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Experimental microwear analysis on Maya obsidian tools : case study of the La Entrada Region, Honduras

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RÉSUMÉ
Cet article présente un cadre d'interprétation pour les fonctions des outils mayas en obsidienne, fondée sur des études expérimentales ainsi que sur les résultats préliminaires d'une analyse de microtraces sur des artefacts provenant de la région de La Entrada, Honduras occidental. En analysant un plus grand nombre d'artefacts, en contexte archéologique, on pourra reconstituer le comportement et les activités spécifiques des anciens Mayas.

ABSTRACT
This paper presents a framework for the interpretation of the functions of Maya obsidian tools, based on experimental studies and the preliminary results of microwear analysis on artifacts from the La Entrada Region, western Honduras. By analyzing more artifacts, in archaeological contexts, it will be possible to reconstruct the specific behavior and activities of the ancient Maya.

Introduction

The Maya's lithic study should be done through their history, that is (1) raw material procurement, (2) manufacture, (3) use, (4) rejuvenation and (5) abandonment of the stone artifacts.

In the Maya archaeology, the study of the stone tool´s function is not advanced, despite its great importance, and formerly the major part of the functions of Maya lithics were interpreted through their morphology, ethnographic studies and use-wear analysis with a low-power microscope (*e. g.* Wilk, 1976 ; Sheets, 1978 ; Lewenstein, 1981). There is a strong relation between the form and function of the lithic, because its form was shaped with the function in mind. It is necessary, however, to establish another typology for the moment of use, through the function of lithics such as deduced by Keeley's (Keeley, 1980) high-power method of microwear analysis, without much consideration of the forms. In this context, a few microwear studies of Maya chert and obsidian artifacts were recently undertaken through the high-power method (Hohol *et al.*, 1986 ; Lewenstein, 1987). Above all, the study of the function of obsidian chipped stone artifacts (*e. g.* Vaughan, 1981 ; Kajiwara, 1982 ; Hurcombe, 1985 ; Sato, 1986 ; Midojima, 1986) is indispensable for the reconstruction of the ancient Maya behavior.

In the meantime, in 1987, the La Entrada Archaeological Project, in Honduras, started an intensive experimental study of use-wear, especially polish and striations, on obsidian and silicate (such as chalcedony and agate) artifacts, conducting 267 experiments as a whole, in order to interpret their function, that is worked materials, location of microwear and motion of use, by means of a high-power microscope (Aoyama, 1989). The method has been applied to Maya artifacts from the La Entrada Region, western Honduras, which was part of the SE Maya periphery from the Middle Preclassic period to the Late/Classic one (900 BC-900 AD). In this paper, the method and preliminary results of the microwear analysis of Maya obsidian artifacts are presented.

Method

In order to build up an experimental framework for the interpretation of the function of Maya obsidian artifacts, 151 replicative experiments of obsidian (table 1) were conducted, under controlled conditions based on the method of Keeley (1980) and the Tohoku University Microwear Research Team in Japan (Kajiwara, Akoshima, 1981). The natural obsidian nodules from Ixtepeque, El Chayal, San Martin Jilotepeque in Guatemala, La Esperanza and Güinope in Honduras were collected for the experimentation. The other purpose of these experiments was to investigate the difference in use-wear through the above-mentioned pre-Columbian obsidian sources. The percussion flakes of obsidian were produced using a stone hammer. These replicas were used by hand without hafting. Before the experiment, some replicas were retouched, but, during the experimentation, no edge rejuvenation was done because of the character of the experiment. Three variables – motion of use, worked material and number of strokes – were controlled independently.

Motion of Use

Seven motions of use – sawing, cutting, grooving, scraping, whittling, chopping and boring – were carried out. In the present study, each movement, which was defined by the position between the experimental implement and worked material on the one hand and the direction of use on the other hand, was simplified in order to produce basic data.

Worked Material

According to the method used by Keeley (1980) and the model of the ancient Maya ecological system (Morley, Brainerd, Sharer, 1983 : 189-204), the experiments were done not only in the field, but also in the laboratory, for Gramineae, composite plant, wood, bamboo, bottle gourd, corn cane, vegetables (chili, squash and avocado), fruit (pineapple and papaya), coconut, yucca, meat, hide (fresh and dry), leather, bone, antler (dry and soaked), *jute* snail (*pachychilus*), soil and stone (obsidian, chalcedony and volcanic tuff). Some hide was mixed with soil and some antlers were immersed in water for one day. The same experiment was repeated by various persons.

Number of Strokes

The number of strokes for each motion was counted, and the number of sawings was counted by go-and-returns.

The microscope used in this study is a metallurgical microscope of 50-800x magnification, with an incident light attachment (Olympus BHM). Magnifications of 100x, 200x and 500x are applied for the observations of use-wear. A magnification of 200x is used for the most part. Magnification of 100x is used mainly for the location of use-wear. To observe details of use-wear, a magnification of 500x is used, although a very limited part of obsidian can be in focus at one time. Archaeological and experimental specimens are observed in the same manner. Meanwhile, microphotos are taken on Fuji Neopan 35 mm black-and-white films and Fujichrome with an Olympus photomicrographic system camera PM-10M attached to the Olympus EMM-7 photo-

N°	Material	Motion	N° of Strokes	Pattern of use-wear
OB1	Gramineae	cutting	500	ah
OB2	Gramineae	cutting	500	aa
OB3	Gramineae	cutting	1000	aa
OB4	Gramineae	cutting	1500	aa
OB5	Gramineae	cutting	2000	aa
OB6	composite plant	cutting	1000	bb
OB7	Gramineae	cutting	2000	aa
OB8	Gramineae	cutting	2000	aa
OB9	Gramineae	cutting	2500	aa
OB10	fresh wood	scraping	2000	bb
OB11	fresh wood	scraping	2000	bb
OB12	fresh wood	scraping	2000	bb
OB13	fresh wood	whittling	2000	bb
OB14	fresh wood	engraving	1500	bb
OB15	fresh wood	sawing	2000	bb
OB16	fresh wood	scraping	2000	bb
OB17	fresh wood	whittling	3000	bb
OB18	fresh wood	cutting	4000	bb
OB19	cooked bone	sawing	250	cc
OB20	cooked bone	sawing	500	cc
OB21	cooked bone	sawing	1000	cc
OB22	cooked bone	sawing	1500	cc
OB23	cooked bone	scraping	1500	dd
OB24	cooked bone	scraping	2000	dd
OB25	fresh bone	scsawing	3000	dd
0B26	fresh bone	sawing	3000	cc
OB27	fresh meat	cutting	750	ii
OB28	fresh hide	scraping	3000	ef
OB29	fresh hide	cutting	3000	ff
OB30	leather	cutting	3000	ee
OB31	fresh hide	cutting	1500	ef
OB32	fresh hide	scraping	1500	ee
OB33	leather	scraping	1500	ee
OB34	chalcedony	rubbing	1000	yy
OB35	obsidian	rubbing	1000	yy
OB36	obsidian	rubbing	1000	yy
OB37	soil	excavating	1000	xx
OB38	soil	excavating	1000	xx
OB39	soil	excavating	1000	xx
OB40	dry hide	scraping	1000	ef
OB41	dry hide	cutting	1000	ef
OB42	dry hide	cutting	1000	ee
OB43	soaked antler	sawing	1000	cc
OB44	dry antler	sawing	1000	hh
OB45	cooked bone	whittling	1500	dd
OB46	soaked antler	sawing	2000	cc
OB47	dry antler	sawing	2000	hh
OB48	yucca	sawing	1500	hh
OB49	yucca	cutting	1500	hh
OB50	chili	cutting	1500	bh
OB51	chili	cutting	1500	hh
OB52	fresh meat	scraping	1500	ii
OB53	fresh meat	cutting	1500	fi
OB54	fresh meat	cutting	3000	ff
OB55	fresh meat	scraping	3000	if
OB56	fresh meat	scraping	1500	ii
OB57	fresh hide	cutting	1500	ff
OB58	yucca	cutting	2500	ee
OB59	hide + soil	cutting	1500	xx
OB60	yucca	cutting	2000	hh
OB61	avocado	sawing	1500	hh
OB62	avocado	sawing	1500	hh
OB63	avocado	sawing	1500	hh
OB64	avocado	cutting	1500	bb
OB65	avocado	sawing	500	hb
OB66	avocado	sawing	500	hh
OB67	avocado	sawing	500	hh
OB68	avocado	cutting	500	hh
OB69	squash (hard)	sawing	500	bb
OB70	squash (hard)	cutting	500	bb
OB71	squash (soft)	sawing	500	ii
OB72	squash (soft)	sawing	500	ii
OB73	squash (hard)	sawing	1500	bi
OB74	squash (hard)	cutting	1500	bb
OB75	squash (soft)	cutting	1500	ii
OB76	squash (soft)	cutting	1500	ii
OB77	papaya	cutting	700	ii
OB78	papaya	cutting	700	ii
OB79	papaya	cutting	730	ii
OB80	papaya	cutting	650	ii
OB81	pineapple	cutting	500	bb
OB82	pineapple	cutting	500	bb
OB83	pineapple	cutting	500	bb
OB84	pineapple	chopping	1100	bb
OB85	pineapple	cutting	1500	bb
OB86	pineapple	engraving	1500	bb
OB87	dry antler	sawing	3000	cc
OB88	fresh bamboo	whittling	500	bb
OB89	fresh bamboo	engraving	1500	bb
OB90	fresh bamboo	scraping	1000	bb
OB91	fresh bamboo	sawing	1000	bb
OB92	fresh bamboo	boring	500	bb
OB93	fresh bamboo	sawing	2500	bb
OB94	fresh coconut	chopping	1000	bb
OB95	fresh coconut	chopping	1000	bb
OB96	fresh coconut	cutting	1500	aa
OB97	dry tecomate	sawing	3500	hb
OB98	dry bamboo	whittling	3000	bb
OB99	dry bamboo	scraping	3000	bb
OB100	bottle gourd	sawing	2000	bb
OB101	tuff	chopping	1000	yy
OB102	tuff	chopping	1000	yy
OB103	tuff	chopping	1000	yy
OB104	tuff	rubbing	1000	yy
OB105	chalcedony	rubbing	1000	yy
OB106	leather	boring	1000	ff
OB107	leather	boring	1000	ff
OB108	leather	boring	1000	ff
OB109	leather	scraping	1000	ff
OB110	leather	scraping	1000	ee
OB111	leather	scraping	1000	ff
OB112	cone cane	cutting	3000	bb
OB113	dry antler	scraping	4000	dd
OB114	soaked antler	scraping	4000	dd
OB115	soaked antler	sawing	3000	cc
OB116	leather	scraping	3000	ee
OB117	fresh wood	sawing	4000	bb
OB118	soaked antler	scraping	4000	dd
OB119	dry antler	scraping	4000	hh
OB120	dry antler	scraping	4000	dd
OB121	leather	cutting	5000	ee
OB122	bottle gourd	cutting	5000	bb
OB123	soaked *jute*	sawing	3000	gg
OB124	soaked *jute*	sawing	3000	gg
OB125	soaked *jute*	chopping	100	gg
OB126	soaked *jute*	chopping	200	gg
OB127	fresh bone	sawing	5000	cc
OB128	fresh bone	sawing	5000	cc
OB129	fresh bone	scraping	5000	dd
OB130	fresh bone	scraping	5000	dd
OB131	fresh bone	sawing	5000	cc
OB132	fresh bone	sawing	5000	cc
OB133	fresh bone	scraping	5000	dd
OB134	dry bone	scraping	5000	dd
OB135	dry bamboo	sawing	5000	bb
OB136	fresh wood	sawing	5000	bb
OB137	fresh wood	whittling	5000	bb
OB138	fresh wood	whittling	5000	bb
OB139	fresh wood	scraping	5000	bb
OB140	dry wood	sawing	5000	bb
OB141	dry wood	sawing	5000	bb
OB142	Gramineae	cutting	5000	aa
OB143	Gramineae	cutting	5000	aa
OB144	composite plant	cutting	5000	bb
OB145	composite plant	cutting	5000	bb
OB146	Gramineae	cutting	5000	aa
OB147	fresh wood	sawing	5000	bb
OB148	fresh wood	scraping	5000	bb
OB149	cone cane	sawing	5000	bb
OB150	cone cane	sawing	5000	bb
OB151	cone cane	sawing	5000	bb

Table 1. List of Experimental Implements.

micrographic exposure meter for the documentation of use-wear.

Before the observation of use-wear, each specimen is hand-washed with water and soap very carefully, then wiped with absorbent cotton and alcohol. Finally, immersion of the piece in warm HCL (10 % solution) is applied for 10 minutes.

According to Keeley (1980), there is an exclusive correlation between polish type and worked material (e. g. bone polish, hide polish, wood polish.). In the Maya archaeology, Hohol *et al.* (1986) and Lewenstein (1987) classified polish types in the same manner. As a result of the study presented on obsidian, in the meanwhile, the correlation between polish and worked material is not absolute, that is both the motion of use and number of strokes can influence the formation of polish. It has been reported, moreover, that some antler and wood polishes are indistinguishable (Moss, 1983 : 87 ; Grace, 1989 : 37). That is why the Tohoku University Microwear Research Team (Kajiwara and Akoshima, 1981 : 10-15) classified the polish on silicaceous hard shale into 11 basic types, which are formed principally by the worked material, and the mentioned classification can be applied to chert artifacts, too (Serizawa *et al.*, 1981). At the same time, obsidian is a volcanic natural glass, and its surface is generally softer than that of silicaceous sedimentary rocks. It is probable that, for the reasons mentioned above, it is not the same polish that forms on the surface of obsidian as on that of silicaceous sedimentary rocks, although some types of polish are very similar. So, through synthetic observation of the striations, polish and

	(Worked Material)											
(Use-wear pattern)	Gramineae	bamboo & gourd	wood	other plants	bone	antler	*jute* snail	hide	meat	soil	stone	Total
aa	10			1								11
ah	1											1
bb		11	18	19								48
bh				1								1
bi				1								1
cc					9	4						13
dd					8	4						12
ee				1				7				8
ef								4				4
ff								7	1			8
fi									2			2
gg							4					4
hb		1		1								2
hh				10		3						13
if									1			1
ii				8				1	1			10
xx								1		3		4
yy											8	8
Total	11	12	18	42	17	11	4	20	5	3	11	151

Table 2. Worked Material and Use-Wear Pattern on Obsidian Experimental Implements.

					(Worked Material)						
(Group of use-wear pattern)	Gramineae	bamboo & gourd	wood	other plants	bone	antler	*jute* snail	hide	meat	soil	stone
a	100.0			2.4							
b		91.7	100.0	50.0							
c					52.9	36.4					
d					47.1	36.4					
e				2.4				55.0			
f								35.0	60.0		
g							100.0				
h		8.3		26.2		27.3					
i				19.0				5.0	40.0		
x								5.0		100.0	
y											100.0

Table 3. Worked Material and Group of Use-Wear Pattern on Obsidian Experimental Implements : percentage of observed occurrence.

micropits, use-wear is classified into 11 patterns, which correspond relatively to the worked material. It must be noted that there is no difference in use-wear with the different pre-Columbian obsidian sources. A complex of different patterns of use-wear is expressed by a primary and a secondary patterns such as « ah », « ef », « dh », and the group of use-wear pattern is represented by a primary pattern. The results of the use-wear analysis on 151 replicative experiments are summarized in tables 2 and 3. In the following, the description of 11 use-wear patterns on obsidian are given (plates 1 and 2).

(1) Pattern « a »

Authentic polish is characteristic of this pattern, or else it is the same as sickle gloss or corn gloss (Witthoft, 1967). The characteristics of patterns are : (1) very smooth and reflective surface, (2) fluid aspect and (3) filled-in striations. Pattern « a » occurs mainly with the use of Gramineae, but it also appears with cutting coconut.

(2) Pattern « b »

The surface of the polish is bright and very smooth, but not as fluid as that of pattern « b ». In spite of its quite developed polish, pattern « b »'s surface is relatively flat. Rather numerous micropits can be observed. Pattern « b » occurs with the use of plants such as wood, bamboo, bottle gourd, composite plant, corn cane, chili, squash, avocado and pineapple.

(3) Pattern « c »

The surface of the polish is bright, flat, but rough and pitted, with the presence of clear striations. Pattern « c » appears principally with sawing and cutting bone and antler, but it also occurs partially with the use of *jute* snail.

(4) Pattern « d »

The surface of the polish is bright, smooth and flat, but the extremity is a little rounded. A few thin striations and micropits are observed. Pattern « d » develops through actions with a transversal direction to the edge of the tool, such as scraping and whittling bone/antler.

(5) Pattern « e »

The polish has an intensely matte texture. The surface is generally rough, and its extention is limited in the area near the edge of the stone. Pattern « e » presents lots of tiny micropits and striations, and it occurs mainly with the use of hide, but also with cutting yucca.

(6) Pattern « f »

The polish is weak. Short striations and lots of micropits can be observed in a limited area near the edge of the experimental implement. If pattern « f » develops, it becomes pattern « e ». Pattern « f » occurs with using hide and meat.

(7) Pattern « g »

The surface of the polish is bright and very flat, but not so rough as in pattern « c ». Pattern « g » presents micropits with a variety of size and many striations, and it appears characteristically with the use of *jute* snail, but it occurs partially with using antler and bone.

(8) Pattern « h »

The polish is weak and dull. Relatively long striations and micropits with a variety of forms and sizes are present. Pattern « h » occurs with using Gramineae, other plants (avocado, chili and bottle gourd, and yucca), dry antler, bone and *jute* snail. It occurs frequently with the use of a hard material in a zone not very much utilized, that is to say pattern « h » is a step towards other use-wear patterns.

(9) Pattern « i »

The polish is weak and occurs at the extremity of convexities on the lithic's surface. The surface of the polish is rounded and smooth, but its extension is very small. Neither striations nor micropits can be observed. Pattern « i » appears when using soft materials such as meat and soft vegetables (papaya and soft squash).

(10) Pattern « x »

The polish is dull with a matt texture. The surface of the polish is very rough, with micropits

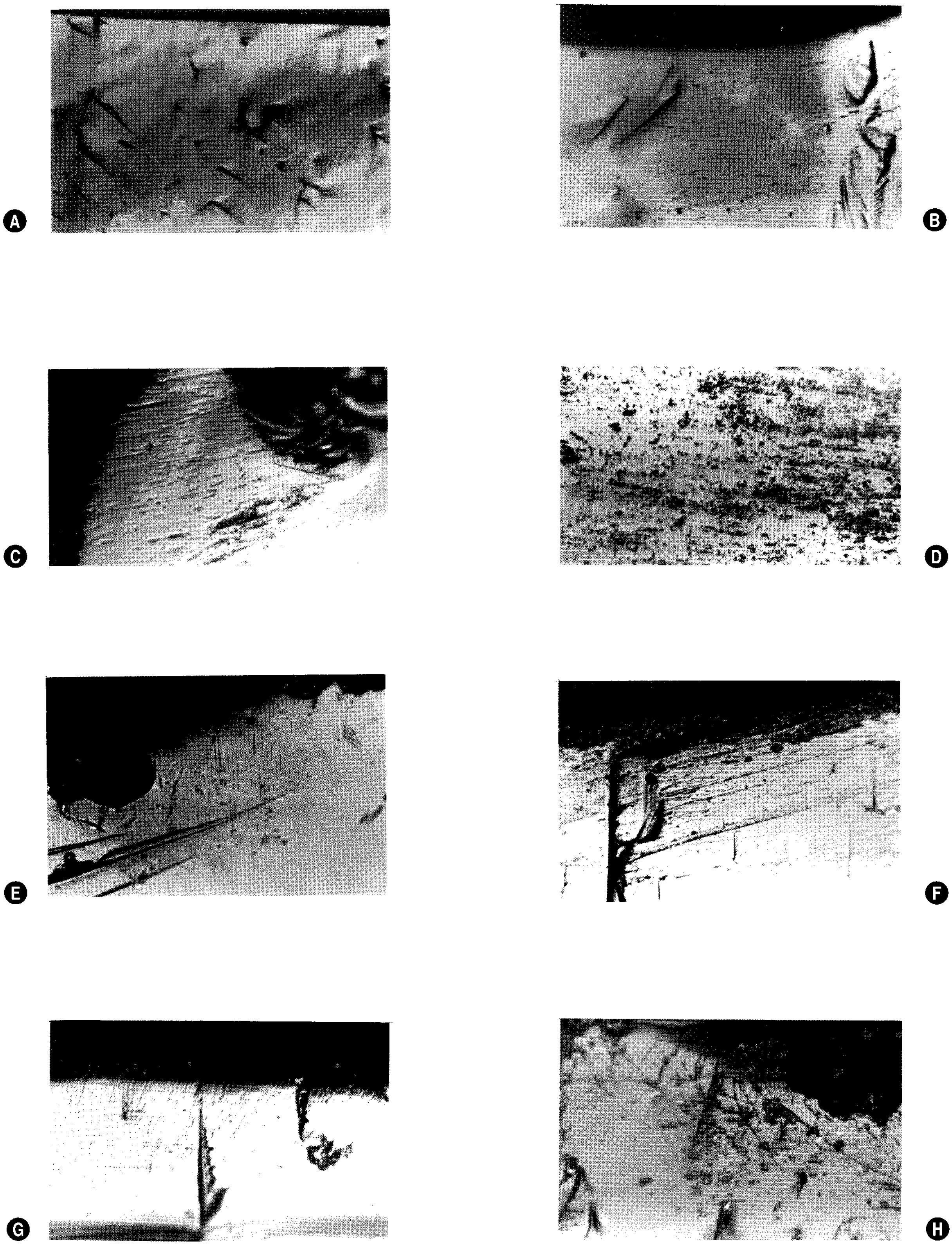

Plate 1. Use-Wear patterns on obsidian tools (1) (200x). **A.** Surface of unused obsidian. **B.** OB143 Gramineae cut 5000 st. pattern a. **C.** OB147 wood sawn 5000 st. pattern b. **D.** OB127 bone sawn 5000 st. pattern c. **E.** OB130 bone scraped 5000 st. pattern d. **F.** OB42 hide cut 1000 st. pattern e. **G.** OB109 leather scraped 1000st. pattern f. **H.** OB124 soaked *jute* snail 3000 st. pattern g.

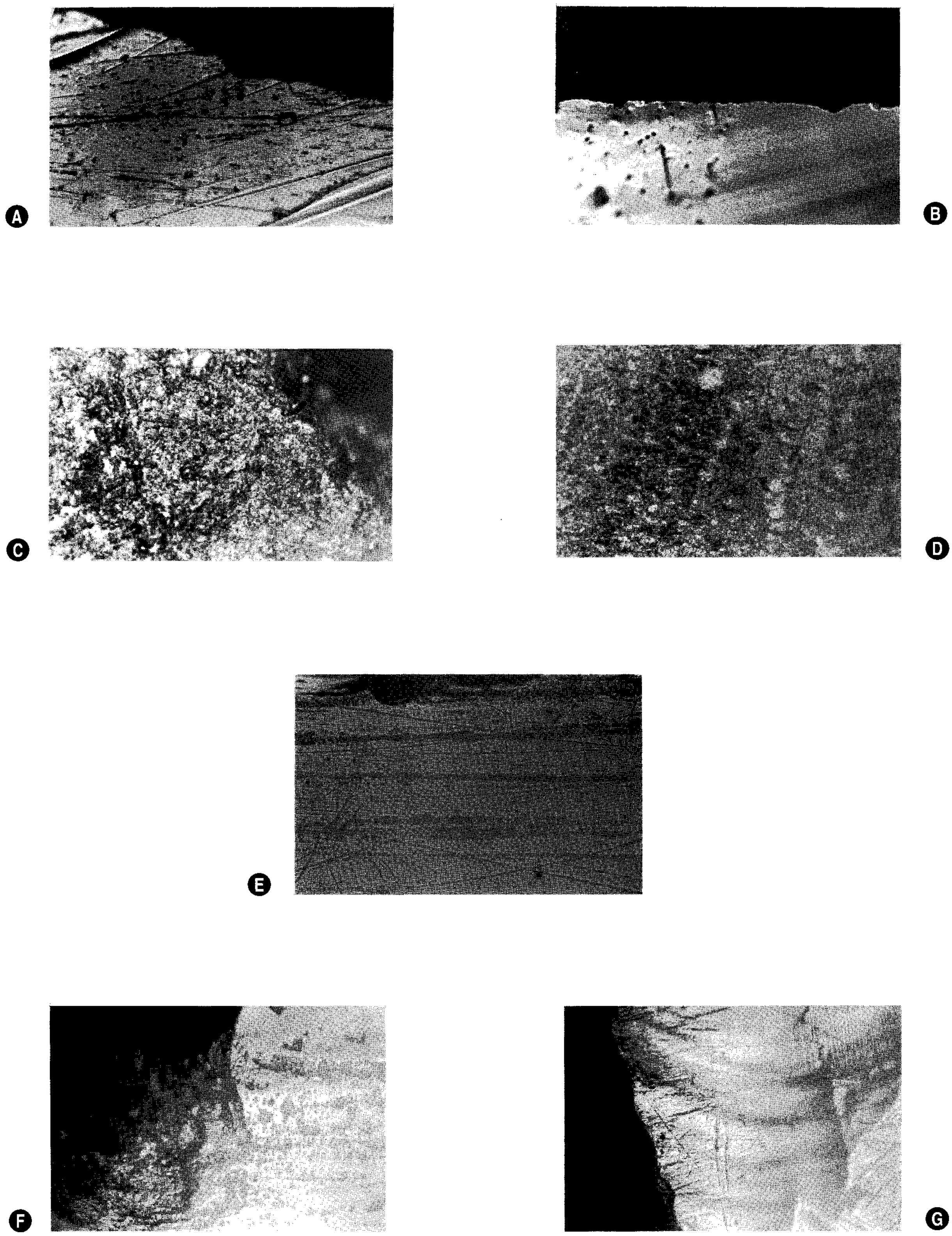

Plate 2. Use-Wear patterns on obsidian tools (2) (200x). **A.** OB58 yucca cut 2500 st. pattern h. **B.** OB28 hide scraped 3000 st. pattern i. **C.** OB37 soil excavated 1000 st. pattern x. **D.** OB35 obsidian rubbed 1000 st. pattern y. **E.** prismatic blade from the site of Diablo, pattern b. **F.** prismatic blade from the site of Los Higos, pattern c. **G.** bifacial point/knife, pattern f.

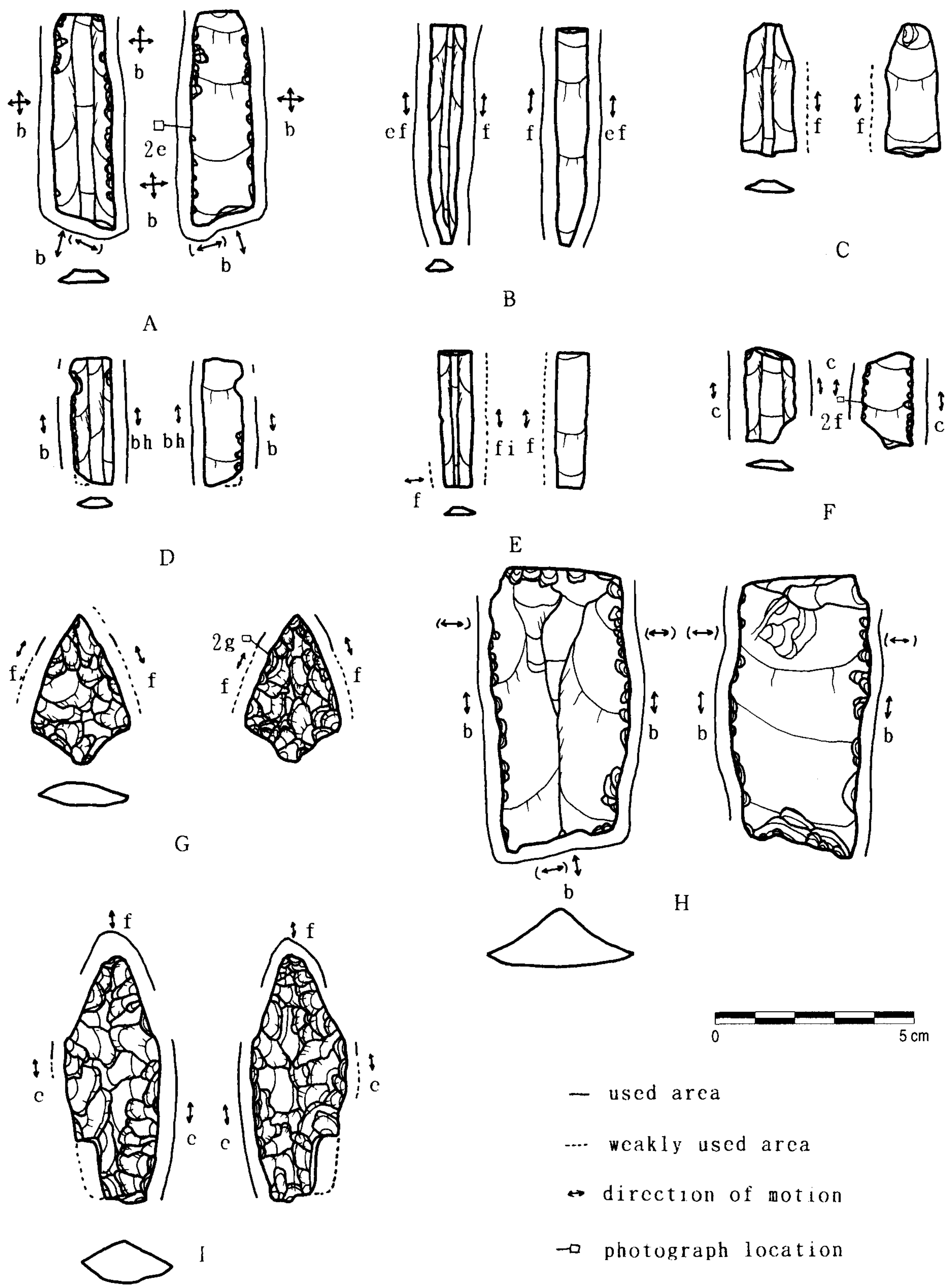

Fig. 1. Maya obsidian artefacts from the La Entrada Region, Honduras showing production morphology and location of use-wear. Drawings are in Japanese technical style.

of a variety of sizes and forms and many striations. Pattern « x » develops when excavating soil and when soil is mixed with another material.

(11) Pattern « y »

The polish is weak with a matte texture. The surface of the polish is rough, but not as rough as that of pattern « x ». Micropits cannot be seen clearly. Many striations are observed not only with a microscope, but also the naked eye. Pattern « y » appears with the use of stone.

Results of the Microwear Analysis

As the microwear analysis on the Maya obsidian artifacts from the La Entrada Region is going on, only preliminary results are presented here. On the basis of the experiments mentioned above, microwear was analyzed on 57 obsidian artifacts (fig. 1). These artifacts are selected through random sampling and classified through the Mesoamerican behavioral typology (Sheets, 1975, 1978 ; Clark, Lee, 1979) into 35 prismatic blades, 4 macroblades, 7 bifacial points/knives, 1 prismatic blade point, 2 fragments of polyhedral core, 2 denticulates, 1 scraper and 5 general debitages pieces. Use-wear is observed on 55 artifacts (96.5 %). Although no use-wear is observed on 2 prismatic blades, there are two possibilities : either (1) these artifacts were not utilized, or (2) they were used for a short time, but no use-wear visible with a high-power microscope was formed.

The most often-used motion was cutting/sawing (64.1 % ; N=84), then scraping (17.6 % ; N=23), whittling (13.0 % ; N=17) and piercing (5.3 % ; N=7) (table 4). In the meantime, hide/meat was the most used worked material (57.4 % ; N=70), followed by wood/plants (32.0 % ; N=39) and bone/antler (10.6 % ; N=13) (table 5).

Because of the small number of analyzed samples, the correlations between lithic type and function have been discussed for three types only, prismatic blade, macroblade and bifacial point/knife, as follows :

For the most part, cutting/sawing (76.6 % ; N=59) was done using both lateral edges of prismatic blades, but scraping (15.6 % ; N=12) or whittling (7.8 % ; N=6) was carried out by some lateral edges and the dorsal edge of three specimens.

(Type)	cuttling/ sawing	scra-ping	whitt-ling	piercing	Total
prismatic blades	59	12	6	0	77
macroblades	6	1	5	0	12
bifacial points/knives	13	5	0	6	24
prismatic blade point	0	0	0	1	1
polyhedral core fragments	2	1	2	0	5
general debitages	3	3	2	0	8
scraper	0	0	2	0	2
denticulates	1	1	0	0	2
Total	84	23	17	7	131

Note : If an artefact has various used areas, the number of motions is counted for each used area ; moreover, if various motions are interpreted in an area, the number of motions is counted for each motion.

Table 4. Correlation between Lithic Typology and Motion of Use.

(Type)	hide/ meat	wood/ plant	bone/ antler	Total
prismatic blades	41	20	13	74
macroblades	1	10	0	11
bifacial points/knives	19	2	0	21
prismatic blade point	1	0	0	1
polyhedral core fragments	1	2	0	3
general debitages	6	2	0	8
scraper	0	2	0	2
denticulates	1	1	0	2
Total	70	39	13	122

Note : If various worked materials are observed in a used area, the number of worked materials is counted for each material.

Table 5. Correlation between Lithic Typology and Worked Material.

Hide/meat (55.4 % ; N=41) was cut or scraped by prismatic blades, and wood/plant (27.0 % ; N=20), and bone/antler (17.6 % ; N=13) was cut/sawn or whittled.

All lateral edges and two dorsal edges of the analyzed macroblades were used to cut/saw (50.0 % ; N=6) or whittle (41.7 % ; N=5) wood/plant (90.9 % ; N=10), but one lateral edge was utilized for scraping hide. A particularly strong correlation between macroblade and wood/plant can be mentioned.

The results of the microwear analysis of bifacial points/knives are very interesting. Generally, point bits were used for piercing (25.0 % ; N=6), and both lateral edges were utilized for cutting (50.0 % ; N=12) and/or scraping (20.8 % ; N=5). In addition, the distal end of one specimen was used for cutting. The main worked material was hide/meat (90.5 % ; N=19), but one sample was used for wood/plant (9.5 % ; N=2), too. That is to say, the bifacial points/knives had the functions not only of piercing tools, but also of knives and/or scrapers.

On the other hand, a possible hafting trace can be observed on a prismatic blade point ; moreover, two fragments of a polyhedral core were re-used to cut and whittle wood/plant and scrape hide. In addition, it is possible that 11 artifacts – that is 5 prismatic blades, 3 bifacial points/knives (fig. 2 : G, I), 2 macroblades (fig. 2 : H) and 1 scraper were rejuvenated because of the difference in use-wear distribution, in spite of the cutting/sawing motion. These artifacts may have been curated tools.

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