zr
<u>Artifact assigned to Zaragoza (Puebla) source</u>[5]				
TIKL-3[2]	434	82 ± 13	.67	.15
Reference groups				
Stross <u>et</u> <u>al</u> 1976	500	70	.79	.21
Asaro <u>et</u> <u>al</u> n.d.	474±21	75.9±.9		

Table 4. Neutron activation verification of XRF assignments. Abundances are given in percent for Na and K and in parts-per-million (ppm) for the other elements. The errors for the individual artifacts reflect the precision of the measurement. For the reference groups the upper value is the abundance and the lower value is the standard deviation or root-mean-square-deviation (RMSD).

<u>Element abundances and errors</u>

	Mn	Ba	Dy	Na %	K %
TIKL-4	164±2	154±18	3.93±.08	2.86±.03	4.43±.30
Ucareo reference	170	162	3.82	2.91	4.27
group	4	12	.10	.03	.25
TIKL-12	453±5	1064±28	2.49±.10	3.08±.03	4.21±.32
Ixtepeque Source	449	1030	2.30	3.05	3.61
(Sidrys' 2-1 source)	9		.11	.06	.26
TIKL-21	640±6	922±35	2.73±.12	3.25±.06	3.83±.27
TIKL 15	639±6	926±32	2.60±.11	3.21±.03	3.58±.31
El Chayal-La Joya-	649	943	2.66	3.15	3.45
Cornelia Dome source	13		.11	.06	.26
TIKL-22	529±5	1130±34	2.18±.11	2.96±.03	3.59±.30
San Martin Jilotepeque	521	1036	2.10	2.92	3.71
area (Rio Pixcaya type)	10	40	.11	.06	.24
TIKL-24	1132±11	<130	16.63±.21	3.96±.04	3.75±.37
Pachuca type	1132	< 36	16.46	3.81	3.64
	25		.34	.13	.46
TIKL-1	389±4	811±28	3.54±.10	3.24±.06	3.57±.25
TIKL-5	395±4	758±25	3.61±.10	3.16±.03	3.83±.30
LBL 391 ppm Mn type	391	839	3.29	3.15	3.64
(very like Otumba source)	6	21	.14	.06	.46
TIKL-3	250±5	432±25	5.11±.10	3.13±.06	4.17±.24
LBL 252 ppm Mn type (very	252	488	4.93	3.05	4.16
likely Zaragoza source)	5	14	.10	.06	.12

Table 5. Detailed analysis of two unassigned artifacts. NAA except where indicated.

Notes to Table 5.

[1] The measurements were calibrated with Standard Pottery whose composition and abundances are given in Perlman and Asaro (1971). The indicated errors are the precision (one standard deviation) of measurement. The accuracies can be deduced from the uncertainties in Standard Pottery given in the reference.

[2] The values in this column are the standard deviations measured in seven Zinapecuaro obsidian rocks, or the experimental error, whichever is larger.

[3] Ba and Zr data from Ericson and Kimberlin (1977) were not included because of uncertainties in these data.

[4] This value was normalized to the LBL calibration system with Teuchitlan and Etzatlan obsidian data.

[5] Measured by XRF.

	68I-45/20 (TIKL-10)	77A-17/7 (TIKL-11)	Zinapecuaro (LBL)	Zinapecuaro (Ericson & Kimberlin 1977)
Al%	7.28±0.13 (1)	6.51±0.10 (1)	6.59±0.15 (2)	
Ba	773 ± 18	34 ± 9	74 ± 12	(3)
Ce	60.5±0.7	47.1±0.7	59.4±8.0	51.1 ± 1.8 (4)
Co	1.16±0.07	0.30±0.05	0.26±0.06	0.21 ± 0.01
Cs	5.58±0.09	10.66±0.15	8.32±0.30	9.9 ± 0.8 (4)
Dy	4.29±0.10	5.04±0.12	4.23±0.23	
Eu	0.642±0.010	0.097±0.006	0.129±0.10	
Fe%	1.277±0.014	0.733±0.010	0.75±0.03	0.72 ± 0.01 (4)
Hf	4.92±0.07	4.43±0.07	4.07±0.10	4.11 ± 0.18 (4)
K%	3.58±0.17	4.00±0.22	3.86±0.30	
La	29.7±0.5	22.3±0.5	29.1±4.6	
Lu	0.362±0.017	0.460±0.020	0.360±0.022	
Mn	276 ± 5	192 ± 4	175 ± 5	
Na%	3.30±0.06	3.10±0.06	2.90±0.05	
Rb	145 ± 5	209 ± 7	186 ± 10	191 ± 7 (4)
Sb	0.17±0.04	0.60±0.06	0.56±0.07	
Sc	3.39±0.03	3.15±0.03	2.78±0.06	3.41 ± 0.14
Sm	4.58±0.05	4.54±0.05	4.51±0.25	
Sr (5)	171 ± 26	<18	<13	
Ta	0.990±0.010	1.671±0.017	1.310±0.664	1.51 ± 0.11 (4)
Th	10.54±0.11	18.33±0.18	16.02±0.58	16.9 ± 0.9 (4)
U	3.21±0.03	5.32±0.04	4.37±0.17	
Yb	2.54±0.03	3.21±0.04	2.64±0.10	2.92 ± 0.28 (4)
Zr (5)	256 ± 38	125 ± 19	112 ± 17	(3)

Table 6. Contexts of 14 analyzed obsidian point-knives from Tikal. Structure group classification follows Moholy-Nagy (1976, 1981) where Range Structure Groups are considered to have been elite residences, Intermediate Structure Groups middle status residences, and Small Structure Groups lower class residences.

Tikal catalogue and lot number	Illustration	Lot context	Structure classification	Structure group Classification
20A-731/74	Fig. 3, a	Midden?	Small structure	Small Structure Group
20B-119/45	Fig. 3, b	Sealed construction	Range structure	Small Structure Group
20D-168/15	Fig. 3, c	Midden	Small structure	Small Structure Group
26B-6/1	Fig. 3, d	Chultun fill	Chultun	Small Structure Group
43F-110/23	Fig. 3, e	Construction fill	Range structure	Twin Pyramid Group
45G-11/7	Fig. 3, f	Construction fill	Range structure	Range Structure Group
66H-27/12(P231)	Fig. 3, g	Problematic burial with Teotihuacan affinities	Chultun	Small Structure Group
67A-137/53	Fig. 3, h	Construction fill	Small structure	Small Structure Group
67A-184/58	Fig. 3, i	Sealed construction	Small structure	Small Structure Group
68I-45/20	Fig. 3, j	Midden?	Small structure	Small Structure Group

(more)

Tikal catalogue and lot number	Illustration	Lot context	Structure classification	Structure group classification
77A-17/7	Fig. 3, k	Construction fill	Unclassified	Intermediate Structure Group
78M-15/18	Fig. 3, l	Mixed surface and construction	Ballcourt mound	Range Structure Group
98F-17/6	Fig. 3, m	Midden	Range structure	Range Structure Group
128E-13/7	Fig. 3, n	Midden	Temple?	Range Structure Group, Navajuelal, Tikal Sustaining Area

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