Prehistoric archaeology. The site of Garba IV

The lithic industry of Level D.

Débitage and tools on flake

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The study of the lithic industry from Garba IV consists of a morpho-technical and typometrical presentation of the artefacts.

A preliminary determination of all the artefacts, including their typometry, was done in order to catalogue them during the various excavation seasons, while the detailed typological study was carried out later on 3002 flake and tools on pebble, equal to 30.57% of the 9821 artefacts (including about 2600 battered and broken pebbles) representing the lithic component from Level D.

The variability and the typological complexity of the Oldowan of Garba IV allowed only limited use of the typology proposed by M.D. Leakey (1971) for Olduvai. For the tools on pebble, therefore, the methodology and the typological definitions by J. and N. Chavaillon (Chavaillon and Chavaillon 1973, Chavaillon *et al.* in this volume) have been mainly employed.

For different reasons, however, the study of some classes of tools on pebble from Garba IV is less detailed, at a typological level, than that which has been proposed in this same volume for Gombore I and Karre. This "simplified" approach does not limit the validity of the comparisons with the cited sites, because the most important typological definitions and the basic concepts of Chavaillon's typology are the same as those adopted for Garba IV.

In particular, the study of the percussion material (battered and broken pebbles, and hammerstones) is much less detailed than the analytical methodology introduced by Chavaillon, who must be acknowledged for giving greater meaning to these materials than was usually considered in similar studies.

In consideration of the extreme quantitative importance of the tools on flake at Garba IV, this category of materials has been intentionally treated more analytically, that is to say at the same typological and typometrical level of flake industries from more recent techno-complexes. It is evident that the detailed analysis of the flake industry from Oldowan and Developed Oldowan sites represents one of the most important aspects of the typological approach to these complexes (Ludwig and Harris 1998; Torre de la and Domínguez-Rodrigo 2001; Torre de la *et al.* 2003, 2004).

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The study of the flake industry has been carried out on the basis of Bordes (1961) typological lists for the Lower Paleolithic, integrated by a type-form (Biddittu and Piperno 1976) already used on other occasions for the study of Lower and Middle Paleolithic industries (Piperno 1999c); this form has been modified again, mainly at the typometrical level, for application to Garba IV.

One of the reasons for using the type-form is that it allows a rapid transformation of the morphotechnical and typometrical data into numerical codes, for their more effective and rapid computer treatment and also for their later utilization in the GIS application (see D'Andrea and Gallotti, Gallotti and Piperno in this volume).

Both the typological and typometrical data of the most important typological groups (Choppers, Rabots, Polyhedrons, Broken pebbles, Battered pebbles, Cores, Flakes and Tools on flake) have therefore been codified on forms and then entered in the database, from which the subsequent GIS application is derived.

Our spatial analyses have taken account of the horizontal distribution of types on the basis of the data in the general inventory. Vertical distribution was not processed, since it shows no irregularities or specific spatial patterns. In cases of significant differences in the distribution of raw materials, thematic distributions of obsidian and/or other volcanic rocks were also analysed. Types characterized by a limited number of specimens and a completely dispersed distribution (polyhedrons, rabots, spheroids, casually trimmed pebbles, handaxes, cleavers and hammerstones) where not included in the analysis. Tools on flake, since they did not show different distributions for individual types, where displayed together in a single Plate and their distribution was then analysed by raw material.

For a taphonomic analysis of the distribution of the lithic industry and faunal remains of paleosurface D see Gallotti, Piperno, in this volume. The general plan of Level D is shown in Fig. 1 (for more detailed plans see Gallotti, Piperno in this volume and Plates in Volume II).

Typological classes

The industry from Level D is largely characterized by a high frequency of flakes reaching more than 43% of the general catalogue total and more than 58% of the materials studied in detail.

Furthermore, the industry is characterized by a relatively high frequency of tools on pebble, reaching more than 11% in total, of which more than 9% represents choppers.

In comparison with the industry of Gombore I, polyhedrons are not very common at Garba IV (0.52%), while rabots are slightly better represented (1.03%). Finally, a single spheroid is present.

Battered (13.31%) and broken (13.37%) pebbles are very frequent. These two classes of materials have not been considered in several counts because it is often difficult to establish the original intent of the percussion traces and above all of the fractures. The remainder of the tool kit appears to be already quite diversified although the types that are best represented (side-scrapers, denticulates, notches, etc.) occur in quite low percentages, while burins (0.05%), end-scrapers (0.19%), and borers (0.10%) are very rare.

In the industry from Level D there are also some artefacts with bifacial removals (0.10%); about half of these may be considered archaic handaxes.

Cleavers are equally rare and are represented by only two artefacts.

Tab. 1 shows the typological variability of Level D.

Fig. 2 indicates the typological diversification of Level D without taking into account battered pebbles, broken pebbles, and hammerstones.

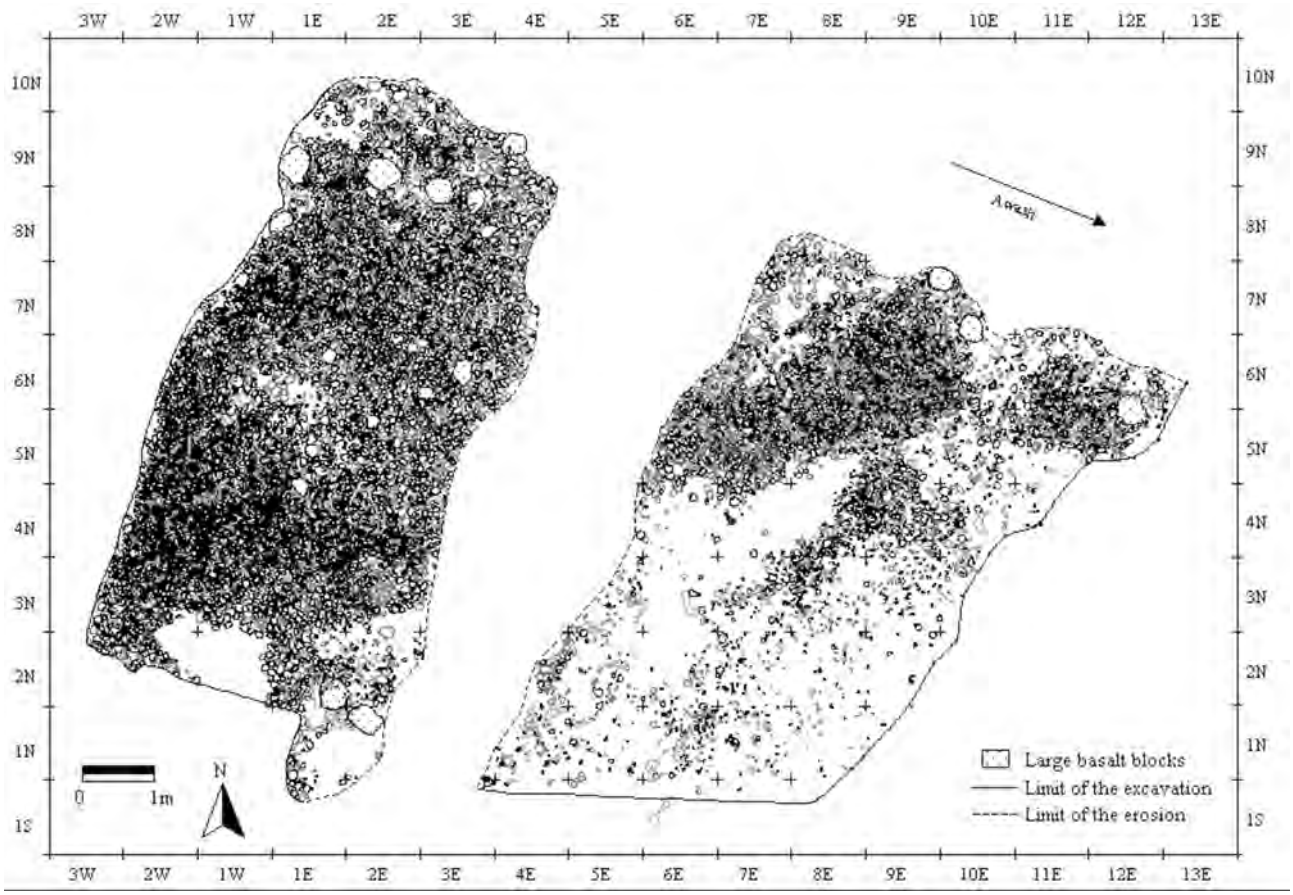


Fig. 1. Garba IV. Plan of Level D (excavations 1973-1982).
(Original plan by G.M. Bulgarelli and M. Piperno, digital map by R. Gallotti)

Type	Catalogue		Studied material	
	N	%	N	%
Flakes	3777	38.46	1438	47.90
Utilized flakes	201	2.05	154	5.13
Retouched flakes	287	2.92	150	5.00
Side-scrapers	178	1.81	139	4.63
Burin	5	0.05	3	0.10
End-scrapers	19	0.19	13	0.43
Borers	10	0.10	6	0.20
Notches	104	1.06	82	2.73
Denticulates	200	2.04	157	5.23
Fragments	635	6.47	251	8.36
Choppers	886	9.02	175	5.83
Polyhedrons	51	0.52		
Heavy end-scrapers	11	0.11		
Rabots	101	1.03	41	1.37
Spheroids	1	0.01		
Casually trimmed pebbles	98	1.00		
Handaxes/bifacial tools	10	0.10	5	0.17
Cleavers	2	0.02		
Cores	613	6.24	228	7.59
Broken pebbles	1313	13.37	76	2.53
Battered pebbles	1307	13.31	84	2.80
Hammerstones	12	0.12		
Total	**9821**		**3002**	

Tab. 1. Typological variability of Level D.

Type	Catalogue		Studied material	
	N	%	N	%
Flakes	3777	52.54	1438	50.60
Utilized flakes	201	2.80	154	5.42
Retouched flakes	287	3.99	150	5.28
Fragments	635	8.83	251	8.83
Side-scrapers	178	2.48	139	4.89
Burins	5	0.07	3	0.11
End-scrapers	19	0.26	13	0.46
Borers	10	0.14	6	0.21
Notches	104	1.45	82	2.89
Denticulates	200	2.78	157	5.52
Choppers	886	12.32	175	6.16
Polyhedrons	51	0.71		
Heavy end-scrapers	11	0.15		
Rabots	101	1.40	41	1.44
Spheroids	1	0.01		
Casually trimmed pebbles	98	1.36		
Handaxes/bifacial tools	10	0.14	5	0.18
Cleavers	2	0.03		
Cores	613	8.53	228	8.02
Total	**7189**		**2842**	

Tab. 2. Typological variability of Level D without battered and broken pebbles, and hammerstones.

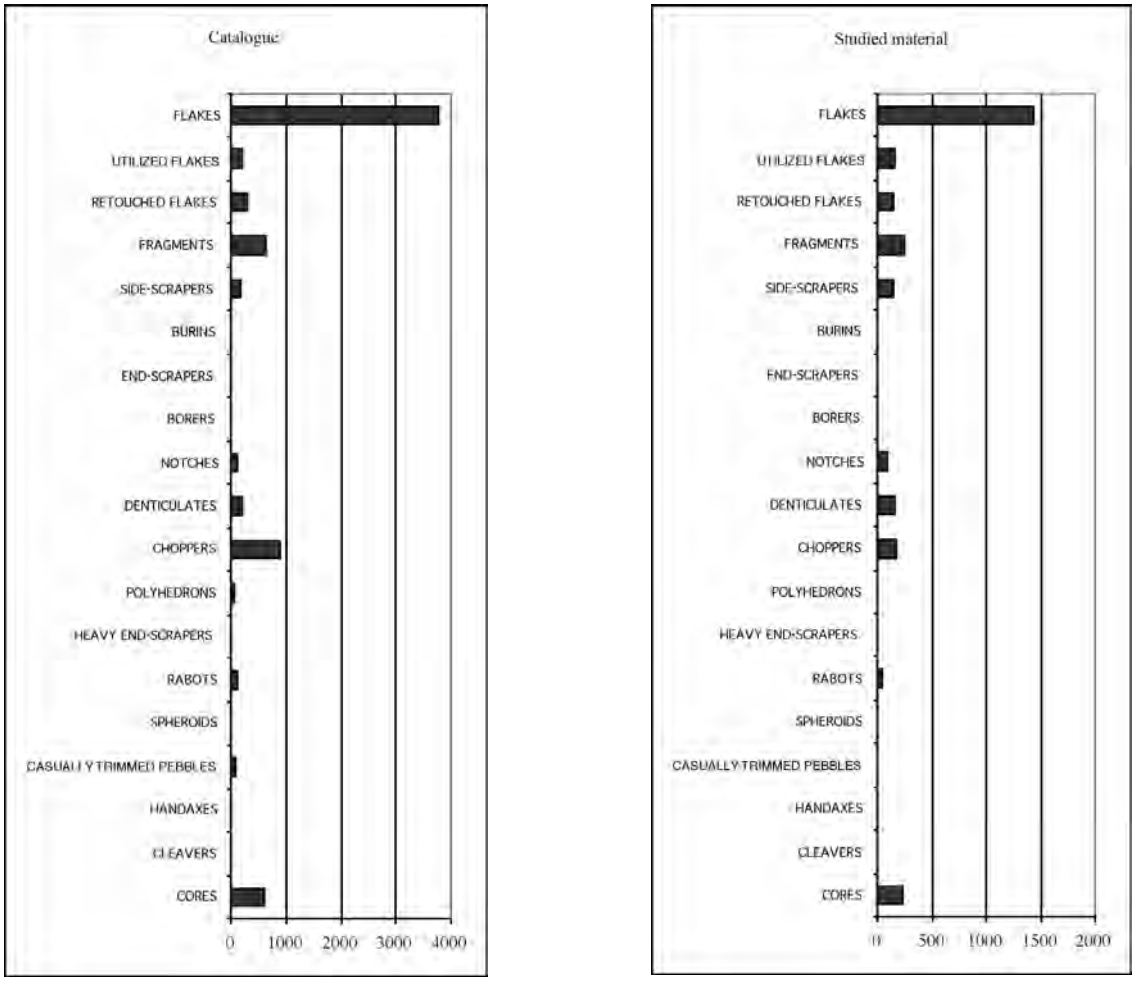


Fig. 2. Typological variability of Level D without battered and broken pebbles, and hammerstones.

Raw material

The two main raw materials employed for the lithic industry of Level D are basalt (53.23%) and obsidian (40.56%), followed, with a much lower frequency, by other volcanic rocks and by an insignificant presence of diverse rocks as indicated in Tab. 3 and in the graph of Fig. 3.

Raw material	Catalogue	
	N	%
Basalt	5228	53.23
Trachybasalt	107	1.09
Trachyte	316	3.22
Rhyolite	53	0.54
Tuff	120	1.22
Obsidian	3983	40.56
Others	14	0.14
Total	**9821**	

Tab. 3. Frequency of the different raw materials utilized in Level D.

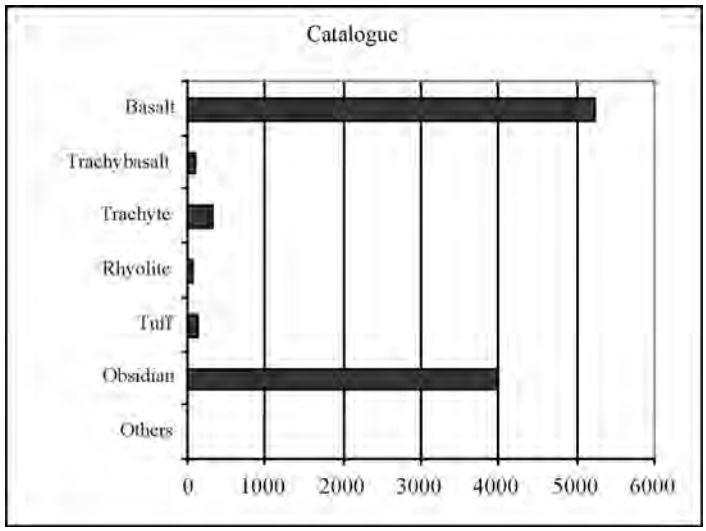


Fig. 3. Frequency of the different raw materials utilized in Level D.

The industry from Level D at Garba IV is characterized by a clear dichotomy in raw material use. Obsidian has been almost exclusively employed for the flake artefacts (among which there are also rare large flakes) while basalt and other volcanic rocks are prevalent in the pebble industry.

The two cleavers are made on large flakes of basalt and tuff, while the large pieces with bifacial retouch and the few handaxes recovered are made on flakes of obsidian and other volcanic rocks. Tab. 4 reports the frequency of the various raw materials employed in the different typological groups according to the determinations in the general catalogue. The percentages indicated are very similar to those of the studied sample.

Type	**Basalt**		**Trachyte**		**Trachybasalt**		**Tuff**		**Rhyolite**		**Obsidian**		**Others**	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Flakes	1243	23.78	10	3.16	40	37.38	55	45.83			2425	60.88	4	28.57
Utilized flakes	64	1.22			2	1.87	2	1.67			133	3.34		
Retouched flakes	71	1.36			3	2.80	1	0.83			212	5.32		
Side-scrapers	40	0.77									136	3.41	2	14.29
Burins	2	0.04									3	0.08		
End-scrapers	3	0.06			1	0.93					15	0.38		
Borers											10	0.25		
Notches	22	0.42			1	0.93					81	2.03		
Denticulates	33	0.63	1	0.32	4	3.74	1	0.83			160	4.02	1	7.14
Fragments	200	3.83	10	3.16	3	2.80	7	5.83			414	10.39	1	7.14
Choppers	801	15.32	19	6.01	35	32.71	9	7.50	2	3.77	19	0.48	1	7.14
Polyhedrons	46	0.88			2	1.87	1	0.83			2	0.05		
Heavy end-scrapers	10	0.19					1	0.83						
Rabots	96	1.84							1	1.89	3	0.08	1	7.14
Spheroids	1	0.02												
Casually trimmed pebbles	74	1.42	2	0.63			1	0.83			21	0.53		
Handaxes/bifacial tools	5	0.10									5	0.13		
Cleavers	2	0.04												
Cores	266	5.09	1	0.32	2	1.87	3	2.50			338	8.49	3	21.43
Broken pebbles	1180	22.57	81	25.63	7	6.54	13	10.83	31	58.49	1	0.03		
Battered pebbles	1058	20.24	191	60.44	7	6.54	26	21.67	19	35.85	5	0.13	1	7.14
Hammerstones	11	0.21	1	0.32										
Total	**5228**		**316**		**107**		**120**		**53**		**3983**		**14**	

Tab. 4. Frequency of the different raw materials utilized in Level D.

The graphs in Fig. 4 synthesize the frequency of the utilization of obsidian and of other volcanic rocks according to the typological groups identified in the lithic industry of Level D.

Flakes

Unmodified flakes

As a whole, more than 64% of the flakes recovered in Level D were obtained from obsidian cores, while just less than 33% were obtained from basalt. The other volcanic rocks have been casually utilized and appear in extremely low percentages (Figs. 5, *1*; 7, *1*, *2*, *4*, *7*; 8, *3*, *6*).

The different raw materials employed are reported in Tab. 5.

Raw material	**Catalogue**		**Studied material**	
	N	%	N	%
Obsidian	2425	64.2	1206	83.87
Basalt	1243	32.91	209	14.53
Trachyte	10	0.26		
Trachybasalt	40	1.06	7	0.49
Tuff	55	1.46	15	1.04
Others	4	0.11	1	0.07
Total	**3777**		**1438**	

Tab. 5. Raw material utilized for unmodified flakes.

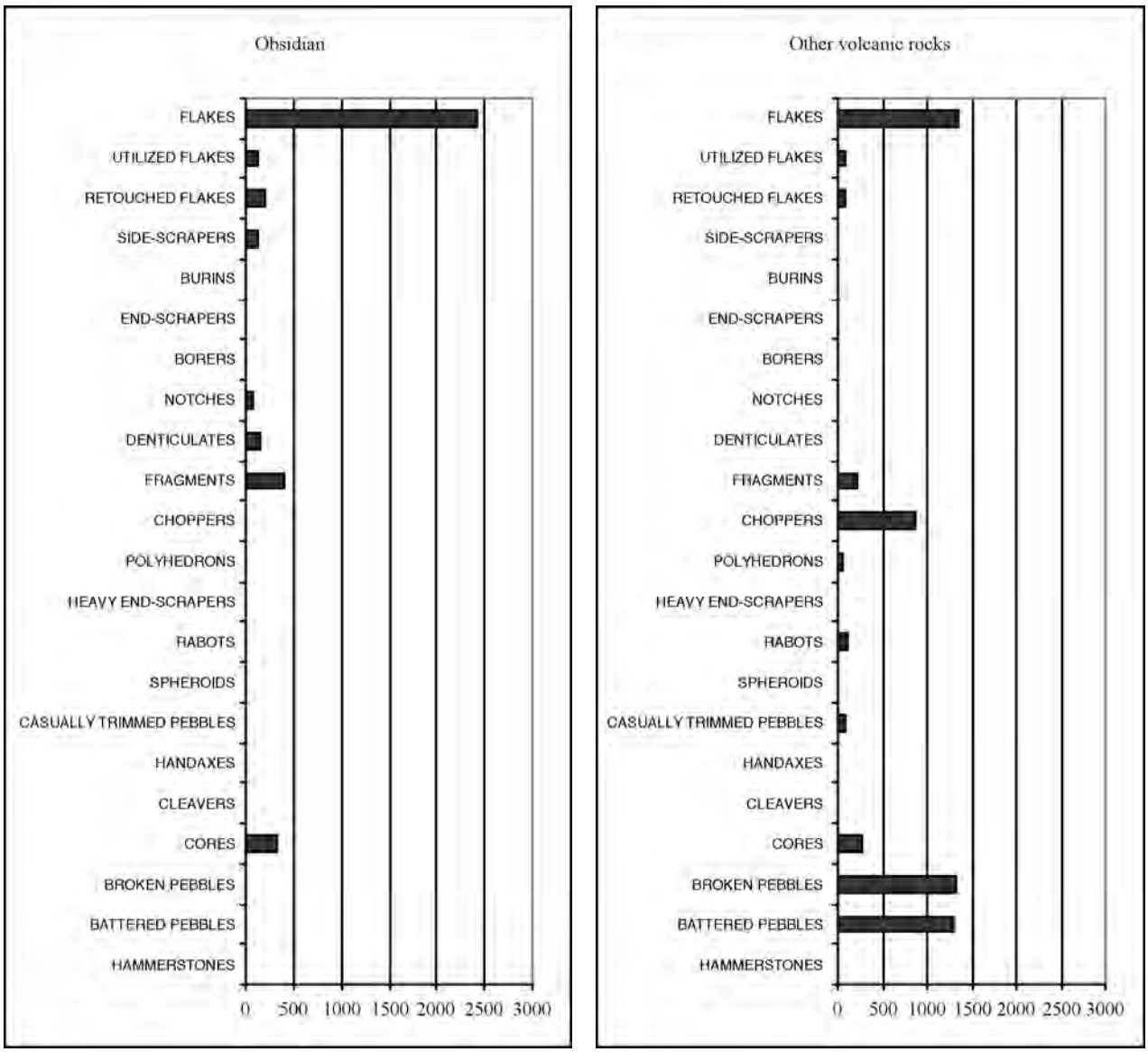


Fig. 4. Typological groups of lithic industry of obsidian and other volcanic rocks in Level D.

Morpho-technical aspects

Of the 3777 unmodified flakes, identified in the general catalogue, 1438 or 38.07%, have been studied. As regards the morpho-technical aspects, the data derive from the flakes analyzed in more detail.

The values of basalt, trachybasalt and tuff have been summed under a single heading: "other volcanic rocks". The only flake included in the "diverse" raw material heading was not considered in this analysis.

Preservation

Regardless of the raw material, more than 85% of the unmodified flakes of the studied sample are complete (Tab. 6).

Preservation	**Obsidian**		**Other volcanic rocks**		**Total**	
	N	%	N	%	N	%
Complete	1046	86.73	203	87.88	1249	86.92
Proximal fragments			1	0.43	1	0.07
Indeterminable fragments	160	13.27	27	11.69	187	13.01
Total	**1206**		**231**		**1437**	

Tab. 6. Frequency of complete and fragmentary flakes in the studied sample.

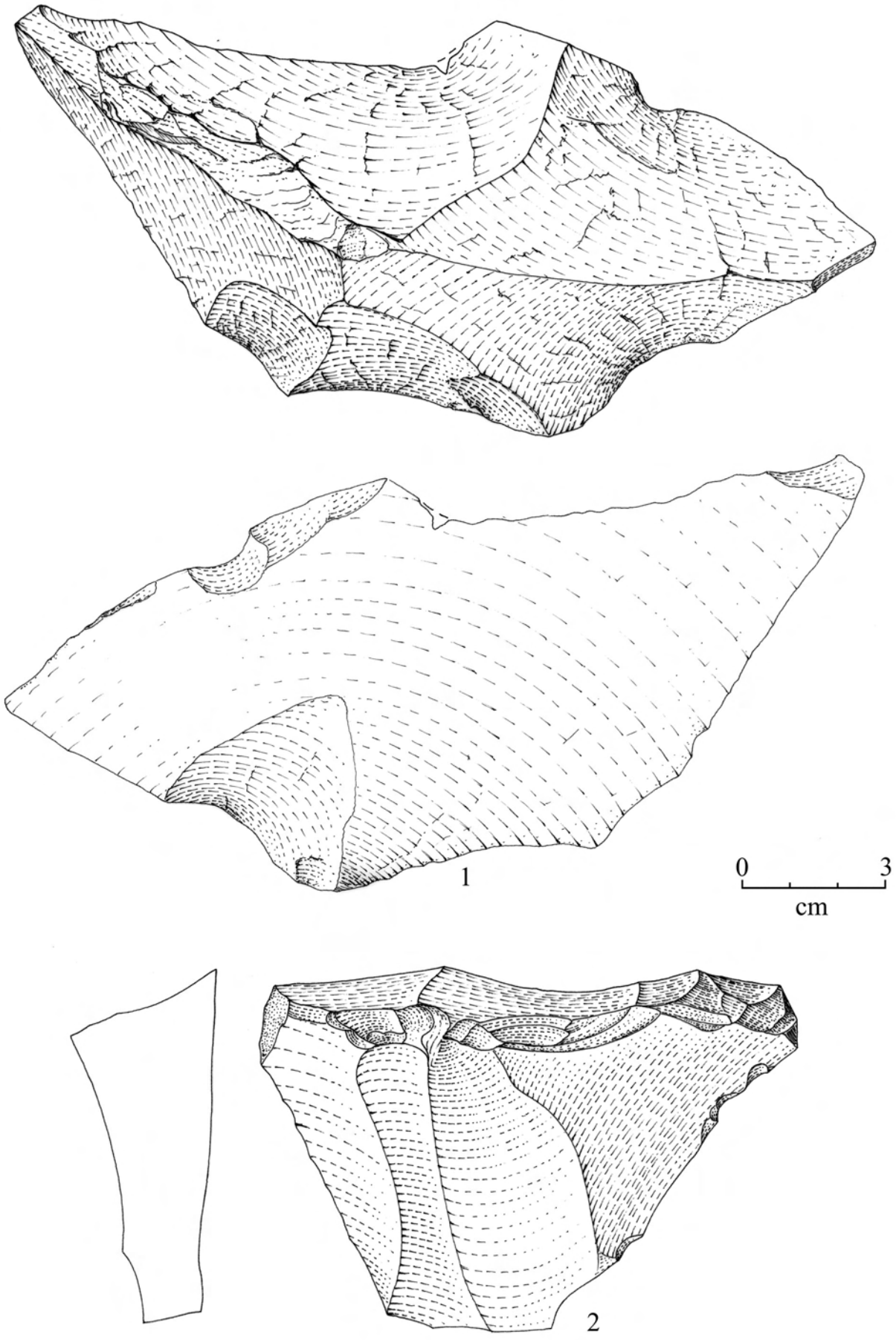


Fig. 5. Garba IV D. 1: large flake (MK 5269); 2: utilized flake (MK 8966). Basalt. *Drawings by M. Pennacchioni*

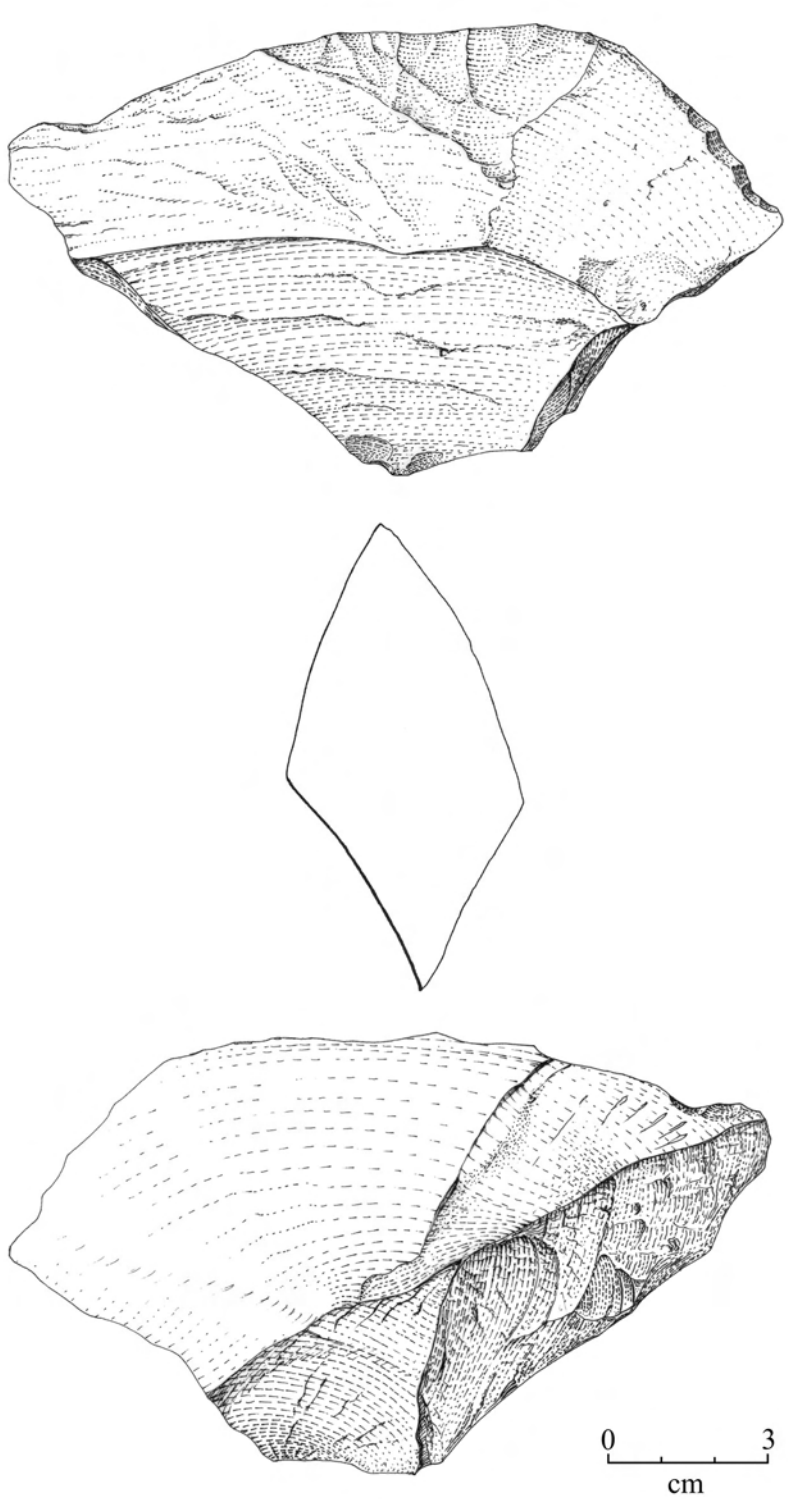


Fig. 6. Garba IV D. Large utilized flake (MK 5563). Basalt. *Drawings by M. Pennacchioni*

Shape

As indicated in Tab. 7, the shape of the flakes shows a good percentage of irregular shapes (more than 23%) corresponding to a control over the knapping techniques that was not yet perfect. The data are similar for both obsidian and other volcanic rocks.

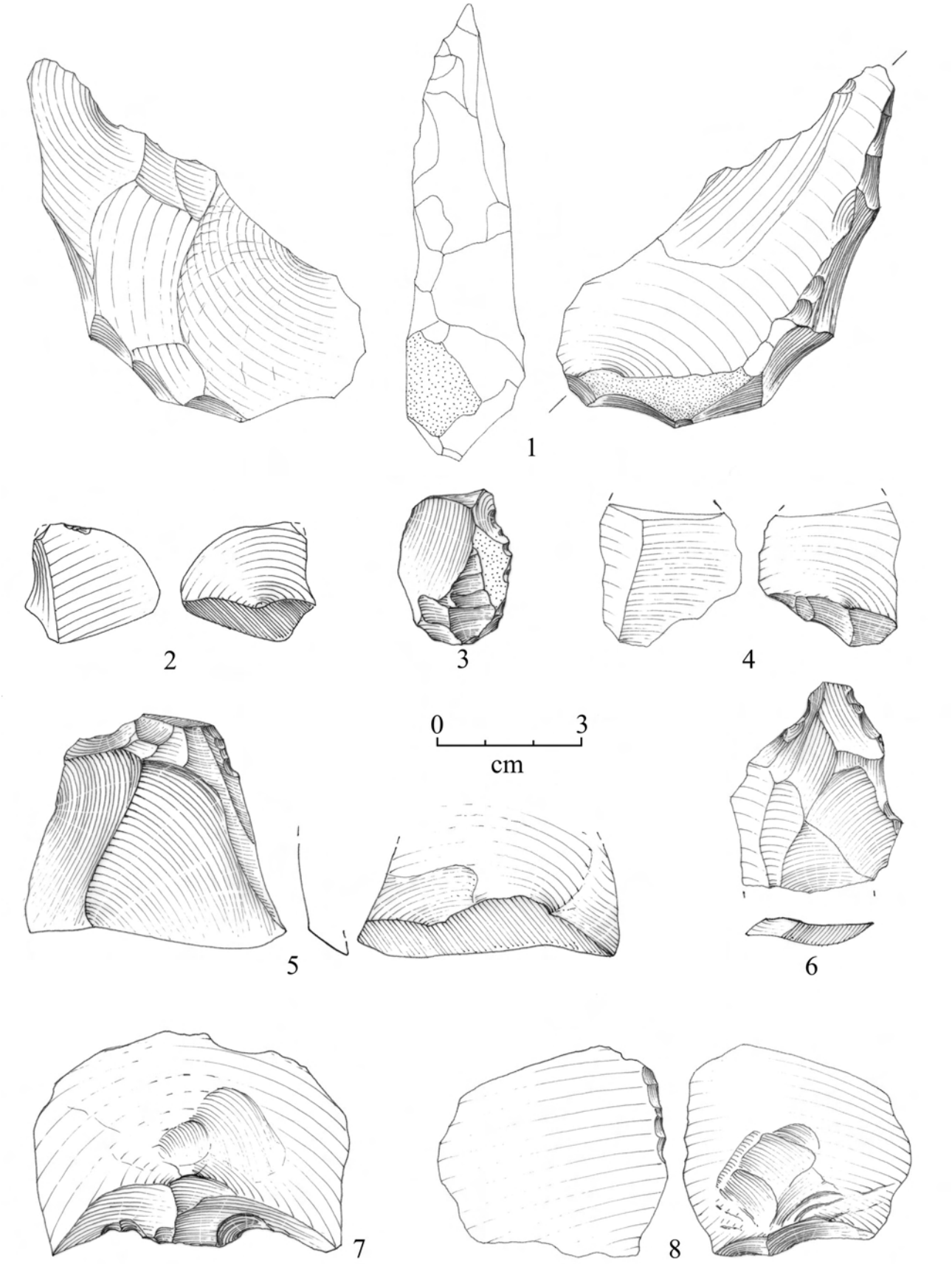


Fig. 7. Garba IV D. 1, 2, 4, 7: flakes (MK 9088, 7999, 5926, 1659); 3, 5, 6, 8: retouched flakes (MK 9853, 3408, 334, 4455). Obsidian. *Drawings by M. Pennacchioni*

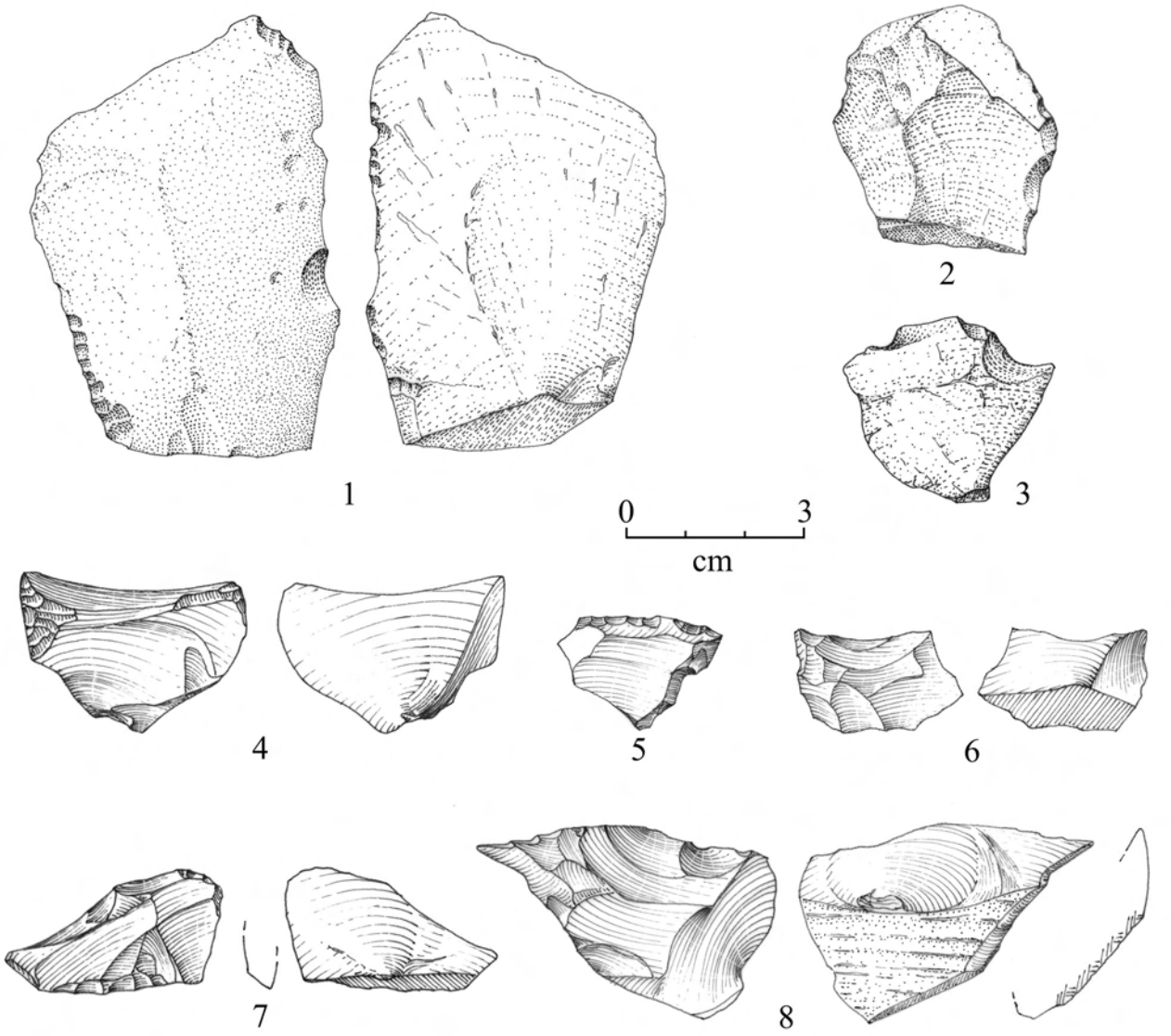


Fig. 8. Garba IV D. 1, 2, 4, 5, 7, 8: retouched flakes [MK 7636, 2629, 9668, 647 (Level C), 654 (Level C), 3185)]; 3, 6: flakes (MK 9995, 8560). 1-3: basalt; 4-8: obsidian. *Drawings by M. Pennacchioni*

Shape	**Obsidian**		**Other volcanic rocks**		**Total**	
	N	%	N	%	N	%
Triangular	112	9.29	19	8.23	131	9.12
Quadrangular	110	9.12	15	6.49	125	8.70
Rectangular	209	17.33	39	16.88	248	17.26
Trapezoidal	172	14.26	35	15.15	207	14.41
Pentagonal	105	8.71	20	8.66	125	8.70
Polygonal	11	0.91	1	0.43	12	0.84
Oval	30	2.49	14	6.06	44	3.06
Elliptical	10	0.83	1	0.43	11	0.77
Circular	16	1.33	3	1.30	19	1.32
Semicircular	51	4.23	4	1.73	55	3.83
1/4 circular	22	1.82	1	0.43	23	1.60
Fan-shaped	26	2.16	9	3.90	35	2.44
Irregular	280	23.22	56	24.24	336	23.38
Indeterminable	52	4.31	14	6.06	66	4.59
Total	**1206**		**231**		**1437**	

Tab. 7. Shape diversification of unmodified flakes.

Striking platform

In most cases, for both obsidian and other volcanic rocks, plain platforms on a negative flake removal, and less often on cortex, dominate in the lithic industry of Garba IV. Dihedral platforms are much less common, while other types of platform are practically absent. On a particular type of platform that is diffused and corresponds to the proximal edge of the flake, it is almost impossible to identify the exact percussion point. These occur quite often (more than 7% of the cases). In many other cases, exceeding 22%, the platforms and bulbs can no longer be identified (Tab. 8).

Striking platform	**Obsidian**		**Other volcanic rocks**		**Total**	
	N	%	N	%	N	%
Plain on removal	681	56.47	122	52.81	803	55.88
Plain on cortex	81	6.72	24	10.39	105	7.31
Punctiform	9	0.75	3	1.30	12	0.83
Punctiform on removal	2	0.17			2	0.14
Dihedral	20	1.66	2	0.87	22	1.53
Facetted concave	1	0.08			1	0.07
Facetted convex	2	0.17			2	0.14
Facetted straight	2	0.17			2	0.14
Absent broken	30	2.49			30	2.09
Absent removed	4	0.33	1	0.43	5	0.35
Unrecognizable	280	23.22	65	28.14	345	24.01
On edge	94	7.79	14	6.06	108	7.51
Total	**1206**		**231**		**1437**	

Tab. 8. Frequency of different types of striking platforms of unmodified flakes.

The graphs in Fig. 9 shows the correspondence in the percentages of the different types of platforms between obsidian flakes and those made from other volcanic rocks.

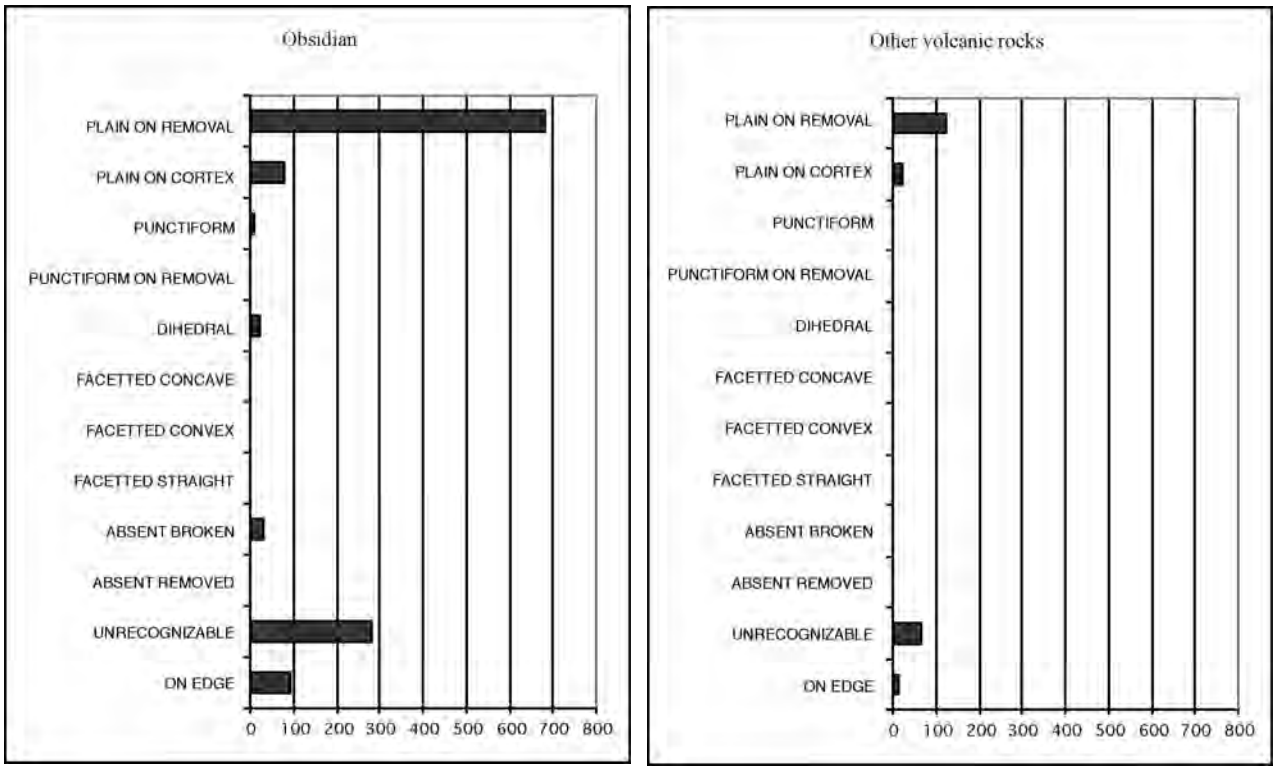


Fig. 9. Different types of striking platforms of unmodified flakes on obsidian and other volcanic rocks.

Removals

As indicated in Tab. 9, the number of removals recognizable on the dorsal face of unmodified flakes indicate a clear dichotomy between the more exhaustive exploitation of obsidian cores and that of other volcanic rocks. First generation obsidian flakes are in fact very rare (3.48%) compared to those of basalt (27.27%), while the frequency of flakes with three or more removals is much higher for obsidian than for basalt, and those with more than five removals are practically only of obsidian. The first datum could probably be explained by considering that a large portion of the first generation basalt flakes may be related to the manufacturing of uni- and bidirectional choppers, while in practice there are no analogous obsidian pebble artefacts. The greater frequency of obsidian flakes with numerous (more than three and especially more than five) dorsal removals derives from the more intense exploitation of obsidian cores in order to obtain flakes with particular shapes and dimensions that can be used later or retouched.

Removals	**Obsidian**		**Other volcanic rocks**		**Total**	
	N	%	N	%	N	%
0	42	3.48	63	27.27	105	7.31
1	161	13.35	30	12.99	191	13.29
2	267	22.14	39	16.88	306	21.29
3	312	25.87	38	16.45	350	24.36
4	231	19.15	14	6.06	245	17.05
5	77	6.38	2	0.87	79	5.5
6	30	2.49			30	2.09
7	18	1.49			18	1.25
9	1	0.08			1	0.07
>9	17	3.48	7	3.03	24	1.67
Undeterminable	50	4.15	38	16.45	88	6.12
Total	**1206**		**231**		**1437**	

Tab. 9. Number of removals of unmodified flakes.

Patina

As is known, it is very difficult to quantify patina on artefacts with the naked eye. In the materials from Level D at Garba IV there are clearly artefacts with different patina, although it was not possible to ascertain the origins of such diversity.

Sometimes, more or less patinated materials have been recovered in close association. Modifications on the external surfaces of the artefacts may be due to taphonomic or petrographic factors that are difficult to evaluate.

Cortex

Most of the flakes of obsidian (73.96%) and of other volcanic rocks (56.28%) are without cortex. The cortex is partially present on 12.02% of the obsidian flakes and on 12.12% of the basalt ones. In a few cases (5.47% for obsidian and 4.76% for basalt) portions of cortex are present on one or more edges of the flakes, while the cortex is more often preserved on the platforms of obsidian flakes (3.89%) than on those of other volcanic rocks (0.86%). The major difference in the presence of cortex can be noted for flakes that have cortex extending over the whole dorsal face. Pebble caps are more frequent among flakes of different volcanic rocks (22.51%) than of obsidian ones (2.99%) confirming the data already observed for the number of removals on the dorsal face (Tab. 10).

Cortex	Obsidian	Other volcanic rocks
Absent	73.96	56.28
Total	2.99	22.51
Partial	12.02	12.12
On edge	5.47	4.76
On platform	3.89	0.86
Indeterminable	1.57	3.46

Tab. 10. Localization of cortex of unmodified flakes.

Typometry

A total of 2672 flakes made of obsidian and other volcanic rocks reported in the general catalogue have been measured and weighed. Among the pieces studied in detail, 1238 flakes have been measured and 1182 flakes have been weighed. The data on the measurements of the platform refer to the studied pieces. The length of the platform has been measured on 510 flakes, the thickness of the platform on 563 flakes, and the angle of the platform on 572.

Length

The length of most of the flakes is between 20 and 50 mm, with few pieces in the upper and lower extremes of the variability range of this parameter: only two obsidian and one basalt flakes are less than 10 mm long, while three obsidian flakes reach values between 120 and 150 mm, and 11 basalt flakes are between 121 and 162 mm long (Tab. 11). It is possible to observe a slight tendency for basalt flakes to be longer than obsidian ones.

	Catalogue		Studied material	
	Obsidian	Other volcanic rocks	Obsidian	Other volcanic rocks
Min	9	8	9	17
Max	150	162	122	144
Mean	38.89	50.32	38.66	50.72

Tab. 11. Minimum and maximum length of unmodified flakes.

The distribution of the length of unmodified flakes is reported in Tab. 12. The graphs in Fig. 10 indicate the distribution of lengths for the sample analyzed in detail.

Lenght (mm)	Obsidian		Other volcanic rocks		Total	
	N	%	N	%	N	%
1\10	2	0.10	1	0.13	3	0.11
11\20	113	5.89	8	1.06	121	4.53
21\30	501	26.09	100	13.30	601	22.49
31\40	599	31.20	199	26.46	798	29.87
41\50	353	18.39	164	21.81	517	19.35
51\60	194	10.10	95	12.63	289	10.82
61\70	79	4.11	62	8.24	141	5.28
71\80	42	2.19	42	5.59	84	3.14
81\90	21	1.09	35	4.65	56	2.10
91\100	8	0.42	19	2.53	27	1.01
101\110	3	0.16	10	1.33	13	0.49
111\120	2	0.10	6	0.80	8	0.30
121\130	1	0.05	4	0.53	5	0.19
131\140	1	0.05	1	0.13	2	0.07
141\150	1	0.05	3	0.40	4	0.15
151\160			2	0.27	2	0.07
161\170			1	0.13	1	0.04
Total	**1920**		**752**		**2672**	

Tab. 12. Distribution of length of unmodified flakes.

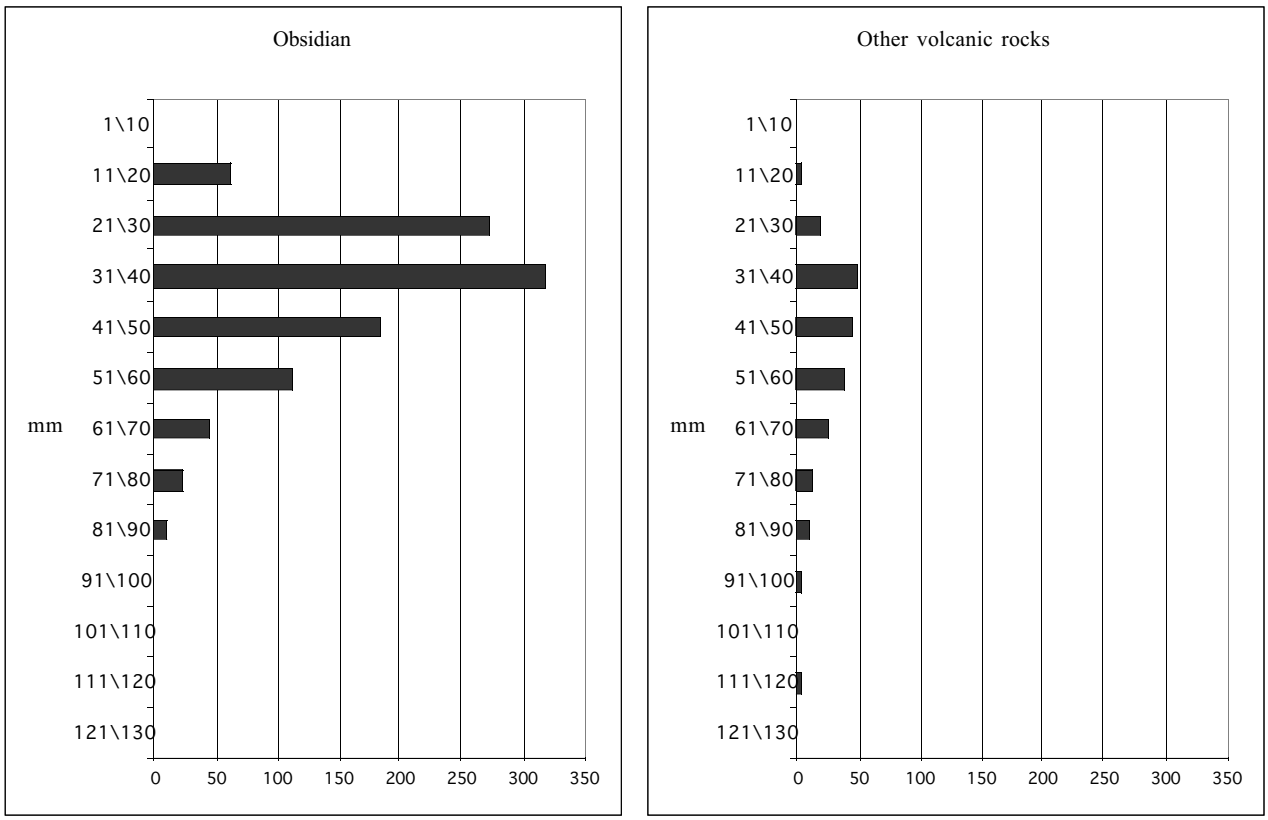


Fig. 10. Distribution of length of unmodified flakes in the studied sample.

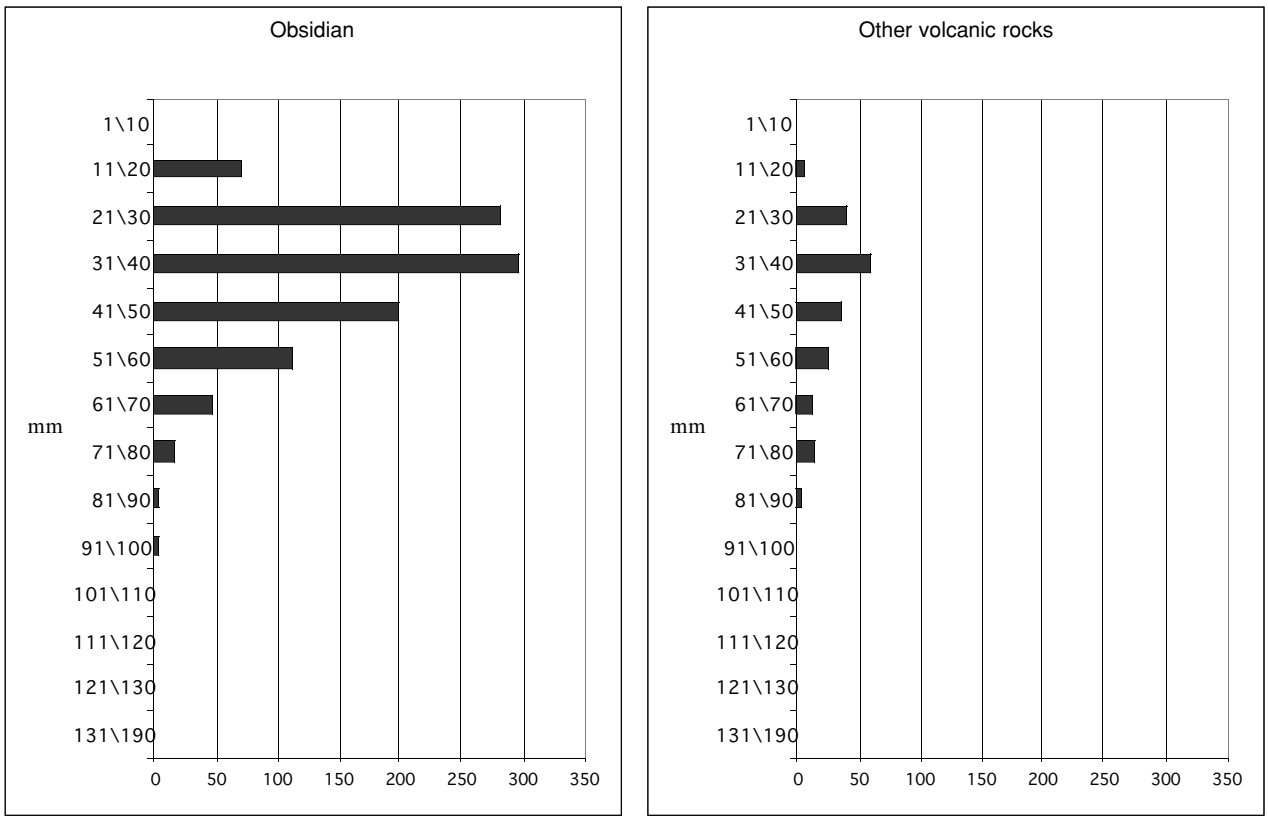


Fig. 11. Distribution of width of unmodified flakes.

Width

The width of most of the flakes of obsidian and of other volcanic rocks is between 11 and 60 mm with only five obsidian flakes and one of basalt less than 10 mm wide; 14 obsidian flakes are between 90 and 110 mm wide and 20 basalt flakes are between 91 and 190 mm wide (Tab. 13).

The distribution of the width of unmodified flakes is reported in Tab. 14; the graphs in Fig. 11 indicate the distribution of width for the sample studied in detail.

	Catalogue		Studied material	
	Obsidian	Other volcanic rocks	Obsidian	Other volcanic rocks
Min	3	10	10	18
Max	109	185	109	185
Mean	35.47	40.57	38.08	45.49

Tab. 13. Minimum and maximum width of unmodified flakes.

Width (mm)	Obsidian		Other volcanic rocks		Total	
	N	%	N	%	N	%
1\10	5	0.26	1	0.13	6	0.22
11\20	195	10.16	55	7.31	250	9.36
21\30	617	32.14	240	31.91	857	32.07
31\40	531	27.66	179	23.80	710	26.57
41\50	314	16.35	99	13.16	413	15.46
51\60	157	8.18	63	8.38	220	8.23
61\70	63	3.28	49	6.52	112	4.19
71\80	24	1.25	33	4.39	57	2.13
81\90	8	0.42	13	1.73	21	0.79
91\100	4	0.21	8	1.06	12	0.45
101\110	2	0.10	7	0.93	9	0.34
111\120			2	0.27	2	0.07
121\130			2	0.27	2	0.07
131\190			1	0.13	1	0.04
Total	**1920**		**752**		**2672**	

Tab. 14. Distribution of width of unmodified flakes.

Thickness

More than 98% of the obsidian flakes and 87% of those of other volcanic rocks are between a minimum of 2 mm and a maximum of 30 mm thick (Tabs. 15 and 16; Fig. 12).

Thickness (mm)	Obsidian		Other volcanic rocks		Total	
	N	%	N	%	N	%
1\10	802	41.77	140	18.62	942	35.25
11\20	910	47.40	378	50.27	1288	48.20
21\30	173	9.01	143	19.02	316	11.83
31\40	26	1.35	60	7.98	86	3.22
41\50	8	0.42	20	2.66	28	1.05
51\60			4	0.53	4	0.15
61\70			4	0.53	4	0.15
71\80	1	0.05	1	0.13	2	0.07
81\90			1	0.13	1	0.04
91\100						
101\110			1	0.13	1	0.04
Total	**1920**		**752**		**2672**	

Tab. 15. Distribution of thickness of unmodified flakes.

	Catalogue		Studied material	
	Obsidian	Other volcanic rocks	Obsidian	Other volcanic rocks
Min	2	3	2	5
Max	80	110	45	63
Mean	12.85	18.81	12.46	12.46

Tab. 16. Minimum and maximum thickness of unmodified flakes.

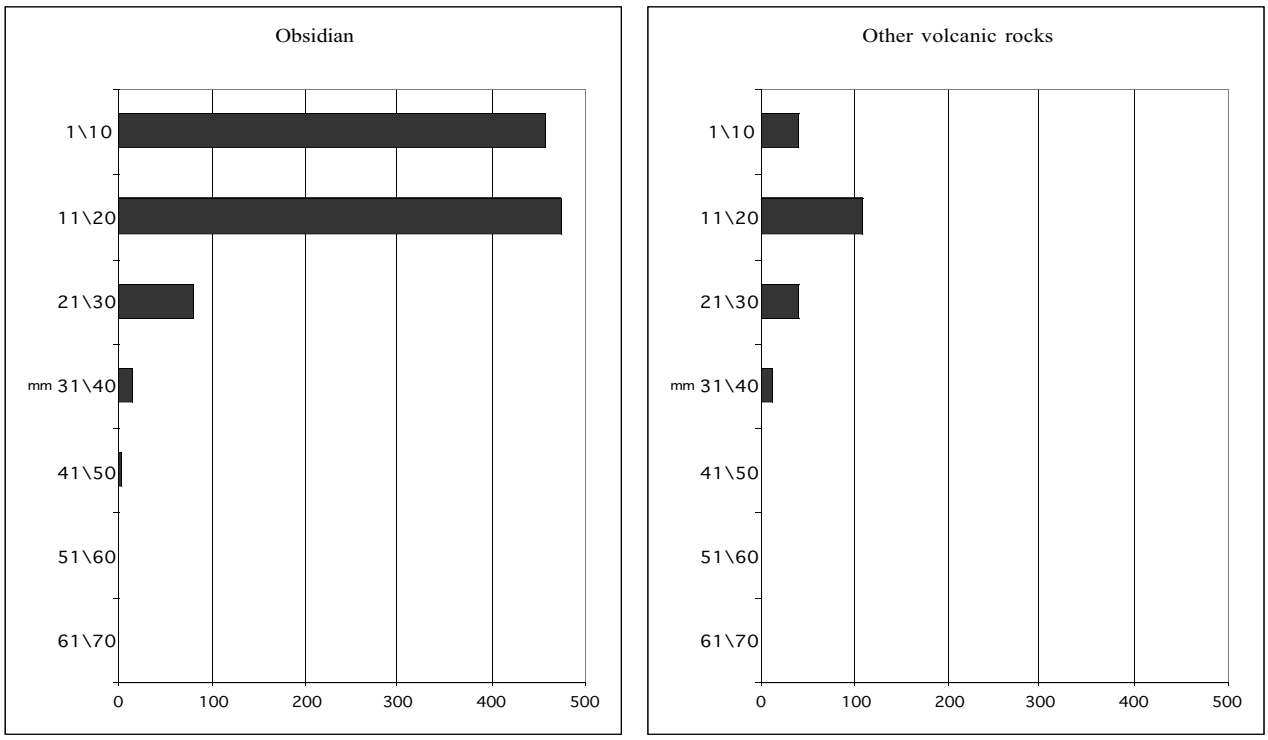


Fig. 12. Distribution of thickness of unmodified flakes from the studied sample.

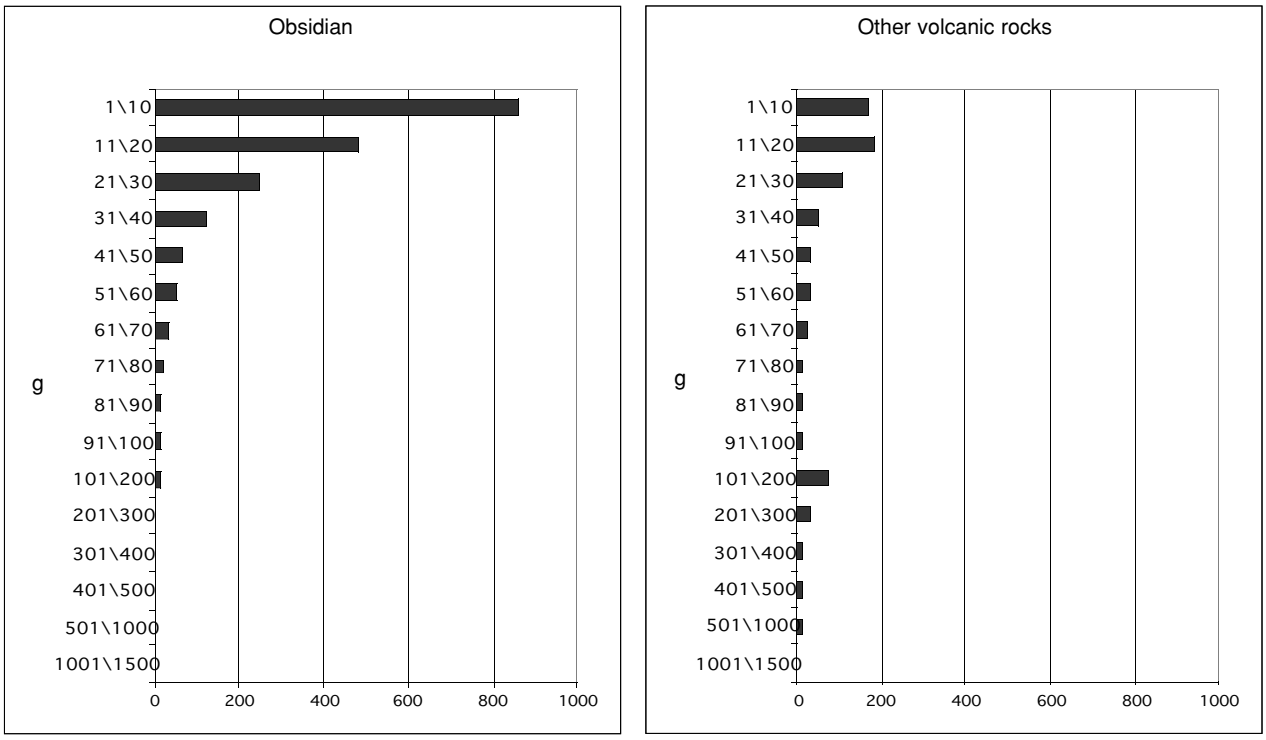


Fig. 13. Distribution of weight of unmodified flakes.

Weight

This parameter presents the greatest variability between the minimum and maximum values (Tabs. 17 and 18; Fig. 13). Among obsidian flakes more than 88% weigh between 1 g and 530 g. Just more than half of the flakes made of other volcanic rocks (66.22%) weigh between 2 g and 40 g while the remaining 33% are distributed among the different classes up to a maximum of 1310 g.

Weight (g)	**Obsidian**		**Other volcanic rocks**		**Total**	
	N	%	N	%	N	%
1\10	857	44.64	169	22.47	1026	38.40
11\20	481	25.05	177	23.54	658	24.63
21\30	247	12.86	104	13.83	351	13.14
31\40	120	6.25	48	6.38	168	6.29
41\50	63	3.28	28	3.72	91	3.41
51\60	51	2.66	31	4.12	82	3.07
61\70	27	1.41	25	3.32	52	1.95
71\80	20	1.04	14	1.86	34	1.27
81\90	16	0.83	8	1.06	24	0.90
91\100	13	0.68	12	1.60	25	0.94
101\200	16	0.83	76	10.11	92	3.44
201\300	4	0.21	27	3.59	31	1.16
301\400	4	0.21	11	1.46	15	0.56
401\500			9	1.20	9	0.34
501\1000	1	0.05	12	1.60	13	0.49
1001\1500			1	0.13	1	0.04
Total	**1920**		**752**		**2672**	

Tab. 17. Distribution of weight of unmodified flakes.

	Catalogue		**Studied material**	
	Obsidian	**Other volcanic rocks**	**Obsidian**	**Other volcanic rocks**
Min	1	2	1	4
Max	530	1310	365	680
Mean	20.37	67.5	20.92	61.26

Tab. 18. Minimum and maximum weight of unmodified flakes.

Length of the platform

In the 510 flakes for which it has been possible to take this measurement, it can be observed that most of the platforms (69% of obsidian flakes and 81% of basalt ones) have values between 11 and 40 mm, with an average just under 25 mm, regardless of the raw material, while platforms longer than 50 mm are rare (Tab. 19).

Lenght (mm)	**Obsidian**		**Other volcanic rocks**		**Total**	
	N	%	N	%	N	%
1\10	34	8.00	4	4.71	38	7.45
11\20	139	32.71	38	44.71	177	34.71
21\30	128	30.12	21	24.71	149	29.22
31\40	81	19.06	11	12.94	92	18.04
41\50	25	5.88	9	10.59	34	6.67
51\60	14	3.29	1	1.18	15	2.94
61\70	3	0.71	1	1.18	4	0.78
71\80	1	0.24			1	0.20
Total	**425**		**85**		**510**	

Tab. 19. Distribution of the length of the platform of unmodified flakes.

Thickness of the platform

The platforms of most of the flakes (97% of obsidian and 97.73% of other volcanic rocks) are between 1 and 20 mm thick, while very thick platforms are almost absent (Tab. 20).

Thickness (mm)	Obsidian		Other volcanic rocks		Total	
	N	%	N	%	N	%
1\10	360	75.79	59	67.05	419	74.42
11\20	105	22.11	27	30.68	132	23.45
21\30	6	1.26	2	2.27	8	1.42
31\40	2	0.42			2	0.36
41\50	1	0.21			1	0.18
51\60	1	0.21			1	0.18
Total	**475**		**88**		**563**	

Tab. 20. Distribution of the thickness of the platform of unmodified flakes.

Angle of the platform

On obsidian flakes the angle of the platform is in most cases (83.61%) between 101° and 130° with a mean of 118.22°, while more than 91% of the flakes obtained from other volcanic rocks show a slight reduction around values between 81° and 120° with a mean of 108.4° (Tab. 21).

Angle	Obsidian		Other volcanic rocks		Total	
	N	%	N	%	N	%
60\70	2	0.41			2	0.35
71\80						
81\90	9	1.87	9	10.00	18	3.15
91\100	19	3.94	20	22.22	39	6.82
101\110	75	15.56	24	26.67	99	17.31
111\120	178	36.93	29	32.22	207	36.19
121\130	150	31.12	8	8.89	158	27.62
131\140	45	9.34			45	7.87
141\150	4	0.83			4	0.70
Total	**482**		**90**		**572**	

Tab. 21. Distribution of values of the angle between the platform and ventral surface of unmodified flakes.

Spatial distribution

Paleosurface D was totally or partially strewn with unmodified flakes. Most (2358 or 62.43%) lay within WS, while ES contained about 1419 (37.57%).

In ES, the maximum frequency and density of flakes is observable in the areas surrounding two large blocks of basalt. The first coincides roughly with squares 9E/7N and 8/9E/6N (with 64, 108 and 134 unmodified flakes respectively), while the second lies within squares 11E/5-6N (52 and 83 flakes). Two more small concentrations, unconnected to the basalt blocks, were found in the same sector, one between squares 8-9E/4N (92 and 67 flakes), the other near the western margin of square 8E/3N (44 flakes).

WS contained an area with a high concentration of flakes in the lower half, especially along the western margin of the excavation. The highest frequencies of unmodified flakes in this area were recorded in squares 2W/4N, 1W/4-5N, 1E/4N. The upper part of WS also contains some small concentrations, especially in squares 1E/7N and 2E/7-8N (with 101, 88 and 108 specimens respectively), but their frequencies are slightly lower. As in the case of ES, this area is distinguished by the presence of large blocks of basalt (Plate 1).

The spatial parameters just described do not differ significantly in the distribution of unmodified flakes by raw material as 1423 flakes (58.68%) where found in WS and 1002 (41.32%) in ES. The high-

est concentration of obsidian flakes in the WS was in the central part, along the western limit of the excavation, and especially in squares 1W/5N and 1W-1E/4N, which yielded 92, 77 and 79 specimens respectively. In ES, the highest density is observable, again, in the north-central portion of the excavation, with frequency peaks in squares 8-9E/6N with 81 and 87 specimens (Plate 2).

The distribution of unmodified flakes of other volcanic rocks shows higher numerical differences than that of obsidian flakes. Some 69.14% of these flakes were found in WS (932), and only 30.86% in ES. They are dispersed over almost the whole surface of WS, with slight concentrations in squares 1W/5N, 2W-1E/4N (42, 78, 63 and 52 specimens). In ES, areas of concentration and dispersal coincide with those previously described for the general distribution of flakes, but with decidedly lower frequencies than those of obsidian flakes (Plate 3).

Utilized flakes

Of 287 flakes with utilization traces diffused over one or more edges (Figs. 5, *2*; 6; 14) reported in the general catalogue, 154 have been studied in more detail. Their distribution according to raw material is indicated in Tab. 22.

Raw material	**Catalogue**		**Studied material**	
	N	%	N	%
Obsidian	133	66.17	99	64.29
Basalt	64	31.84	54	35.06
Trachybasalt	2	1.00	1	0.65
Tuff	2	1.00		
Total	**201**		**154**	

Tab. 22. Distribution of raw material of utilized flakes.

Morpho-technical aspects

Whole flakes represent 89.9% of obsidian utilized flakes and 90.91% of those of other volcanic rocks.

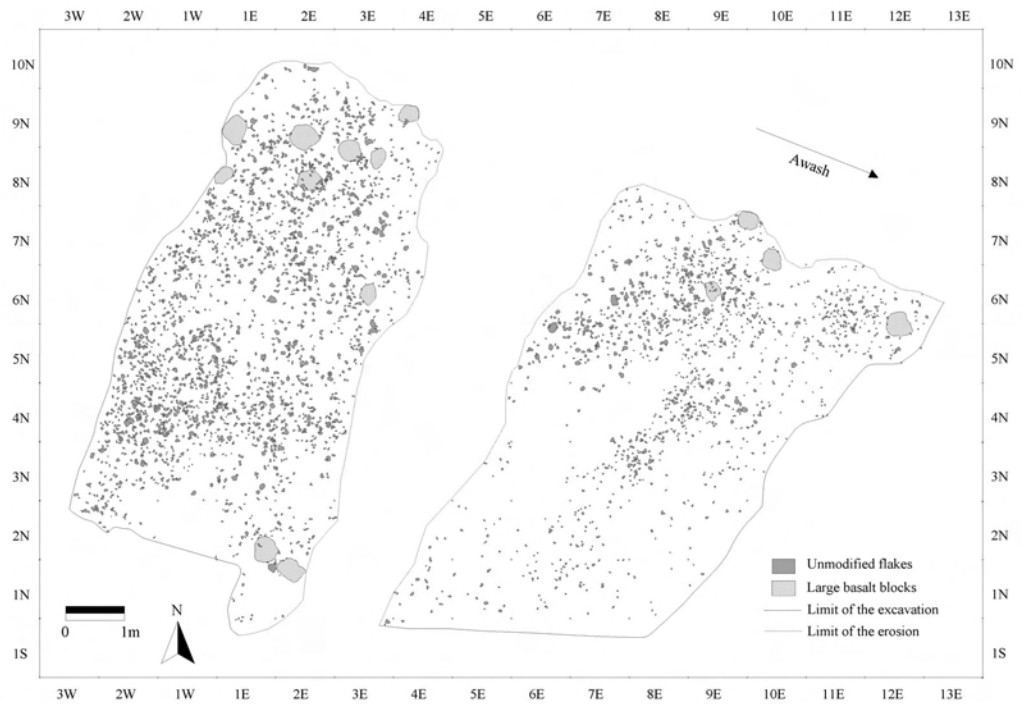
It seems that irregular flakes, usually frequent among the unmodified flakes, have not been used even in low percentages, while the most common utilized flakes are quite regular with a prevalence of rectangular ones.

Striking platform

As regards the platforms, the data agree with those already presented for unmodified flakes (Tab. 23).

Striking platform	**Obsidian**		**Other volcanic rocks**		**Total**	
	N	%	N	%	N	%
Plain on negative scar	52	52.53	30	54.55	82	53.25
Plain on cortex	8	8.08	8	14.55	16	10.39
Punctiform	1	1.01			1	0.65
Dihedral	1	1.01	2	3.64	3	1.95
Absent broken			1	1.82	1	0.65
Absent removed	1	1.01			1	0.65
Unrecognizable	27	27.27	11	20.00	38	24.68
On edge	9	9.09	3	5.45	12	7.79
Total	**99**		**55**		**154**	

Tab. 23. Frequency of different types of platform of utilized flakes.



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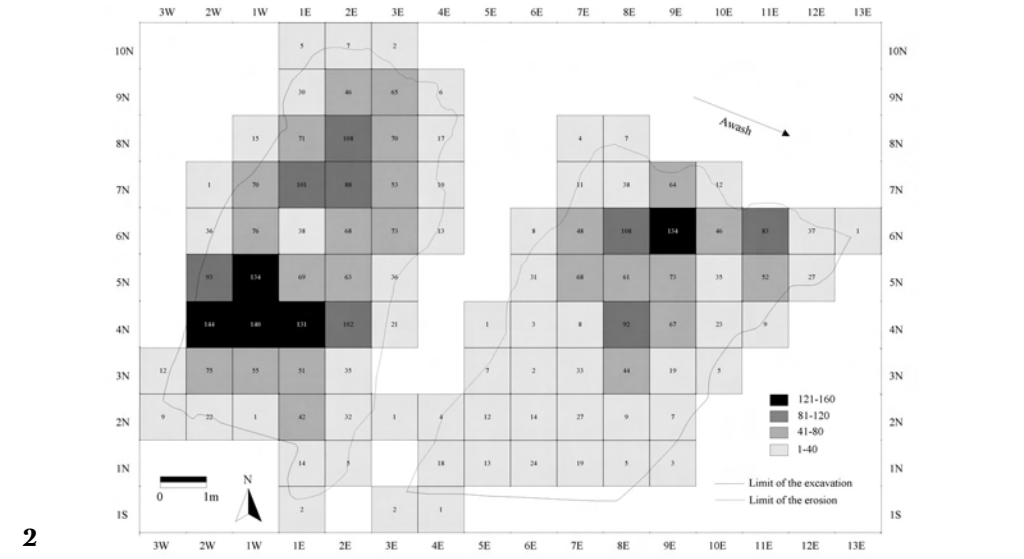

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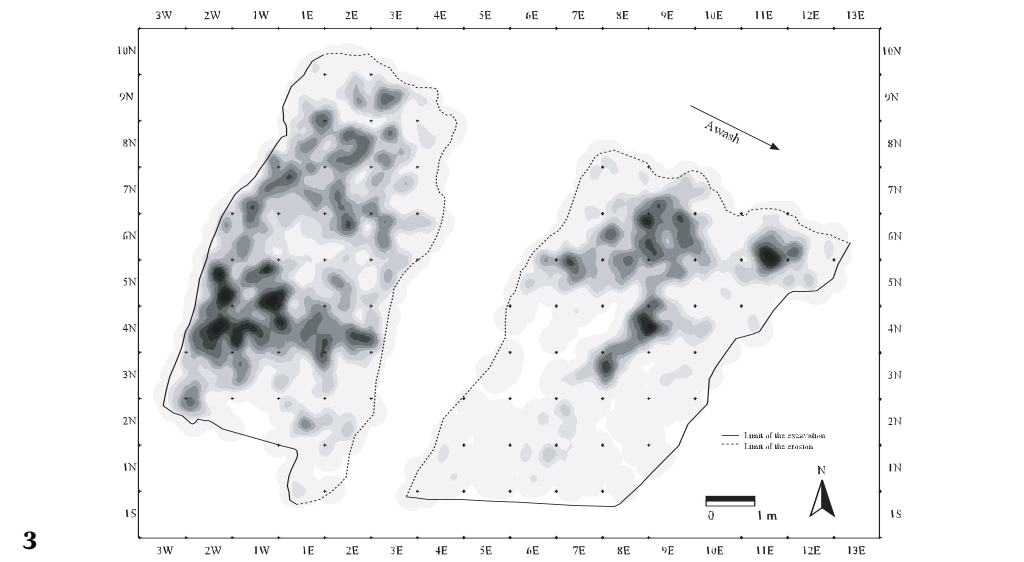
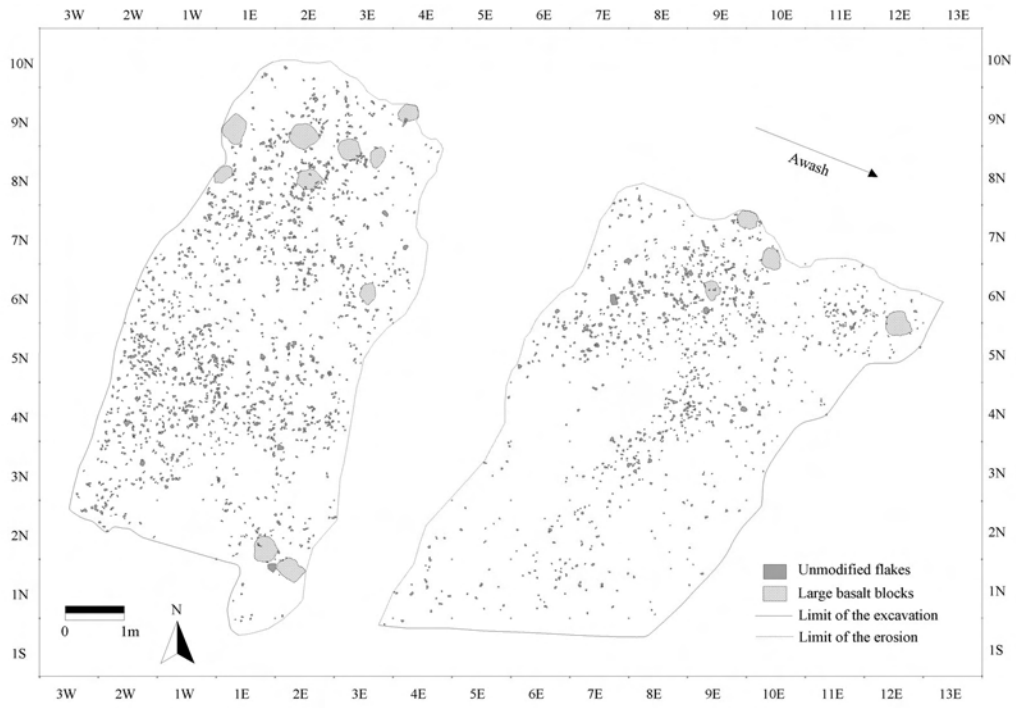


3

Plate 1. Garba IV D. 1. Plan of unmodified flakes. (*Original plan by G. M. Bulgarelli and M. Piperno, digital map by R. Gallotti*) 2. Frequency of unmodified flakes. 3. Density areas of unmodified flakes.



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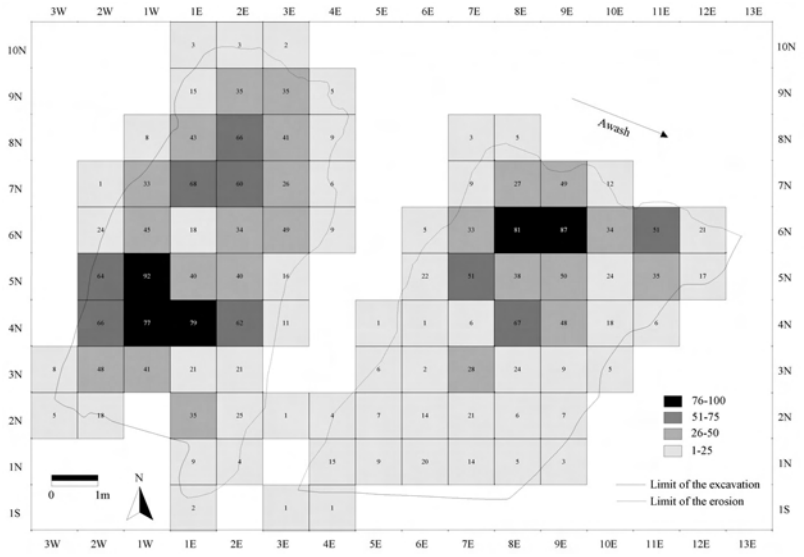

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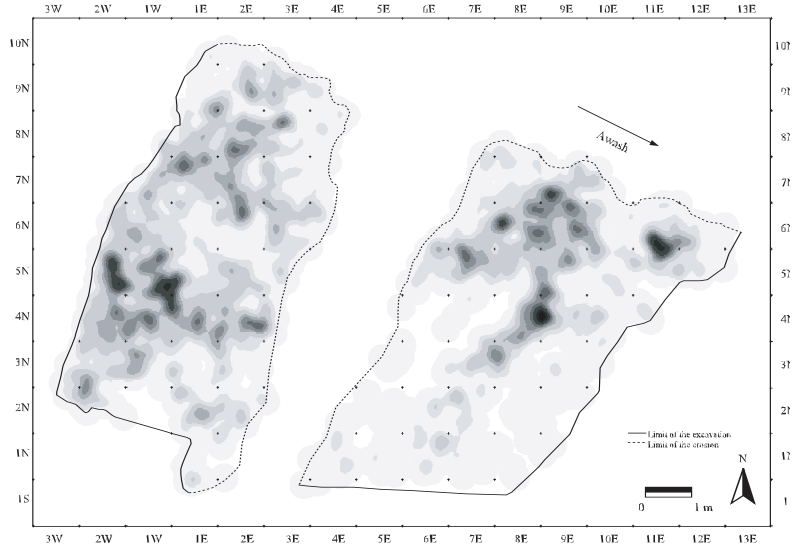
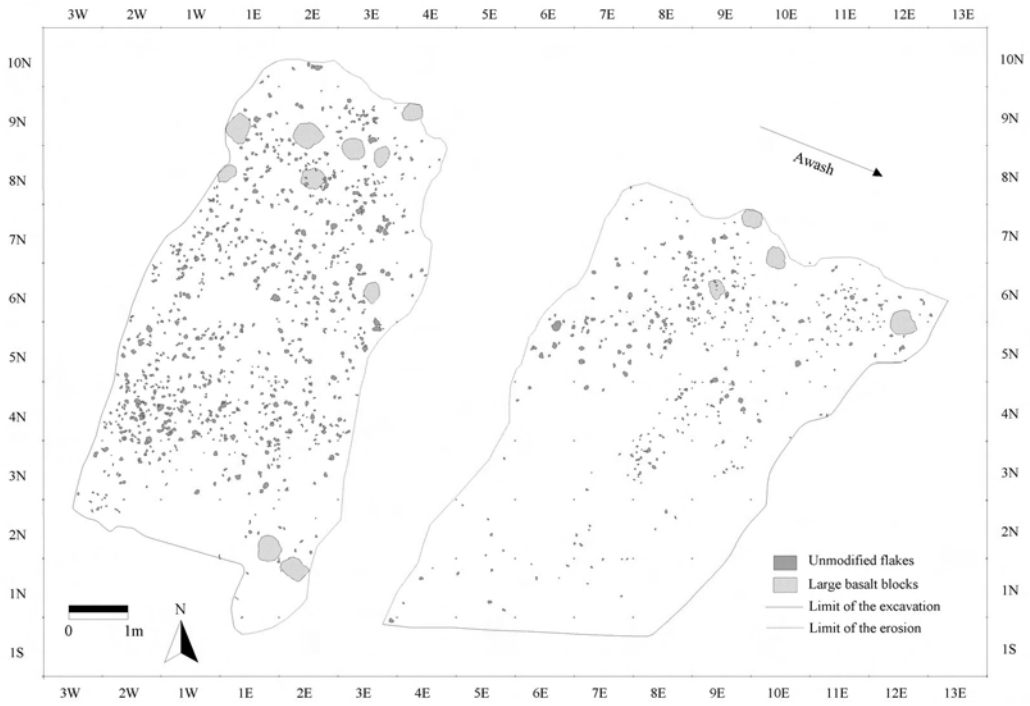


3

Plate 2. Garba IV D. 1. Plan of obsidian unmodified flakes. (*Original plan by G. M. Bulgarelli and M. Piperno, digital map by R. Gallotti*) 2. Frequency of obsidian unmodified flakes. 3. Garba IV D. Density areas of obsidian unmodified flakes.



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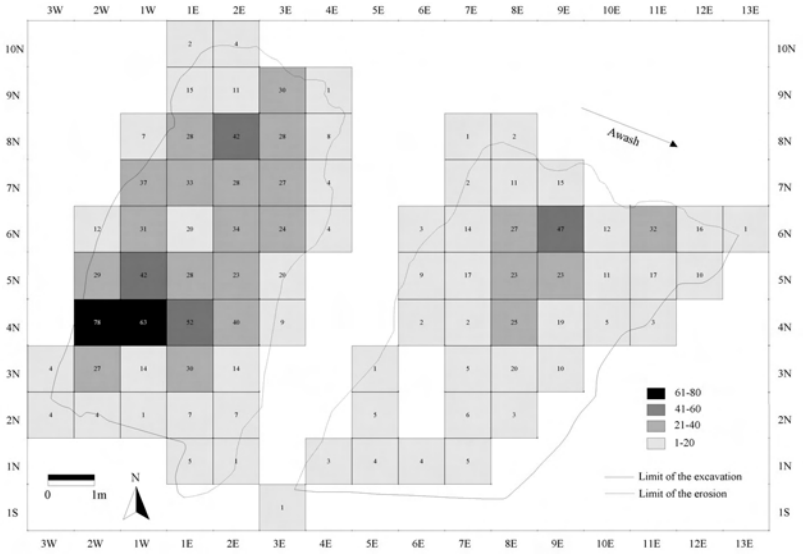

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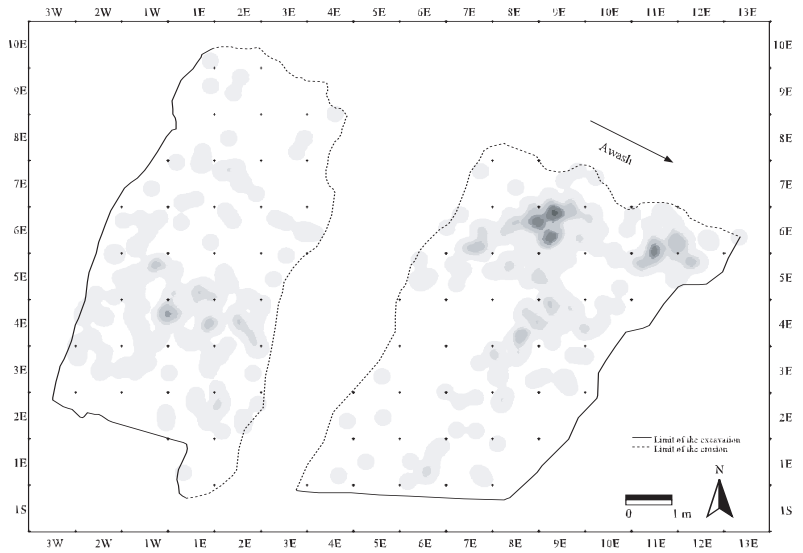


3

Plate 3. Garba IV D. 1. Plan of unmodified flakes on various volcanic rocks. (*Original plan by G. M. Bulgarelli and M. Piperno, digital map by R. Gallotti*) 2. Frequency of unmodified flakes on various volcanic rocks. 3. Density areas of unmodified flakes on various volcanic rocks.

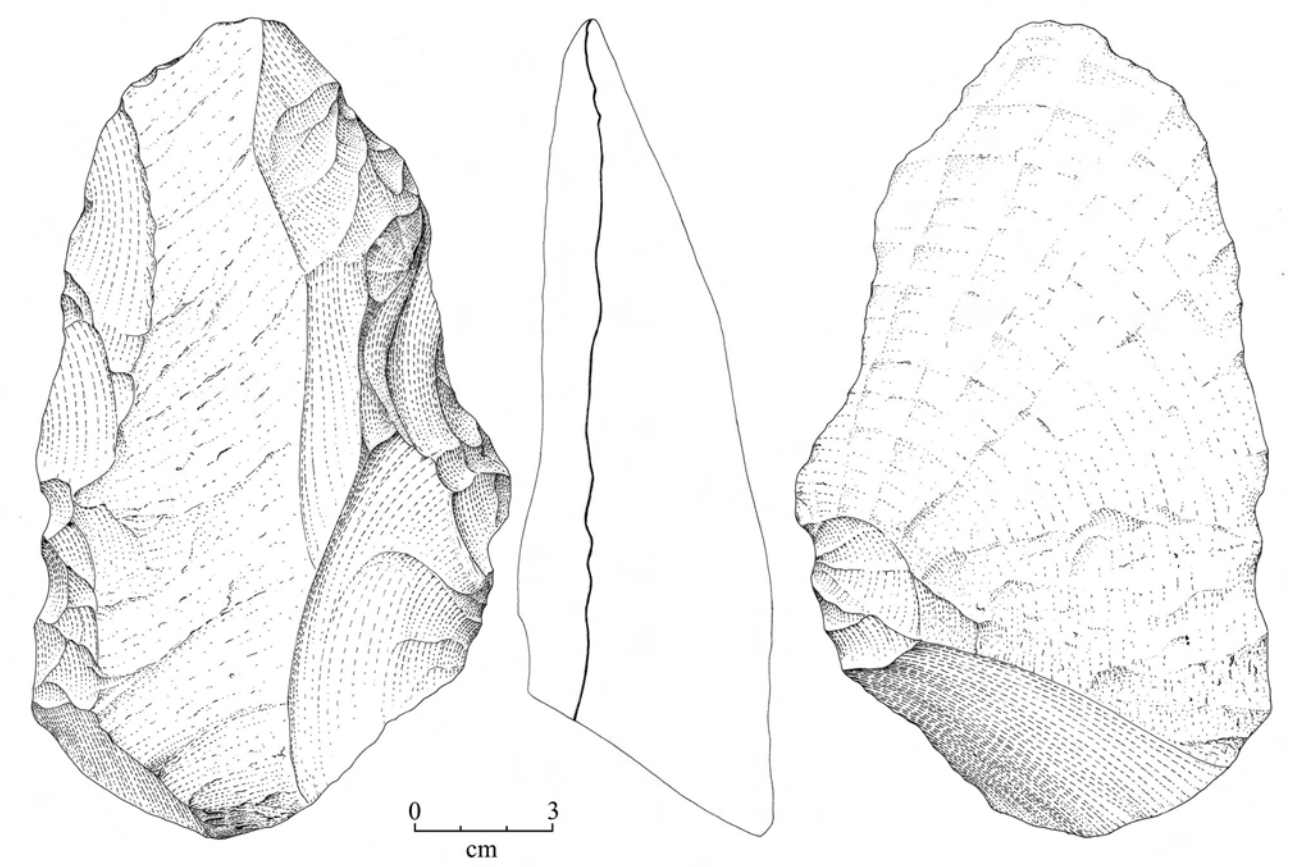


Fig. 14. Garba IV D. Large utilized flake (MK 4808). Basalt. *Drawings by M. Pennacchioni*

Removals

Utilized flakes behave exactly the same as unmodified ones for this feature as well, with a higher frequency of flakes having between 1 and 4 previous removals (Tab. 24).

Removals	**Obsidian**		**Other volcanic rocks**		**Total**	
	N	%	N	%	N	%
0	1	1.01	11	20.00	12	7.79
1	11	11.11	7	12.73	18	11.69
2	15	15.15	12	21.82	27	17.53
3	31	31.31	7	12.73	38	24.68
4	26	26.26	2	3.64	28	18.18
5	6	6.06	3	5.45	9	5.84
6	2	2.02			2	1.30
8	1	1.01			1	0.65
>8	4	4.04	2	3.64	6	3.90
Indeterminable	2	2.02	11	20.00	13	8.44
Total	**99**		**55**		**154**	

Tab. 24. Number of negative scars of utilized flakes.

Cortex

Cortex is absent on 69.7% of the modified obsidian flakes and on 40% of those of other volcanic rocks; it is total on 21.82% of the flakes of other volcanic, partial respectively on 12.12% and 38.18%, on the edge on 9.09% in both cases, on the platform on 5.05% of obsidian flakes and absent in the other cases.

Localization of utilization traces

Of the 99 utilized obsidian flakes, 18 have traces on the right edge. In 12 cases they are continuous, in two cases discontinuous, in one case they are localized on the proximal portion and in three on the distal portion. The utilization traces are marginal with a direct position: in one case it is rectilinear direct, in two cases it is rectilinear continuous. In one case they are inverse, in one case alternate. Thirteen flakes have been utilized on the left lateral edge. In nine cases the traces are continuous, in one case discontinuous, in two cases they are localized on the proximal portion, in one case on the distal portion. The utilization traces are marginal with a direct position (10): in one case they are direct rectilinear continuous. In two cases the traces are inverse, in one case alternate.

Twenty-seven flakes have been utilized on the distal edge, eight in a discontinuous, seven in a continuous way; in two cases the traces are localized on the medial portion, in five cases on the distal portion, in one case both on the distal and medial portions. The utilization is marginal. In 17 cases it is direct. Only one utilized flake has inverse retouch.

Of the 55 utilized flakes made of other volcanic rocks, 12 present traces on the right edge; in 10 cases they are continuous and in two cases discontinuous. The traces are marginal with a direct position (in one case it is direct rectilinear continuous). In one case it is alternate rectilinear continuous.

Nine utilized flakes present traces on the left lateral edge. In six cases they are continuous, in one case localized on the proximal portion, and in two cases they are both on the proximal and medial portions.

The utilization traces are marginal with a direct position (6): in one case they are direct convex continuous, in another direct sinuous denticulate. In one case they are inverse.

Three flakes have been utilized on the transversal distal edge, one in a discontinuous way, one on the proximal portion, one on the distal portion. The traces are marginal; in three cases they are direct, in two cases inverse, and in three alternate.

Only one flake is utilized on the transversal proximal edge in a continuous way. The utilization is marginal with a direct position.

Typometry

In the general catalogue, except for one fragment, 159 utilized flakes have been measured and weighed.

In the catalogue of the studied pieces the three dimensions have been taken for 136 flakes of the 150 studied in detail and 120 have been weighed. The data on the measurements of the platform derive exclusively from the catalogue of the studied pieces. The length of the platform has been measured on 47 utilized flakes, the thickness of the platform on 56, and the angle of the platform on 53.

The values of length, width, thickness and weight as well as the typometry of the platforms, are also similar to those of unmodified flakes, confirming the casualness of the choice in the fortuitous utilization of a blank.

Length, width, thickness and weight

Length ranges between 11 mm and 160 mm, but is between 21 mm and 60 mm for more than 78% of flakes on various raw materials.

Width ranges between 11 mm and 90 mm with more than 83% of the pieces between 21 mm and 60 mm. Thickness ranges between 1 mm and 60 mm, with 94% of the pieces between 1 mm and 30 mm, regardless of the raw material.

Weight ranges from 3 g to 1100 g, with a higher frequency of pieces (64.78%) between 3 g and 30 g and a second peak in frequency, equal to 23.40% of the flakes made of other volcanic rocks, between 101 g and 200 g.

Striking platform length, thickness and angle with ventral face

The typometry of the platforms is also not very different from the data already observed for unmodified flakes: length between 2 mm and 120 mm (more than 87% between 11 mm and 40 mm); thickness between 2 mm and 25 mm with a maximum frequency between 2 mm and 15 mm (more than 93% of the flakes in various raw materials); variability of the platform/ventral face angle between 81° and 130°, with more than 90% of the obsidian flakes with values between 111° and 130° and more than 80% of the angles of the flakes of other volcanic materials with slightly smaller angles with values between 91° and 120°.

Spatial distribution

In this case, too, finds were more plentiful in WS than in ES (137 specimens, amounting to 68.16%, vs. 64, 31,84%). In WS, the central part yielded practically no utilized flakes, while the highest concentration was observed in the lower part, with a peak in both frequency and density in square 2E/4N (17 specimens). In ES, utilized flakes lay within the upper part, with a higher, although hardly significant, frequency (9 specimens) in the square where one of the large basalt blocks stood (Plate 4). This distribution matches that of utilized obsidian flakes; only 4 utilized flakes of other volcanic rocks were found in ES. Thus, the difference in number between ES and WS is strongly influenced by the fact that utilized flakes of other volcanic rocks were found almost exclusively in the latter sector. Furthermore, the frequency of used obsidian flakes is slightly higher in WS (WS: 71 specimens, 54.20%; ES: 60 specimens, 45.80%).

The distribution of utilized flakes is less homogeneous than the general distribution of flakes, since they are found almost exclusively within the previously mentioned areas of concentration (Plate 5).

Retouched flakes

This group includes flakes with traces of retouch, often marginal, but sometimes also invasive, partial or continuous. However, the retouch on these flakes is not important enough to include them in more defined typological categories, such as side-scrapers or denticulates (Figs. 7, *3*, *5*, *6*, *8*; 8, *1*, *2*, *4*, *5*, *7*, *8*; 15).

Of the 287 flakes reported in the general catalogue, 150 have been studied in detail.

Tab. 25 shows the distribution of retouched flakes according to various raw materials.

Raw material	**Catalogue**		**Studied material**	
	N	%	N	%
Obsidian	212	73.87	118	78.67
Basalt	71	24.74	30	20.00
Trachybasalt	3	1.05	2	1.33
Tuff	1	0.35		
Total	**287**		**150**	

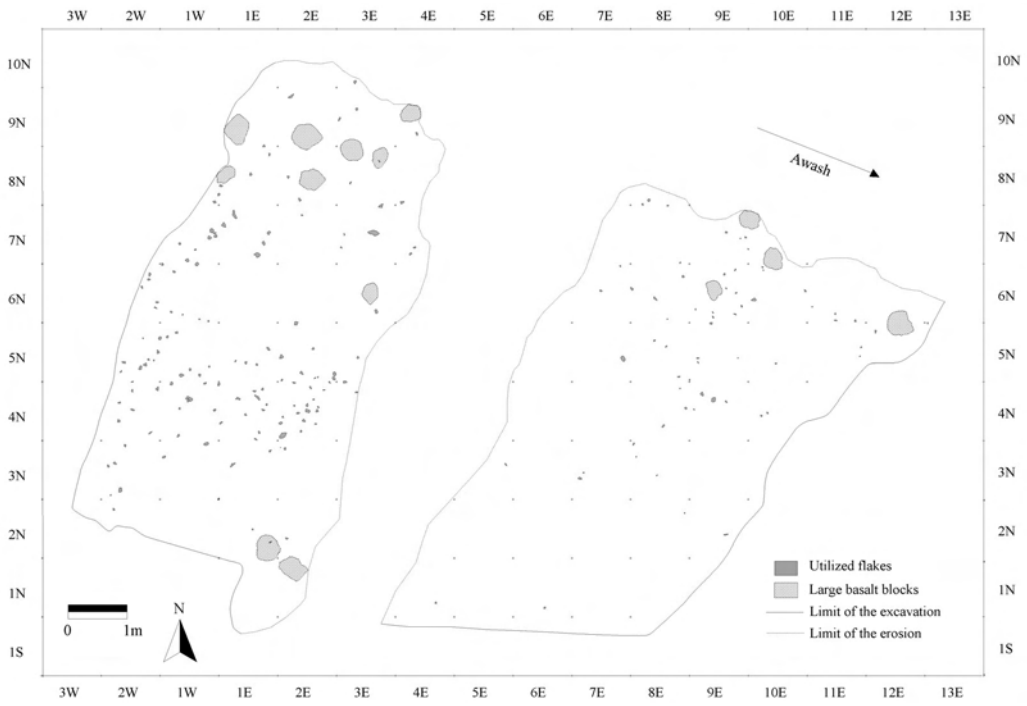
Tab. 25. Raw material utilized for retouched flakes.

Morpho-technical aspects

The data reported in the following paragraphs refer to the elaboration of the observations made on the 150 retouched flakes analyzed in detail.

Preservation and shape

Most of the retouched flakes both of obsidian and of other volcanic rocks are complete (85.33%), while a little more than 14% are fragmentary flakes, which often cannot be easily oriented. Triangular to polygonal flakes are prevalent, while semicircular to oval ones are much more rare.



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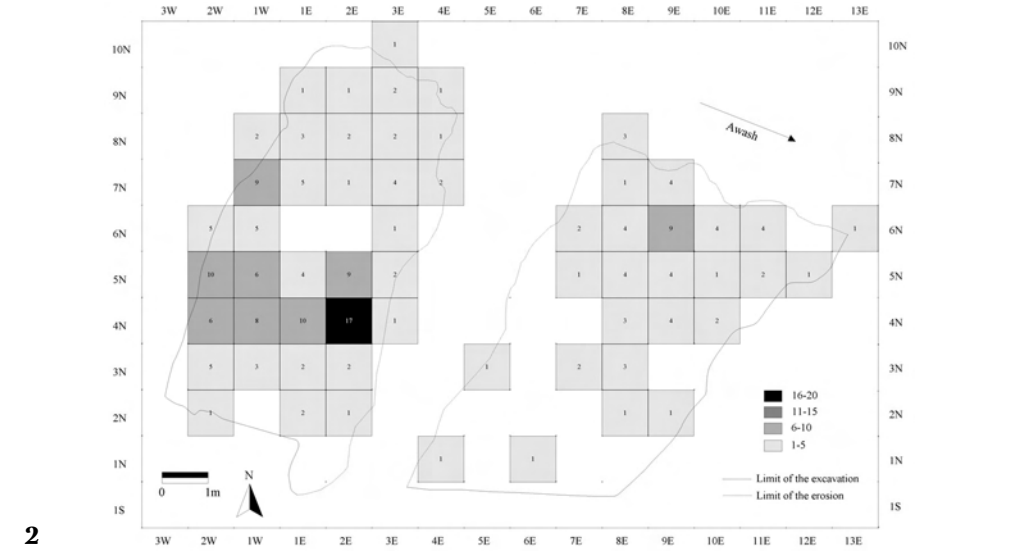

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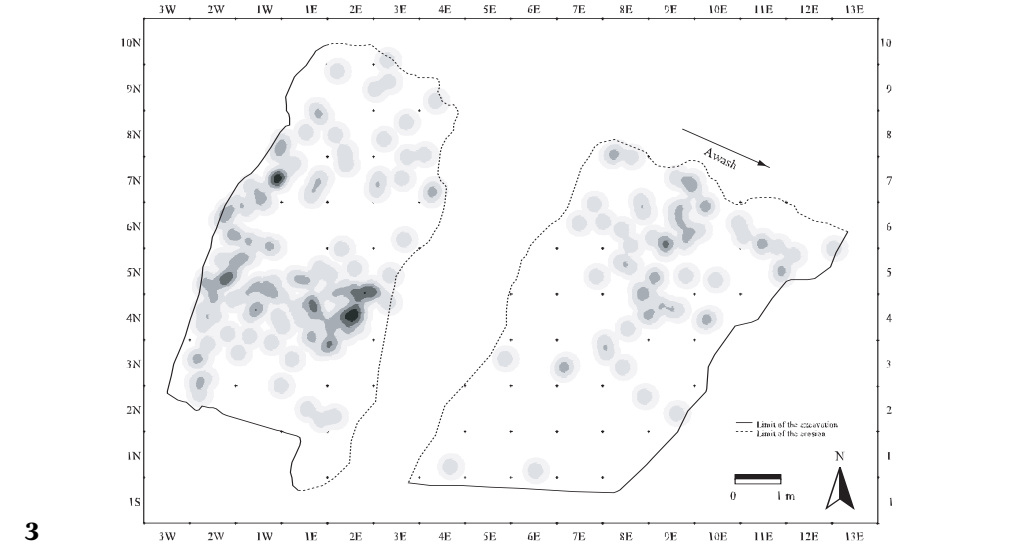

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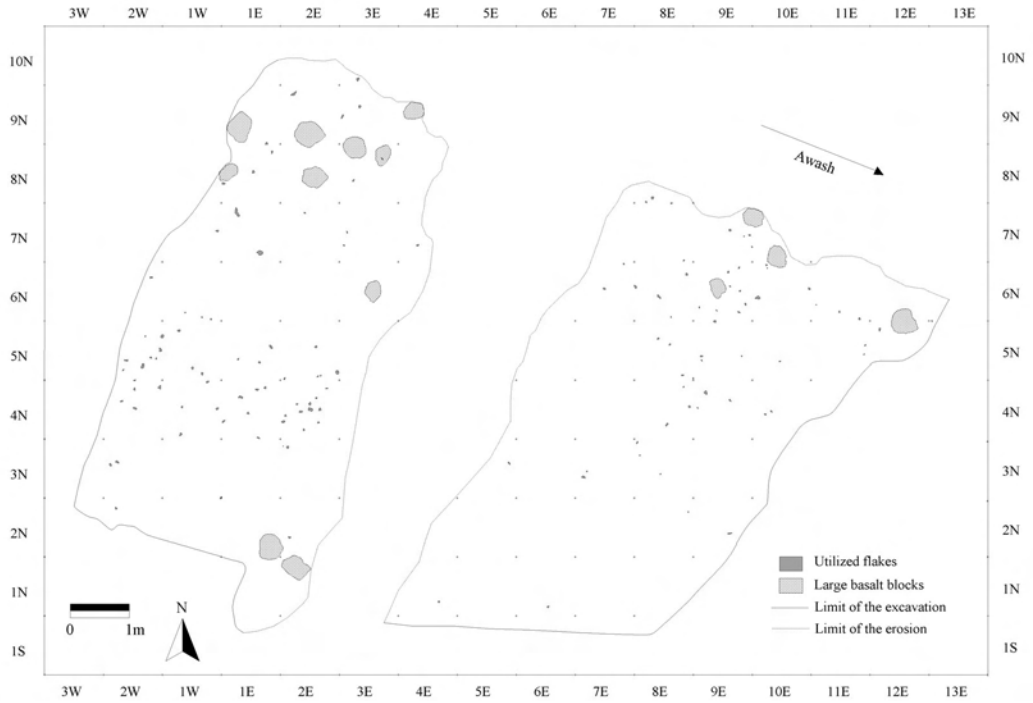
Plate 4. Garba IV D. 1. Plan of utilized flakes. (*Original plan by G. M. Bulgarelli and M. Piperno, digital map by R. Gallotti*) 2. Frequency of utilized flakes. 3. Density areas of utilized flakes.



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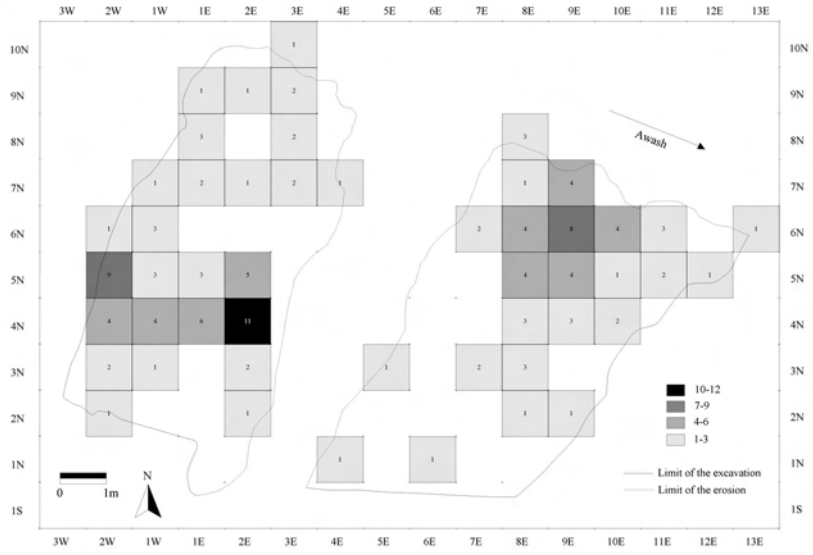

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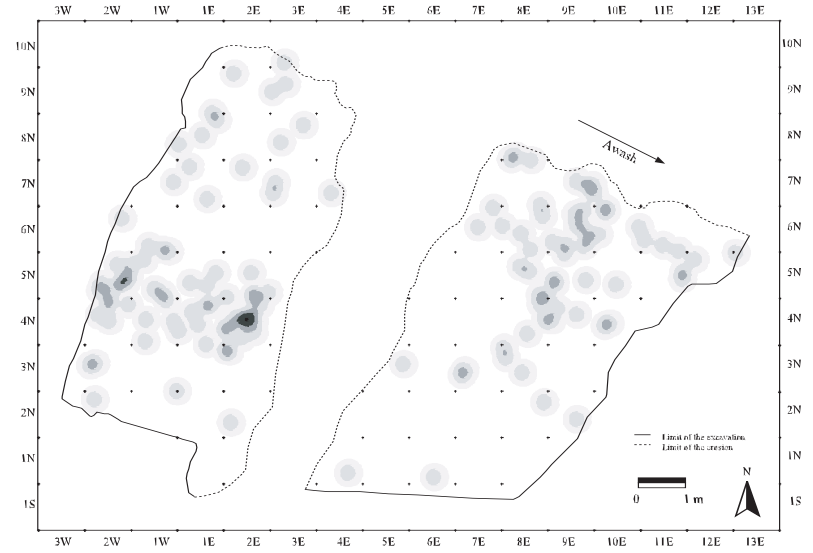

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Plate 5. Garba IV D. 1. Plan of obsidian utilized flakes. (*Original plan by G. M. Bulgarelli and M. Piperno, digital map by R. Gallotti*) 2. Frequency of obsidian utilized flakes. 3. Density areas of obsidian utilized flakes.

Striking platform

As with unmodified flakes, the platform of retouched ones is usually plain on a negative scar (46.61% for the obsidian flakes and 78.13% for those of other volcanic rocks); among obsidian flakes there are also low frequencies of platforms on cortex (7.63%) and punctiform (1.69%) or dihedral platforms (1.69%) which are not found on flakes of other volcanic rocks. The distribution of different kinds of platforms is identical to that observed for unmodified flakes (Tab. 26).

Striking platform	**Obsidian**		**Other volcanic rocks**		**Total**	
	N	%	N	%	N	%
Plain on negative scar	55	46.61	25	78.13	80	53.33
Plain on cortex	9	7.63			9	6.00
Punctiform	2	1.69			2	1.33
Punctiform on removal			1	3.13	1	0.67
Dihedral	2	1.69			2	1.33
Absent removed	5	4.24			5	3.33
Unrecognizable	36	30.51	4	12.50	40	26.67
On edge	9	7.63	2	6.25	11	7.33
Total	**118**		**32**		**150**	

Tab. 26. Frequency of different types of striking platforms of retouched flakes.

Removals

As in the case of unmodified flakes, retouched flakes completely covered with cortex are more frequent among those from other volcanic rocks (20%) than among obsidian ones (2.54%). Most of the flakes (77.96% for obsidian and 60% for other volcanic rocks) have from one to four previous removals, while there are fewer with five or more (Tab. 27).

Removals	**Obsidian**		**Other volcanic rocks**		**Total**	
	N	%	N	%	N	%
0	3	2.54	6	20.00	9	6.00
1	18	15.25	6	20.00	24	16.00
2	21	17.80	6	20.00	27	18.00
3	31	26.27	4	13.33	35	23.33
4	22	18.64	2	6.67	24	16.00
5	6	5.08			6	4.00
6	2	1.69			2	1.33
<6	7	5.93	2	6.67	9	6.00
Indeterminable	8	6.78	6	20.00	14	9.33
Total	**118**		**30**		**150**	

Tab. 27. Number of removals of retouched flakes.

Cortex

In most cases (78.81% for obsidian and 62.50% for other volcanic rocks) the retouched flakes are without cortex. The other cases are represented by only a few pieces.

Localization of the retouch

Obsidian

Of the 118 obsidian retouched flakes, 48 present retouch on the right edge. In eleven cases it is discontinuous, in ten it is total, in six it is localized on the proximal portion, in two cases on the medial portion,

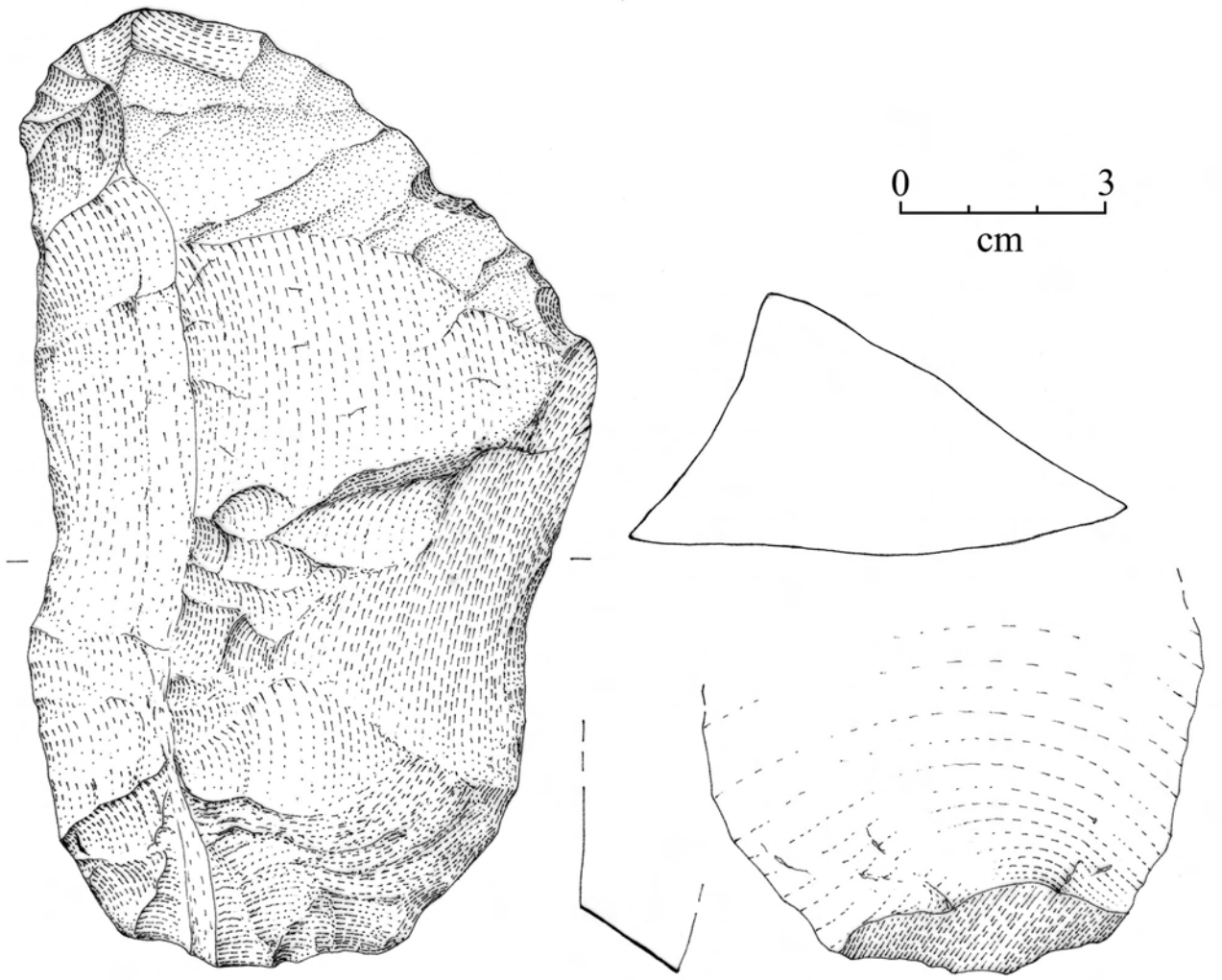


Fig. 15. Garba IV D. Large retouched flake (MK 5847). Basalt. *Drawings by M. Pennacchioni*

in eight cases on the distal one, in two cases both on the distal and medial portions. The retouch is simple marginal in 35 cases, simple invasive in two cases, abrupt in two cases, flat invasive in one case.

In 38 cases the retouch is direct: in three cases it is rectilinear direct, in four cases rectilinear direct continuous, in three cases it is concave continuous, in two concave denticulate, in three cases concave with notch, in two convex continuous, in one convex denticulate, in one sinuous, in one sinuous continuous, in two sinuous denticulate. In six cases the position is inverse, in one case it is alternate.

Twenty-eight flakes are retouched on the left lateral edge. In five cases the retouch is discontinuous, in three cases it extends over the entire edge, in three cases it is localized on the proximal portion, in two cases on the medial portion, in five on the distal one, in one cases it is both on the proximal and medial portions, and in two cases both on the distal and medial portions. In 15 cases the retouch is simple marginal, in four simple invasive, in one abrupt marginal, in one abrupt invasive. In 24 cases the position of the retouch is direct, in five cases inverse, in one alternate.

Twenty flakes are retouched on the distal portion, in 12 cases the retouch is continuous, in eight discontinuous. The retouch is simple marginal in 15 cases, simple invasive in two cases, abrupt invasive in two, flat marginal in one case. The retouch is usually direct, except in two cases when it is inverse and in one case alternate.

Four flakes are retouched on the transversal proximal edge; in one case the retouch is continuous, in one discontinuous, in one it is on the central left portion. The retouch is simple marginal in one case, simple invasive in another case. The position of the retouch is direct.

Other volcanic rocks

Of the 32 retouched flakes made of other volcanic rocks, 12 are retouched on the right edge. In four cases the retouch is discontinuous, in two cases it is total, in one it is localized on the medial portion, in one on the distal portion, in one both on the proximal and medial portions, in one case on the distal and medial portions. The retouch is always simple marginal, direct in five cases, inverse in four cases and alternate in three.

Twelve flakes present retouch on the left lateral edge. In one case the retouch is discontinuous, in two cases it is total, in one case it is localized on the medial portion, in two cases on the distal one, in two other cases it is localized on both the proximal and medial portions. The retouch is simple marginal in eight cases, simple invasive in two, abrupt marginal in one. In seven cases the position of the retouch is inverse, in four cases alternate.

On six flakes the retouch is continuous on the transversal distal edge. The retouch is simple marginal in two cases, abrupt marginal in one case. The position of the retouch is always direct.

Only one flake is retouched on the transversal proximal edge, on the left portion. The retouch is simple marginal inverse.

Typometry

The three dimensions and the weight have been measured for 235 retouched flakes reported in the general catalogue.

Of the 150 pieces studied in detail, excluding the fragmentary flakes, 136 retouched flakes have been measured and 132 have been weighed. The data on the measurement of the platform have been drawn exclusively from the catalogue of the studied pieces. The length of the platform has been measured on 45 retouched flakes, the thickness of the platform on 50, and the angle of the platform on 51.

Length, width, thickness and weight

Length ranges between 11 mm and 160 mm, but for more than 84% of the obsidian retouched flakes the length is between 21 mm and 60 mm, while 48.22% for the flakes made of other volcanic rocks it is between 31 mm and 60 mm.

Width ranges between 11 mm and 140 mm, with 87.38% of the obsidian flakes between 21 mm and 60 mm; within the same range, the width of most flakes of other volcanic rocks (64%) is instead between 41 mm and 90 mm.

Thickness ranges between 2 mm and 70 mm with maximum frequency (83.8%) between 2 mm and 20 mm for obsidian flakes, while almost all flakes of other volcanic rocks (92.86%) are between 2 mm and 40 mm.

As regards the weight, most of the obsidian flakes (84.36%) are between 3 g and 40 g, while flakes above this weight are very rare. The weight of the flakes made of other volcanic rocks is more uniformly distributed, presenting a concentration (39.29%) between 3 g and 30 g and a second smaller peak (28.57%) between 101 g and 400 g (Fig. 16).

Striking platform length, thickness and angle with ventral face

More than 86.67% of the platforms, regardless of raw material, are between 11 mm and 40 mm long and between 2 mm and 10 mm thick (70% of obsidian flakes and 80% of other volcanic rocks). The angle between the platform and ventral face is between 101° and 130° for 87.87% of obsidian retouched flakes and between 101° and 120° for 72.22% of those of other volcanic rocks.

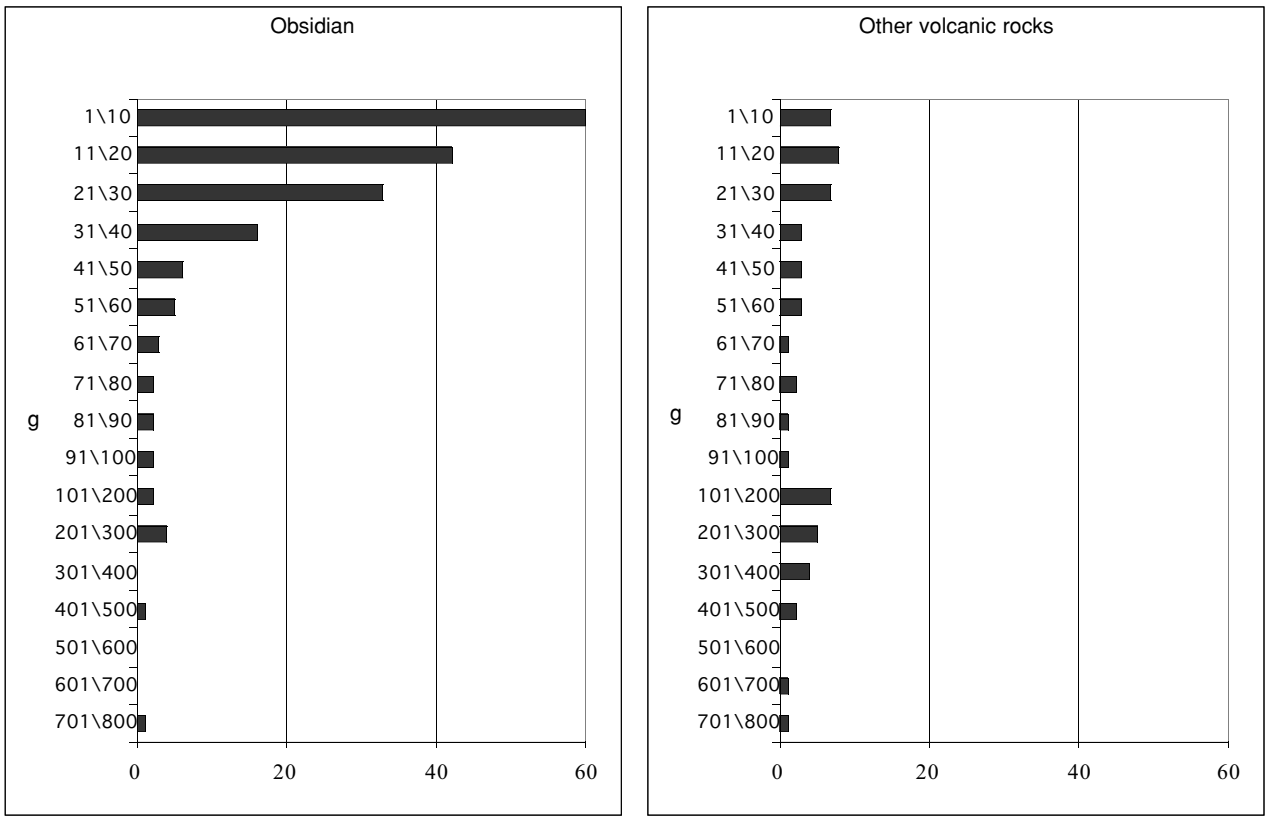


Fig. 16. Distribution of weight of retouched flakes.

Spatial distribution

Of the 287 retouched flakes identified in the general inventory, 189 (65.85%) were found in WS and 98 (34.15%) in ES. These percentages are very close to those of unmodified and used flakes. The concentration and dispersal areas of retouched flakes roughly coincide with those of unmodified flakes, but the density areas are smaller and numerically insignificant (Plate 6).

Retouched flakes of rocks other than obsidian (75) do not show specific distribution patterns. Their number in ES is irrelevant and their distribution in WS shows no significant patterns of aggregation, being rather homogeneous except for a relative scarcity in the central part of the sector.

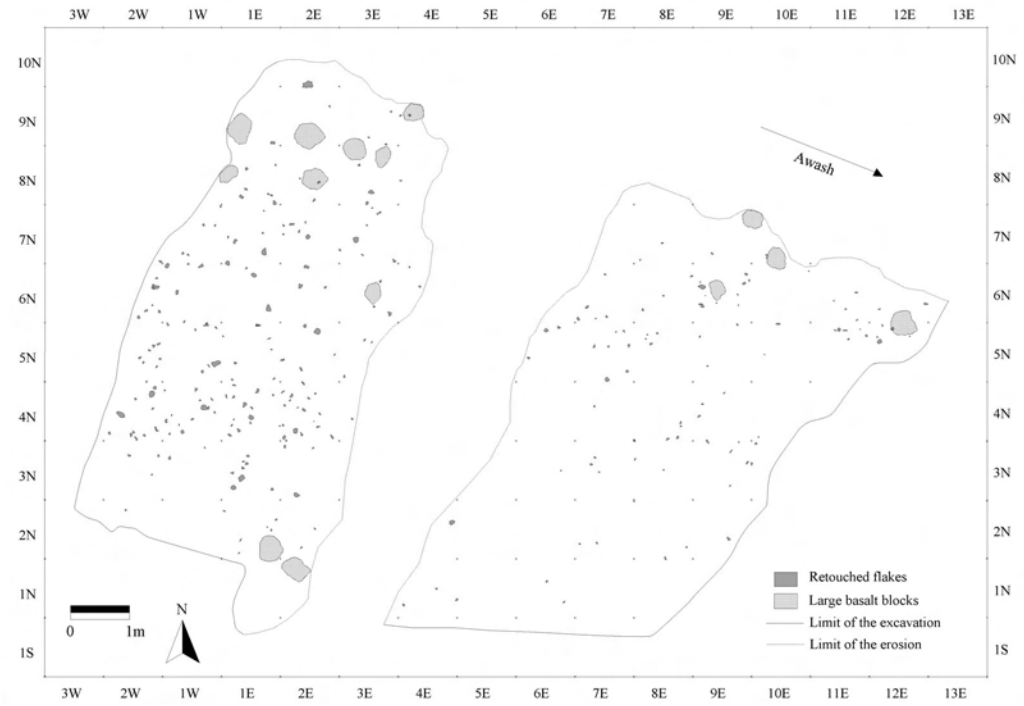
Retouched flakes of obsidian are distributed in the two sectors in the same percentages observed for all flakes (WS: 130 specimens, 61.32%; ES: 82 specimens, 38.68%). Concentration areas are also approximately the same as those described for all flakes, although they appear to be more dispersed in ES. In WS, squares 1-2E/4N have the highest frequency, with 14 and 13 specimens, while in ES the highest density (10 specimens) is observable, again, in one of the squares (9E/6N) where one of the large blocks of basalt is located (Plate 7).

Tools on flake

Side-scrapers

The side-scrapers, although not very common in this lithic assemblage dominated by unmodified flakes, represent a typologically well-defined tool at Garba IV D. Sometimes, as in the case of some small double or déjetés side-scrapers, the manufacture is extremely accurate.

Of the 178 side-scrapers identified in the general catalogue, 138 (77.52%) have been studied.



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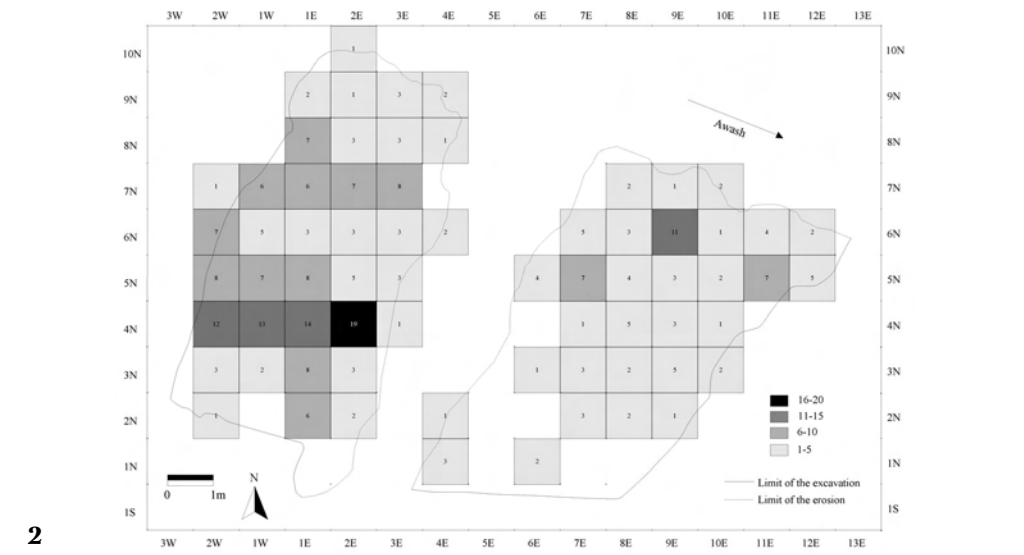

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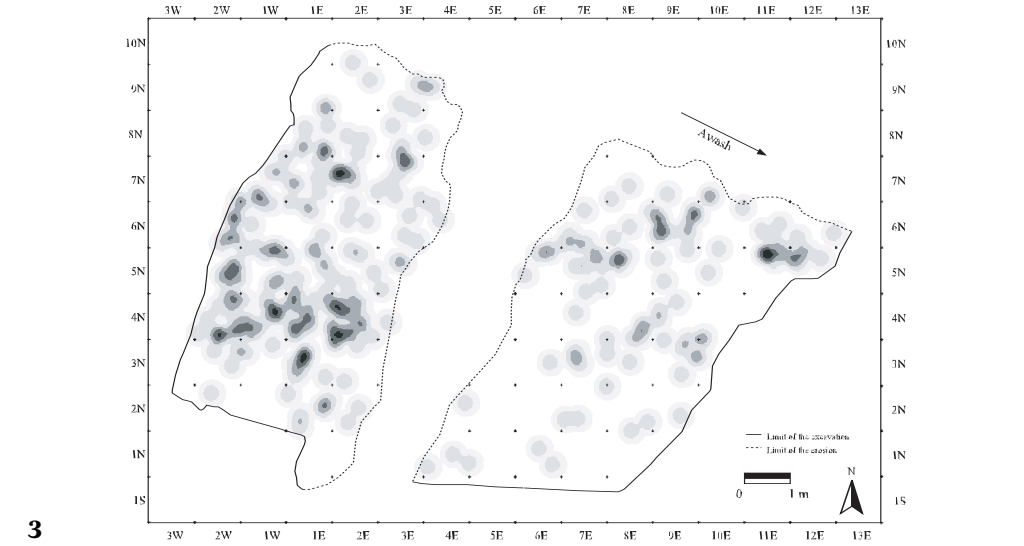

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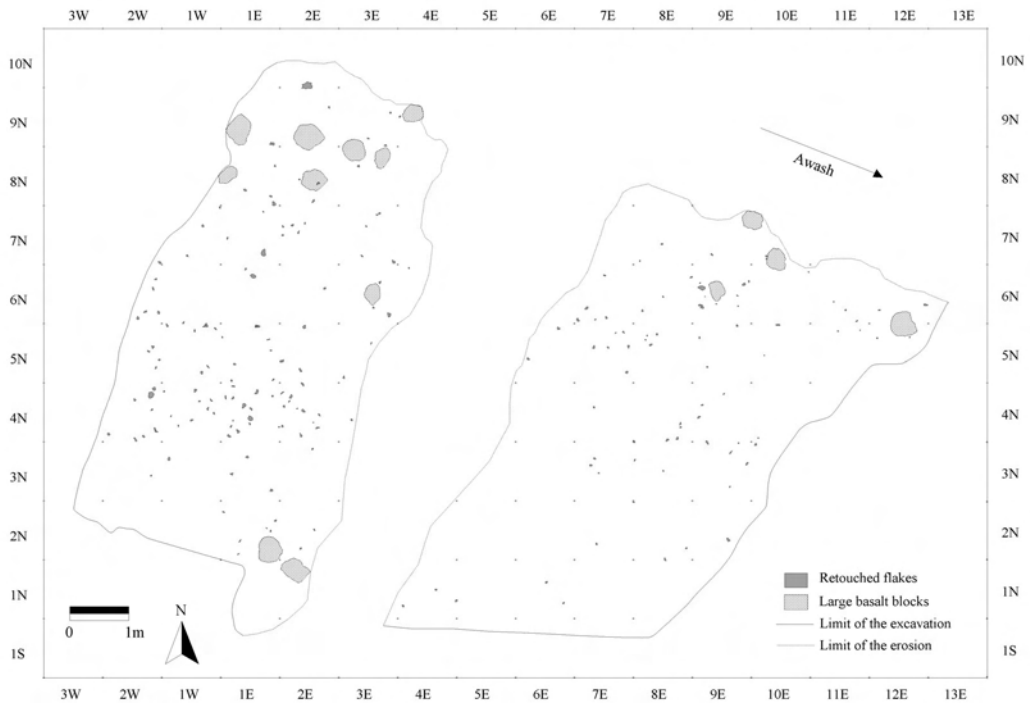
Plate 6. Garba IV D. 1. Plan of retouched flakes. (*Original plan by G. M. Bulgarelli and M. Piperno, digital map by R. Gallotti*) 2. Frequency of retouched flakes. 3. Density areas of retouched flakes.



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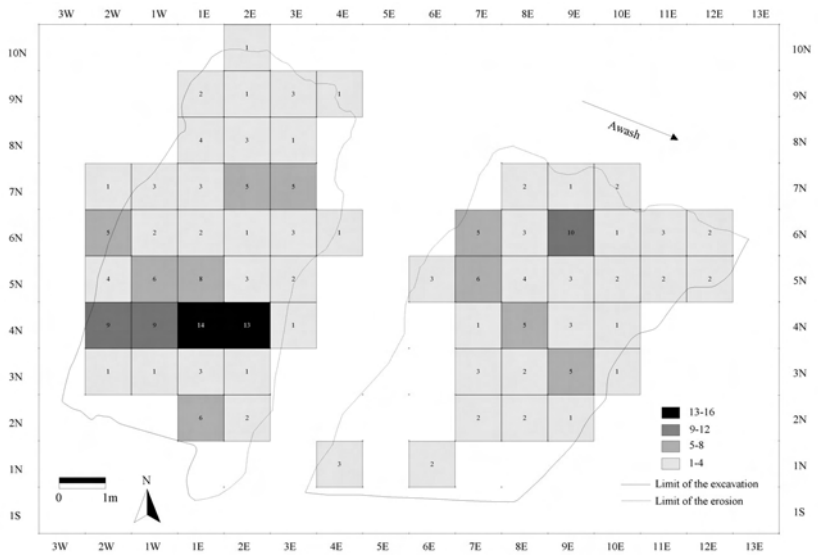

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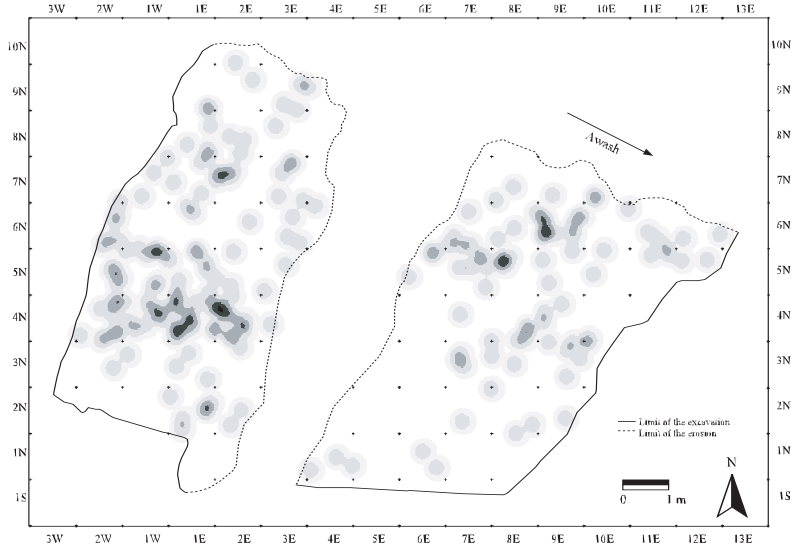

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Plate 7. Garba IV D. 1. Plan of obsidian retouched flakes. (*Original plan by G. M. Bulgarelli and M. Piperno, digital map by R. Gallotti*) 2. Frequency of obsidian retouched flakes. 3. Density areas of obsidian retouched flakes.

Raw material

Most of the side-scrapers have been obtained from obsidian flakes (76.40%), while only 23.59% of them are made of basalt and other volcanic rocks (Tab. 28).

Raw material	Catalogue		Studied material	
	N	%	N	%
Obsidian	136	76.40	111	80.43
Basalt	40	22.47	27	19.56
Others	2	1.12		
Total	**178**		**138**	

Tab. 28. Raw material utilized for side-scrapers.

Morpho-technical aspects

Regarding the side-scrapers, and in particular the obsidian ones, the wide typological diversity within this group must be stressed (Tab. 29), although each type of side-scraper, with the exception of the simple side-scrapers (42.03%) and the transversal ones (31.88%), appear in very low percentages (double side-scrapers: 5.07%; convergent side-scrapers 4.35%; déjeté side-scrapers: 9.42%; lateral-transversal side-scrapers: 2.17%; side-scrapers on ventral face: 5.07%).

Type	Obsidian		Other volcanic rocks		Total	
	N	%	N	%	N	%
Simple straight	12	10.81	4	14.81	16	11.59
Simple convex	14	12.61	3	11.11	17	12.32
Simple concave	19	17.12	5	18.52	24	17.39
Simple conc./conv.			1	3.70	1	0.72
Double straight	1	0.90			1	0.72
Double straight/concave	1	0.90			1	0.72
Double biconvex	4	3.60			4	2.90
Double biconcave			1	3.70	1	0.72
Convergent	6	5.41			6	4.35
Déjeté	12	10.81			12	8.70
Double déjeté	1	0.90			1	0.72
Transversal straight	13	11.71	2	7.41	15	10.87
Transversal convex	17	15.32	4	14.81	21	15.22
Transversal concave	3	2.70	3	11.11	6	4.35
Transversal conc./conv.	2	1.80			2	1.45
Lateral-transversal			3	11.11	3	2.17
On ventral face	6	5.41	1	3.70	7	5.07
Total	**111**		**27**		**138**	

Tab. 29. Typological diversification of side-scrapers.

Preservation

Among obsidian side-scrapers, 104 are complete, seven are indefinable fragments. Of the 27 side-scrapers made of other volcanic rocks, 23 are complete and four are fragmentary.

Striking platform

There is a clear similarity between the frequencies of different kinds of platforms recognizable on side-scrapers and those observed on unmodified flakes (Tab. 30).

Striking platform	Obsidian		Other volcanic rocks		Total	
	N	%	N	%	N	%
Plain on negative scar	65	58.56	15	55.56	80	57.97
Plain on cortex	6	5.41	2	7.41	8	5.80
Dihedral	1	0.90			1	0.72
Facetted concave	1	0.90			1	0.72
Absent removed	5	4.50	1	3.70	6	4.35
Unrecognizable	23	20.72	6	22.22	29	21.01
On edge	10	9.01	3	11.11	13	9.42
Total	**111**		**27**		**138**	

Tab. 30. Frequency of different types of platform of side-scrapers.

Removals

Regarding the number of removals on the dorsal face, the data obtained for side-scrapers are also not very different, from those observed on unmodified flakes, even if percentages vary slightly (Tab. 31).

Removals	Obsidian		Other volcanic rocks		Total	
	N	%	N	%	N	%
0	4	3.60	2	7.41	6	4.35
1	12	10.81	7	25.93	19	13.77
2	21	18.92	4	14.81	25	18.12
3	32	28.83	5	18.52	37	26.81
4	17	15.32	2	7.41	19	13.77
5	8	7.21	1	3.70	9	6.52
6	4	3.60			4	2.90
8	1	0.90			1	0.72
9	1	0.90			1	0.72
<9	10	9.01	1	3.70	11	7.97
Indeterminable	1	0.90	5	18.52	6	4.35
Total	**111**		**27**		**138**	

Tab. 31. Number of negative scars of side-scrapers.

Cortex

Cortex is absent on 74.77% of obsidian side-scrapers and on 48.15% of those of other volcanic rocks. Some 2.70% of the obsidian side-scrapers and 7.41% of those of other volcanic rocks are on pebble caps; 22.51% of the obsidian side-scrapers and 44.43% of those of other volcanic rocks have portions of cortex on the dorsal face, on the edge or on the platform. These data are again very similar to those observed for unmodified flakes.

Composite character

Six obsidian side-scrapers are associated with a denticulate, three with a clactonian notch and one with a retouched notch. Among the side-scrapers made of other volcanic rocks, three are associated with a denticulate, three with a retouched notch.

Simple side-scrapers (Figs. 17, *1*, *2*; 18, *1*, *5*, *6*; 19, *1*, *3*, *5*, *7*, *10*)

Retouch

Obsidian

Twenty-three simple side-scrapers are retouched on the right edge, 20 on the left edge, two on the transversal distal edge.

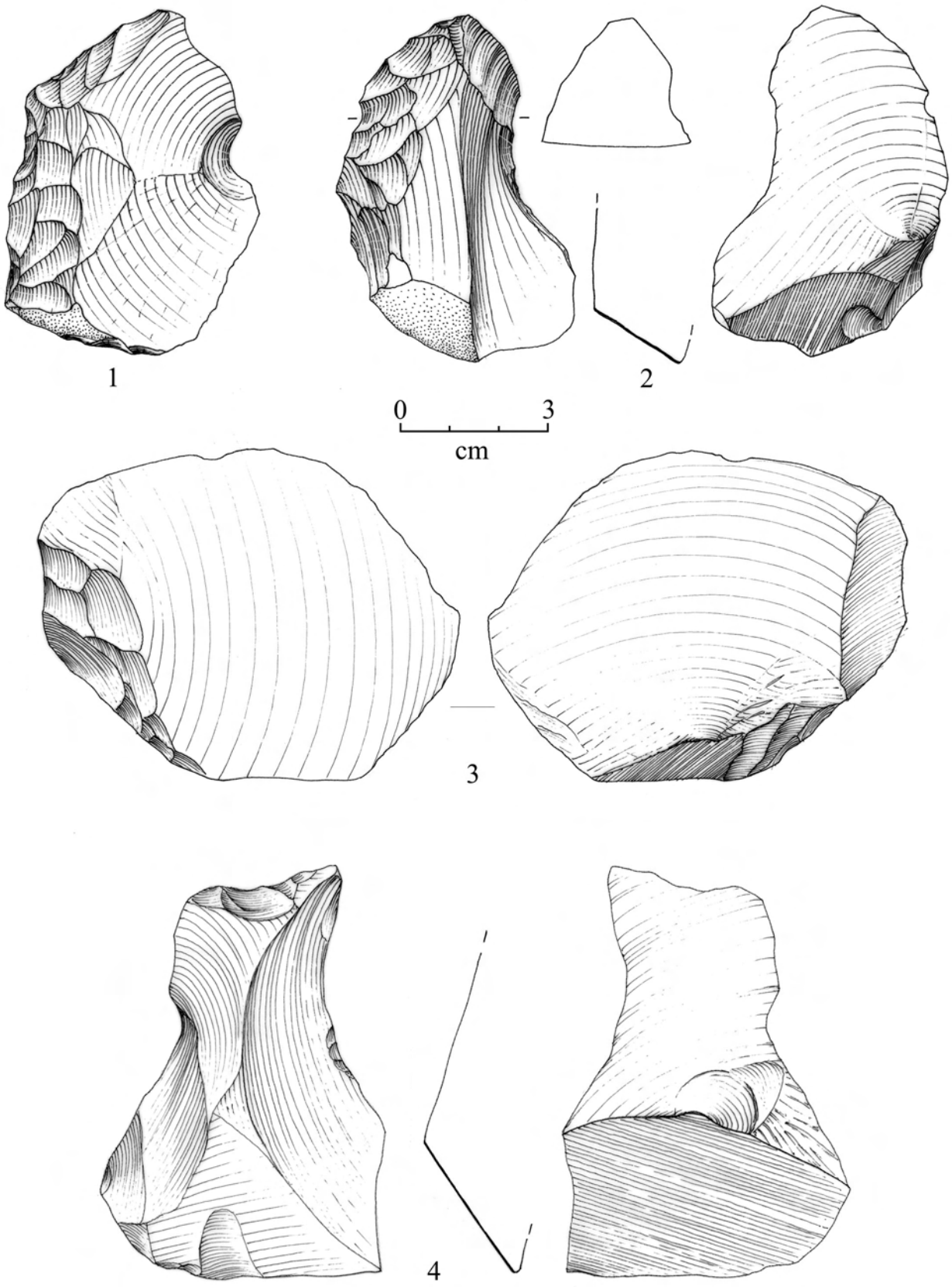


Fig 17. Garba IV D. 1, 2: side-scrapers (MK 6964, 9071); 3: inverse side-scraper (MK 5759); 4: truncated flake (MK 5632). Obsidian. *Drawings by M. Pennacchioni*

In 17 cases the retouch is simple marginal, in 15 cases simple invasive, in seven abrupt invasive, in one it is flat invasive, in three it is raised marginal scaled, in one raised marginal, in one raised invasive scaled, in two cases raised invasive. The position of the retouch is mainly direct. There is inverse retouch in only ten cases. The outline of the retouch is mainly rectilinear (13), followed by convex (15), concave (12), and sinuous (1).

Other volcanic rocks

Seven simple side-scrapers are retouched on the right edge, nine on the left edge. In seven cases the retouch is simple marginal, in five simple invasive, in three abrupt invasive. Six simple side-scrapers present direct retouch, three inverse, one alternating. Rectilinear retouch is dominant (6), followed by convex (4), sinuous (2), and concave (1).

Double side-scrapers (Figs. 18, *2*, *4*; 21, *3*)

Retouch

Obsidian

Both right and left edges have continuous retouch. Two simple side-scrapers are retouched on both edges with simple marginal retouch, three with simple invasive retouch, two with abrupt invasive retouch.

Two side-scrapers present inverse rectilinear retouch on the right edge; one of these presents direct concave retouch on the left edge, the other inverse convex retouch. One presents direct concave retouch on the right edge, and direct sinuous retouch on the left edge. Two have direct convex retouch on both edges. One presents inverse convex retouch on the two edges.

Other volcanic rocks

The only double side-scraper of basalt has retouch localized on the proximal and medial portions both on the right and left edges. The retouch is simple marginal. The outline is sinuous direct.

Convergent side-scrapers (Fig. 19, *9*)

Retouch

In the six convergent side-scrapers analyzed, both right and left edges present continuous retouch in three cases, discontinuous in two cases, distal in one.

The retouch is simple marginal in one case, simple invasive in three cases, abrupt invasive in two.

Two convergent side-scrapers present direct rectilinear retouch on the right edge and direct convex on the left edge; one presents alternate rectilinear retouch on both edges; one direct rectilinear retouch on both edges; one direct convex retouch on the left edge and alternate convex on the right edge; one has direct concave retouch on the right edge and alternating convex on the left edge.

Déjeté side-scrapers (Figs. 19, *13*; 26, *2*)

Retouch

Six are oriented to the right and six to the left, one is double. Simple marginal retouch is present in three cases, in six cases simple invasive, in two cases abrupt invasive retouch, in three cases raised marginal scaled, in two cases raised invasive lamellar retouch.

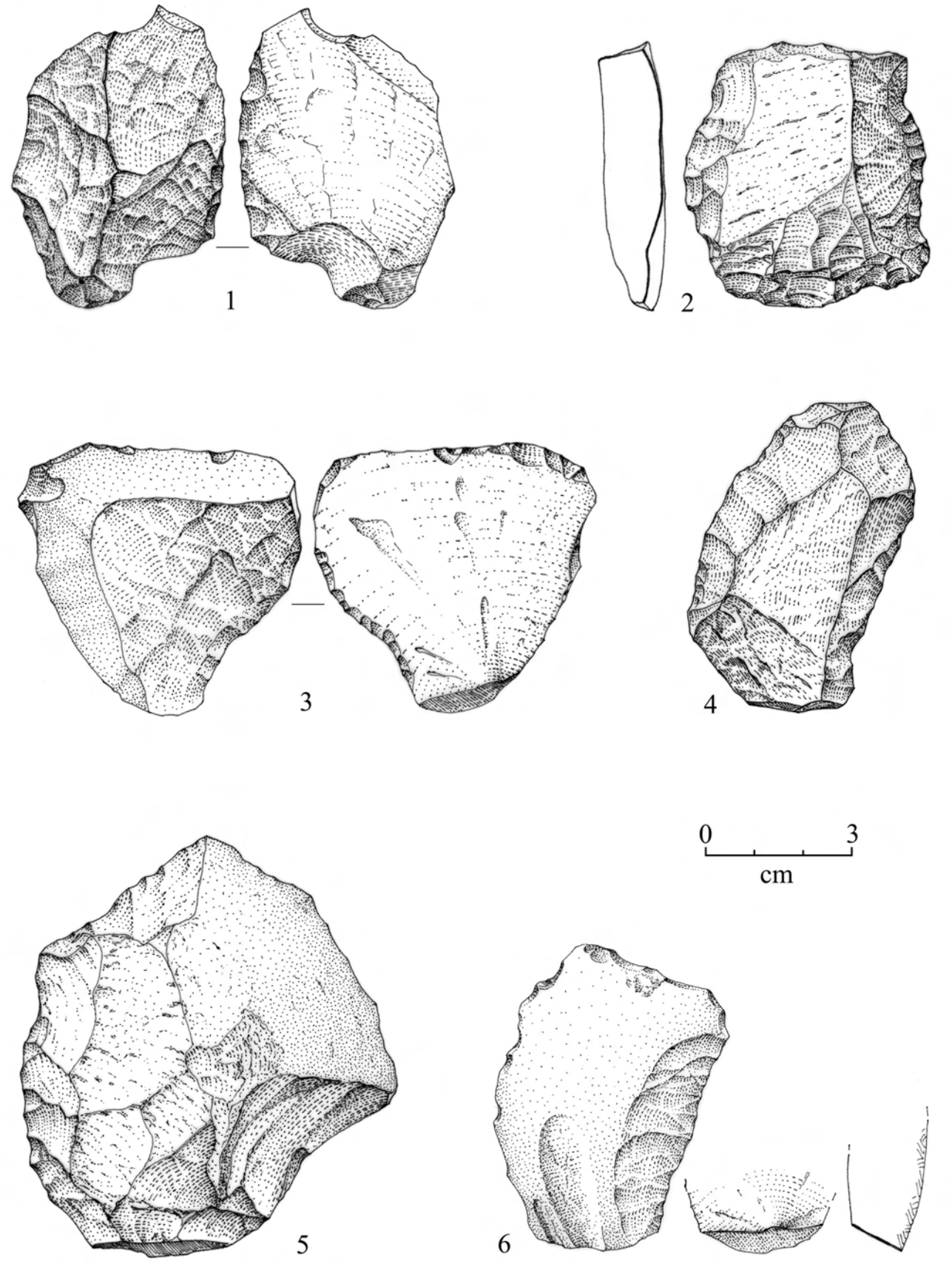


Fig. 18. Garba IV D. 1, 5: simple convex side-scrapers (MK 3267, 9831); 2: biconvex side-scraper (MK 9860); 3: simple concave side-scraper (MK 5167); 4: convex-concave side-scraper (MK 9876); 6: simple straight side-scraper (MK 7962). Basalt. *Drawings by M. Pennacchioni*

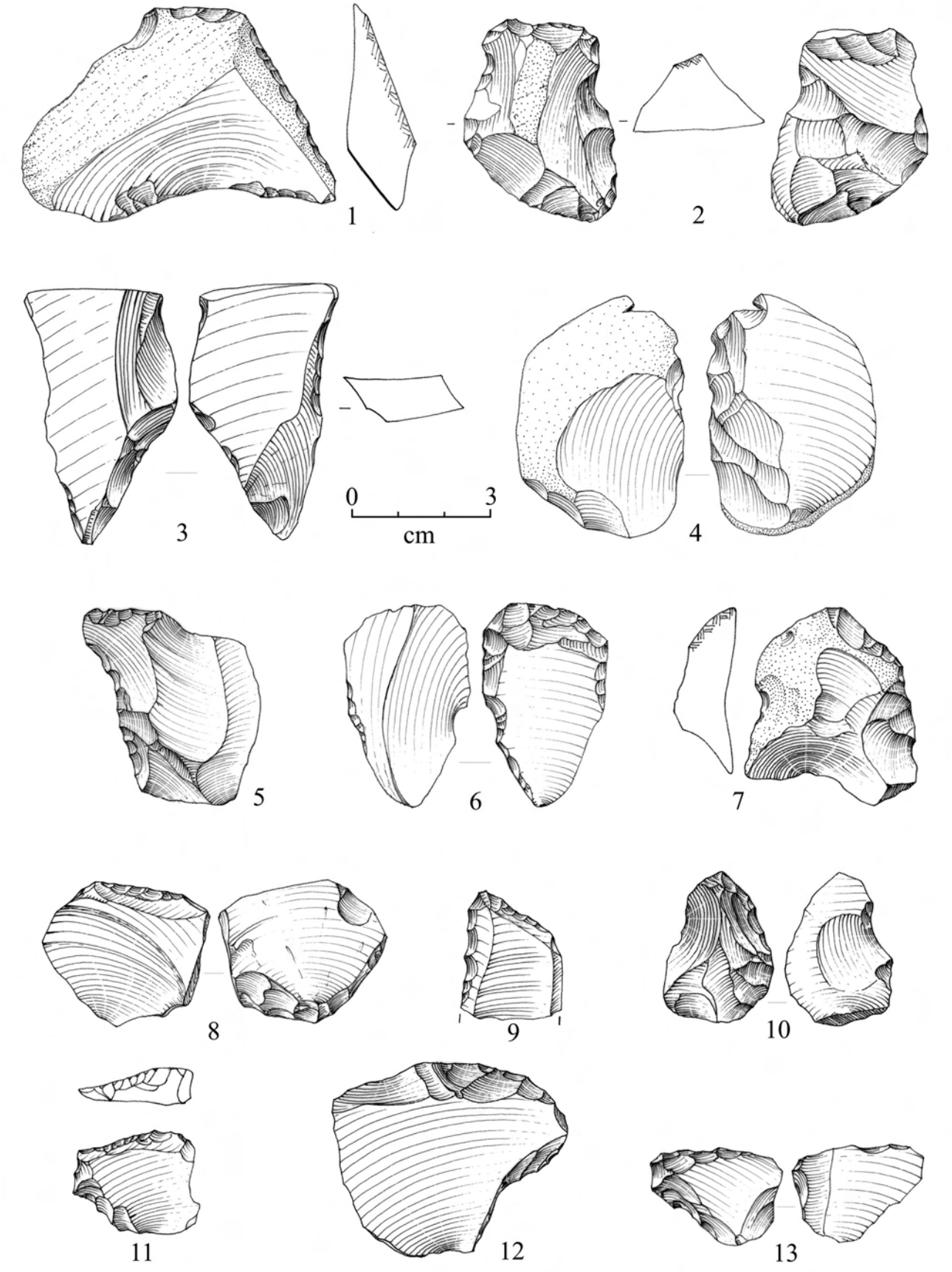


Fig. 19. Garba IV D. 1: simple straight side-scraper (MK 5619); 2, 6, 8, 11, 12: transversal side-scrapers (MK 6973, 2805, 911, 6311, 6853); 3: side-scraper with alternate retouch (MK 6691); 4: inverse side-scraper (MK 6483); 5: simple concave side-scraper (MK 5613); 7, 10: simple convex side-scrapers (MK 8995, 9105); 9: convergent side-scraper (MK 964); 13: déjeté side-scraper (MK 566). Obsidian. *Drawings by M. Pennacchioni*

In seven cases the retouch is direct rectilinear, in three cases direct sinuous, in one case alternate rectilinear, in one case inverse concave.

Transversal side-scrapers (Figs. 19, *2*, *6*, *8*, *11*, *12*; 20, *1*, *3*, *4*; 21, *1*, *2*; 22; 23; 26, *1*)

Retouch

Obsidian

Of the 35 transversal side-scrapers analyzed, retouch is present in 32 cases on the transversal distal edge, in three cases on the proximal one.

Among the distal transversal side-scrapers, eight have simple marginal retouch, ten simple invasive retouch, one abrupt marginal retouch, four abrupt invasive, one raised marginal scaled retouch, two raised marginal lamellar retouch, two raised invasive scaled retouch, and three raised invasive retouch.

In eight cases the retouch is direct rectilinear, in two cases it is direct concave, in 15 cases it is direct convex, in two cases it is direct sinuous, in two cases it is inverse concave, in one inverse convex.

Among the proximal transversal side-scrapers, one has simple marginal retouch, two simple invasive retouch. In two cases the retouch is inverse concave, in one inverse convex.

Other volcanic rocks

Retouch is localized on the distal transversal edge. In seven cases it is continuous, in one case it is localized in the central portion, in one case it is both on the central and left part of the edge. In five cases the retouch is simple marginal, in three simple invasive, in one abrupt invasive.

The outline of the retouch is in three cases concave direct, in two cases convex direct, in one case sinuous direct, in one case rectilinear inverse, in one concave inverse, in one convex inverse.

Lateral-transversal side-scrapers (Fig. 20, *2*, *5*, *6*)

Retouch

In the three lateral-transversal side-scrapers of basalt, the retouch is localized on the lateral edges as well as on the transversal distal one. The retouch is always simple marginal.

In two cases it is alternate convex on the right edge and direct convex on the left and transversal edges, in the other case it is inverse concave on the right edge and alternate sinuous on the two other edges.

Side-scrapers on ventral face (Figs. 17, *3*; 19, *4*)

Retouch

In four cases the retouch is localized on the right edge, in one case on the left edge, in one other case on the transversal distal edge. The retouch is simple marginal in two cases, simple invasive in three and abrupt invasive in one.

The outline of the retouch is rectilinear in three cases, convex in one, concave in one, sinuous in one.

Typometry

Of the 139 side-scrapers analyzed, 127 have been measured 126 have been weighted. The length of the platform has been measured on 44 side-scrapers, the thickness of the platform on 51, and the angle on 53.

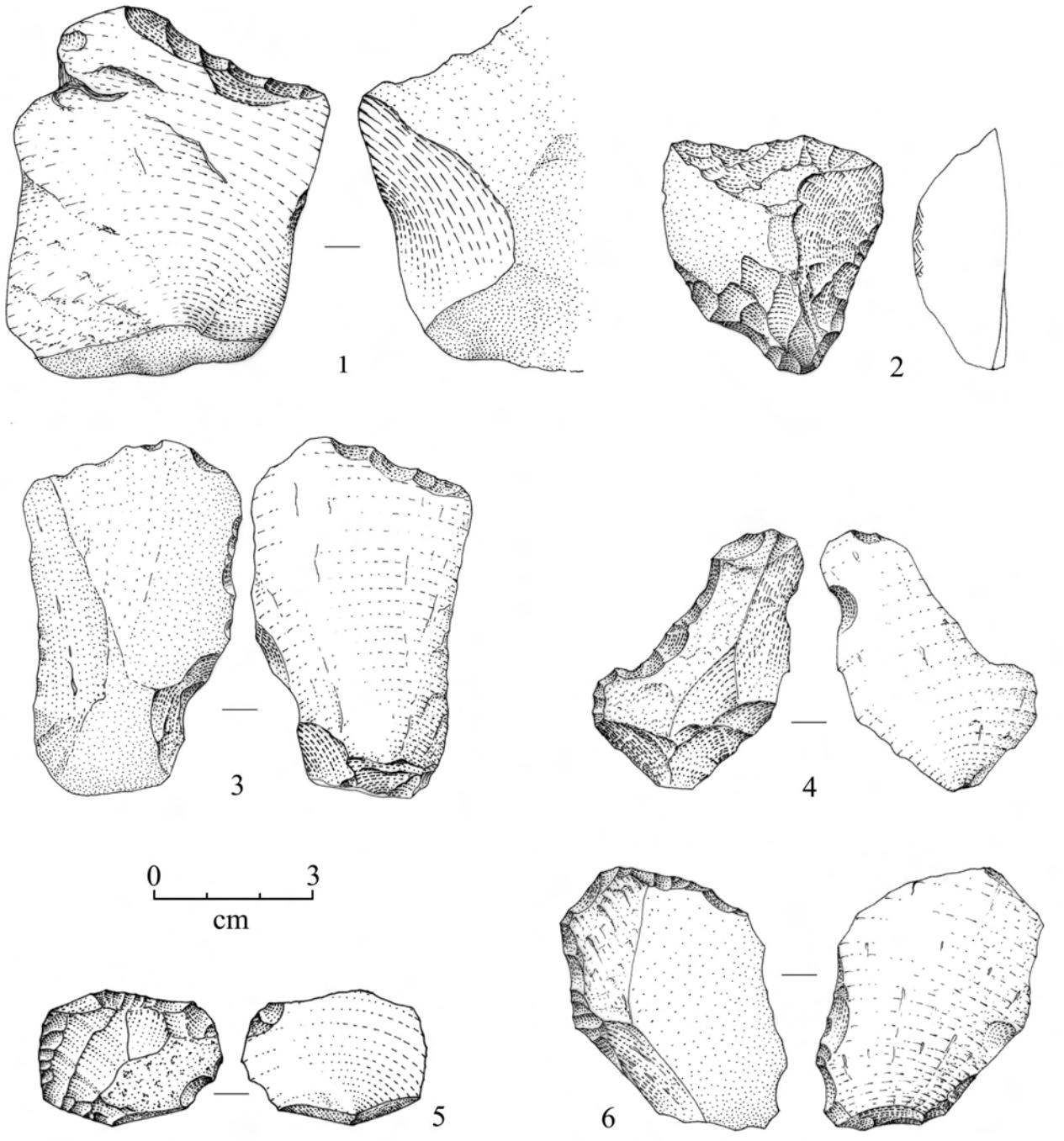


Fig. 20. Garba IV D. 1, 3, 4: transversal side-scrapers (MK 9944, 476, 7939); 2, 5, 6: lateral-transversal side-scrapers (MK 5968, 7741, 9224). Basalt. *Drawings by M. Pennacchioni*

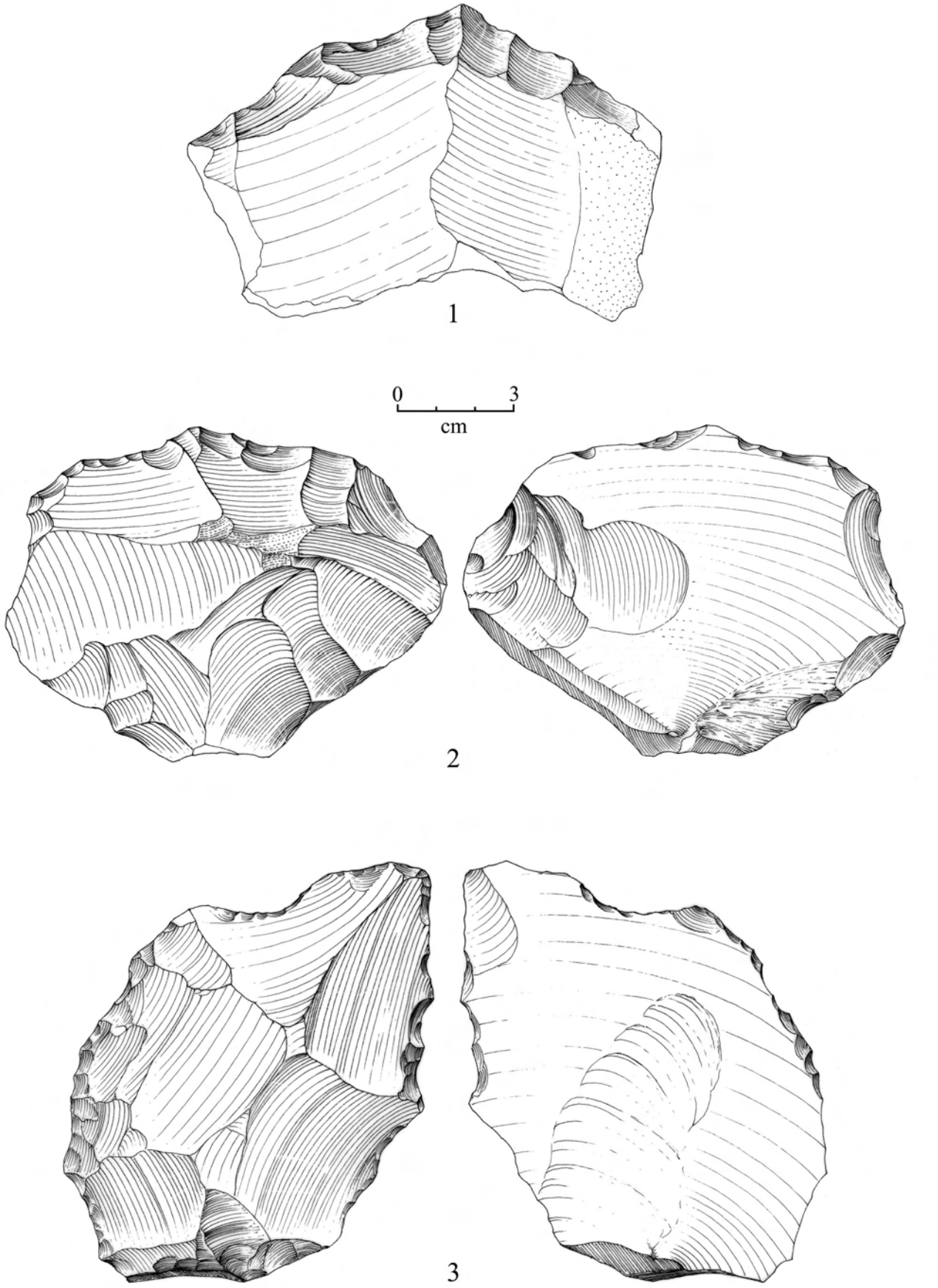


Fig. 21. Garba IV D. 1, 2: transversal side-scrapers (MK 4864, 9750); 3: double side-scraper (MK 8422). Obsidian.
Drawings by M. Pennacchioni

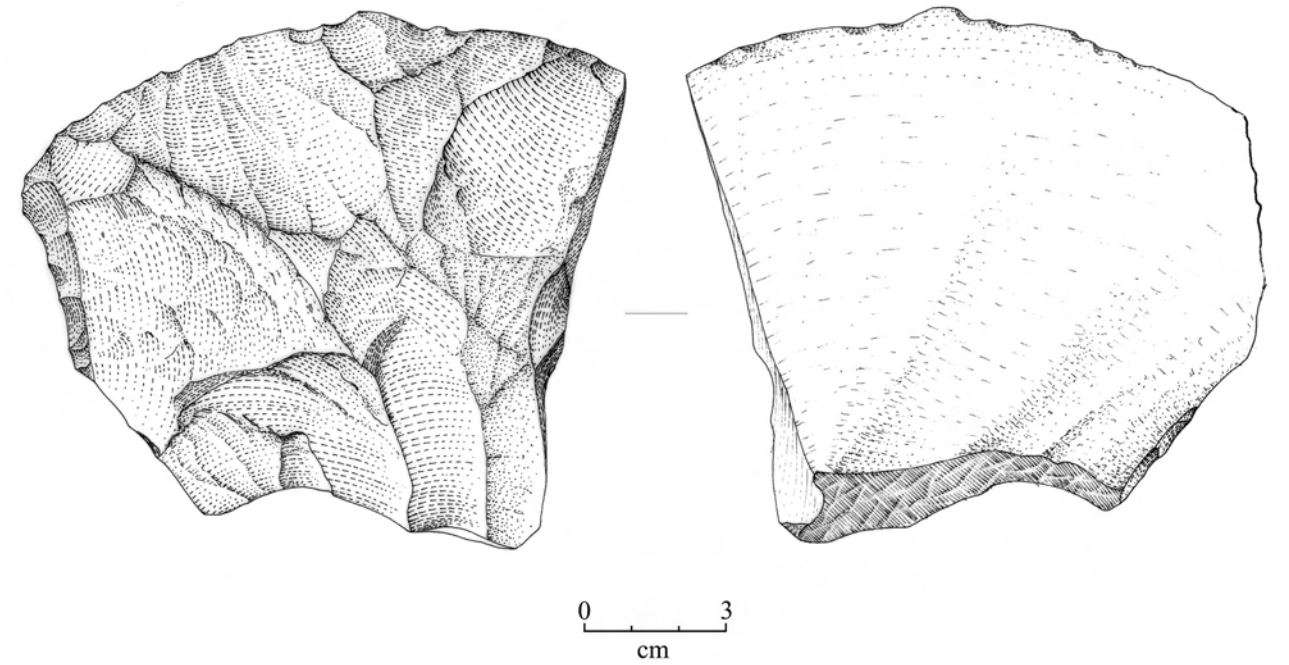


Fig. 22. Garba IV D. 1: transversal side-scraper (MK 8164). Basalt. *Drawings by M. Pennacchioni*

Length, width, thickness and weight

The obsidian side-scrapers are, on average, obtained from slightly smaller blanks compared to those made of other volcanic rocks. Of the obsidian side-scrapers, 86.28% are between 21 mm and 60 mm long with a mean of 43.57 mm; while 76% of those of other volcanic rocks are between 41 mm and 70 mm, with an average of 58.24 mm. The data correspond to the slight elongation observed for unmodified flakes made of other volcanic rocks.

The data on the width of side-scrapers are more uniform, with 79.41% of the pieces between 21 mm and 60 mm (mean 45.73 mm) compared to almost all the pieces made of other volcanic rocks with values between 31 mm and 70 mm (mean 48.76 mm). Also the data on thickness are quite uniform: 93.14% of the obsidian blanks and 96% of those of other volcanic rocks are between 2 mm and 30 mm.

Regardless of raw material, analysis of the weight of side-scrapers, with a mean of 49.32 g for obsidian and of 78.92 g for other volcanic rocks, shows a distribution in two distinct groups (Fig. 24): the first between 2 g and 60 g with more than 85.25% of the obsidian pieces and 70.83% of other volcanic rocks, and a second, more restricted group with artefacts between 91 g and 500 g (9.8% obsidian and 16.67% other volcanic rocks).

Striking platform length, thickness and angle with the ventral face

The typometrical data on the platforms of side-scrapers are not very different from those observed on unmodified flakes. For 67.74% of the obsidian pieces and for 84.62% of those of other volcanic rocks, the length of the platform is between 11 mm and 30 mm and between 2 mm and 30 mm respectively.

Of the platforms on obsidian blanks 97.37% are between 2 mm and 20 mm thick compared to 92.31% on other volcanic rocks, with a mean of 9.21 mm for the former and of 10.38 mm for the latter

The angle between the platform and ventral face for most of the obsidian pieces (74.42%) is between 101° and 130°, with a mean of 113.39°, while all the side-scrapers of other volcanic rocks have a slightly smaller angle, between 91° and 120°, with a mean of 106.8° (Fig. 25).

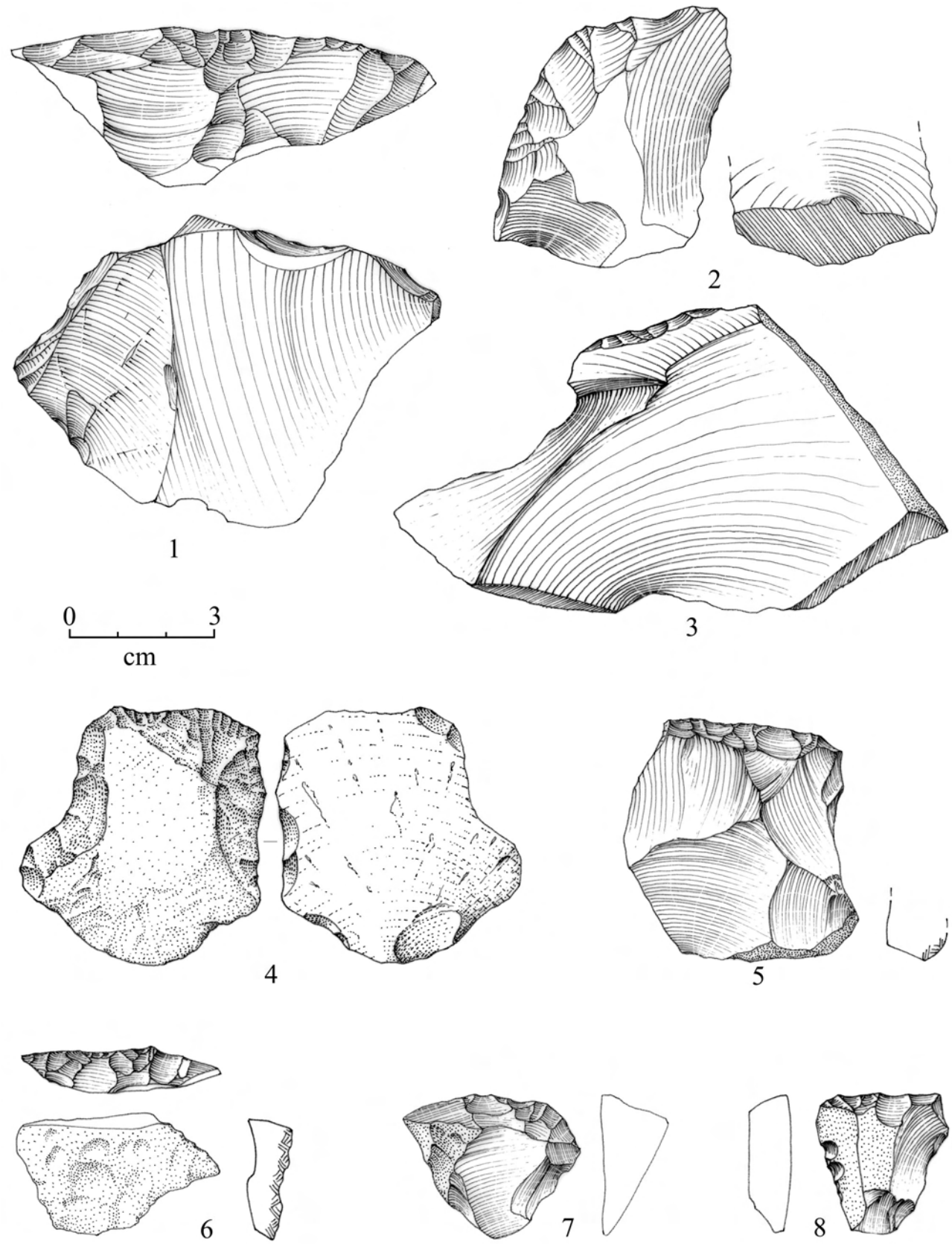


Fig. 23. Garba IV D. 1-8: transversal side-scrapers (MK 6684, 6630, 4428, 8482, 3573, 6583, 7087, 9195). 1-3, 5-8: obsidian; 4: basalt. *Drawings by M. Pennacchioni*

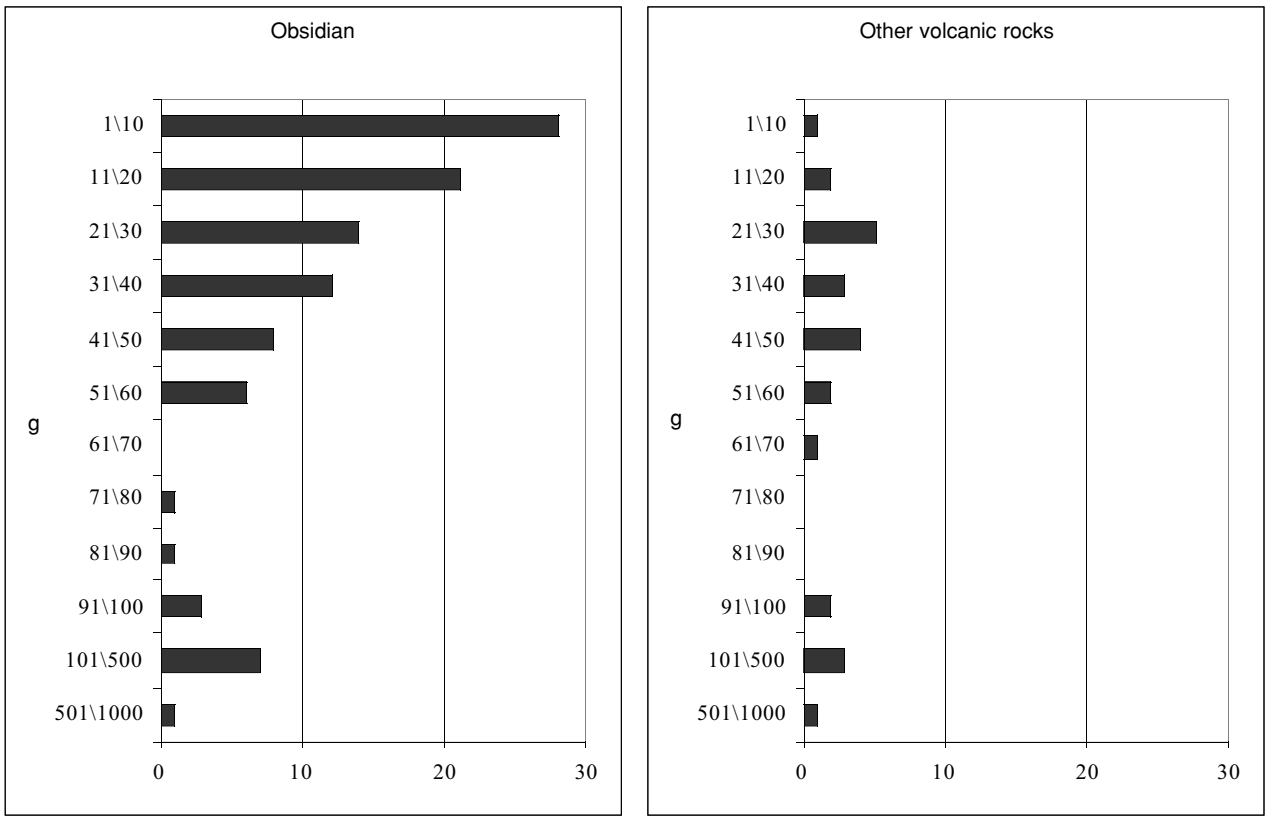


Fig. 24. Distribution of weight of side-scrapers.

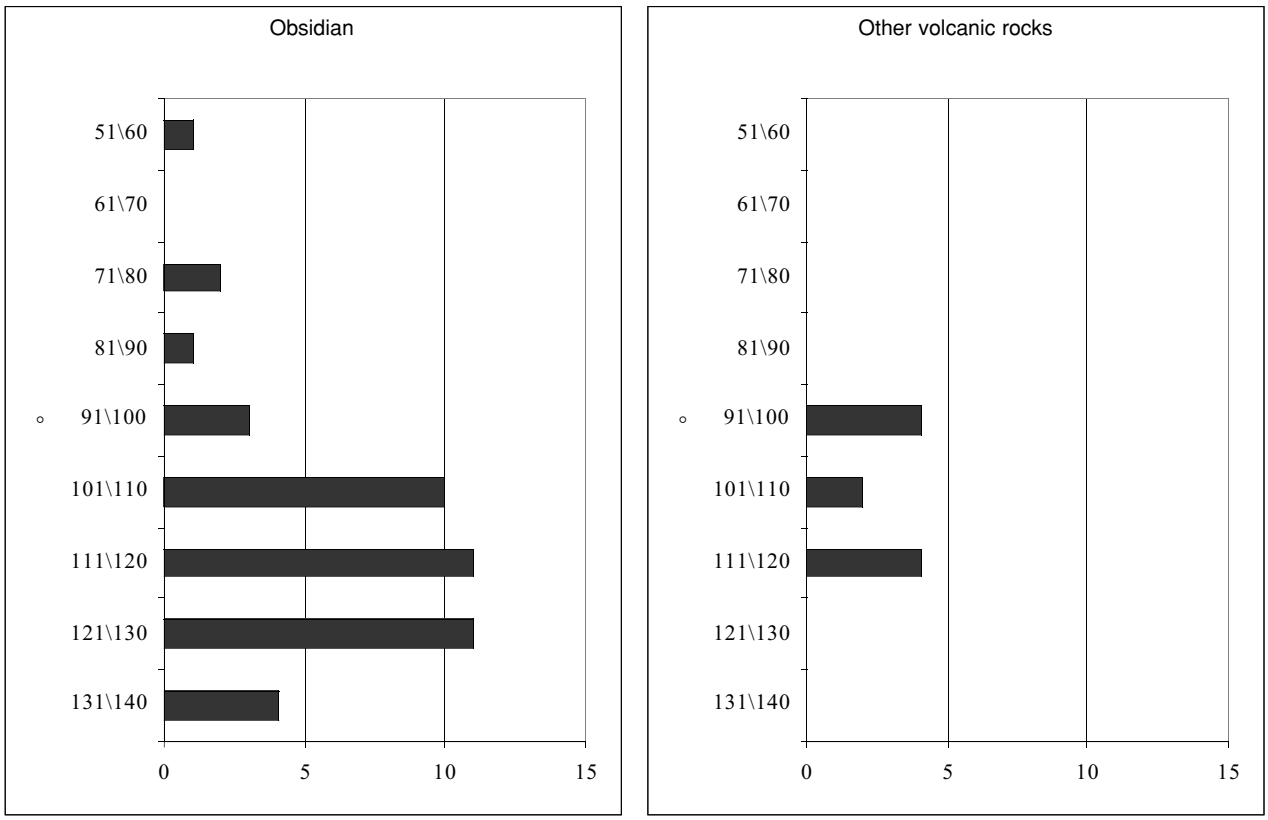


Fig. 25. Distribution of platform/ventral face angle of side-scrapers.

End-scrapers

End-scrapers are not very common (19) in Level D at Garba IV (Fig. 27, *1*, *2*). However, some of them may be defined as typical, with a front that is well defined by retouch. Sometimes they are composite tools. Of the thirteen end-scrapers studied in detail, eleven are of obsidian and two of basalt. Two end-scrapers among the obsidian ones are atypical, two atypical déjetés, two carinated, four frontal, and one lateral. A carinated end-scraper is associated with a clactonian notch, a frontal one with a denticulate, another frontal with a notch.

Both the basalt end-scrapers are frontal and complete. In one case the platform is plain on a negative scar, in the other case it is not recognizable. Both are on flakes with total cortex.

Striking platform

In seven cases the platform is not recognizable, in one case it is plain on a negative scar, in one plain on cortex, and in two cases it seems to have been removed.

Cortex

In eight cases the cortex is absent. In one case the cortex is partial proximal lateral right, in one case partial medial central, and in one other case completely covers the platform.

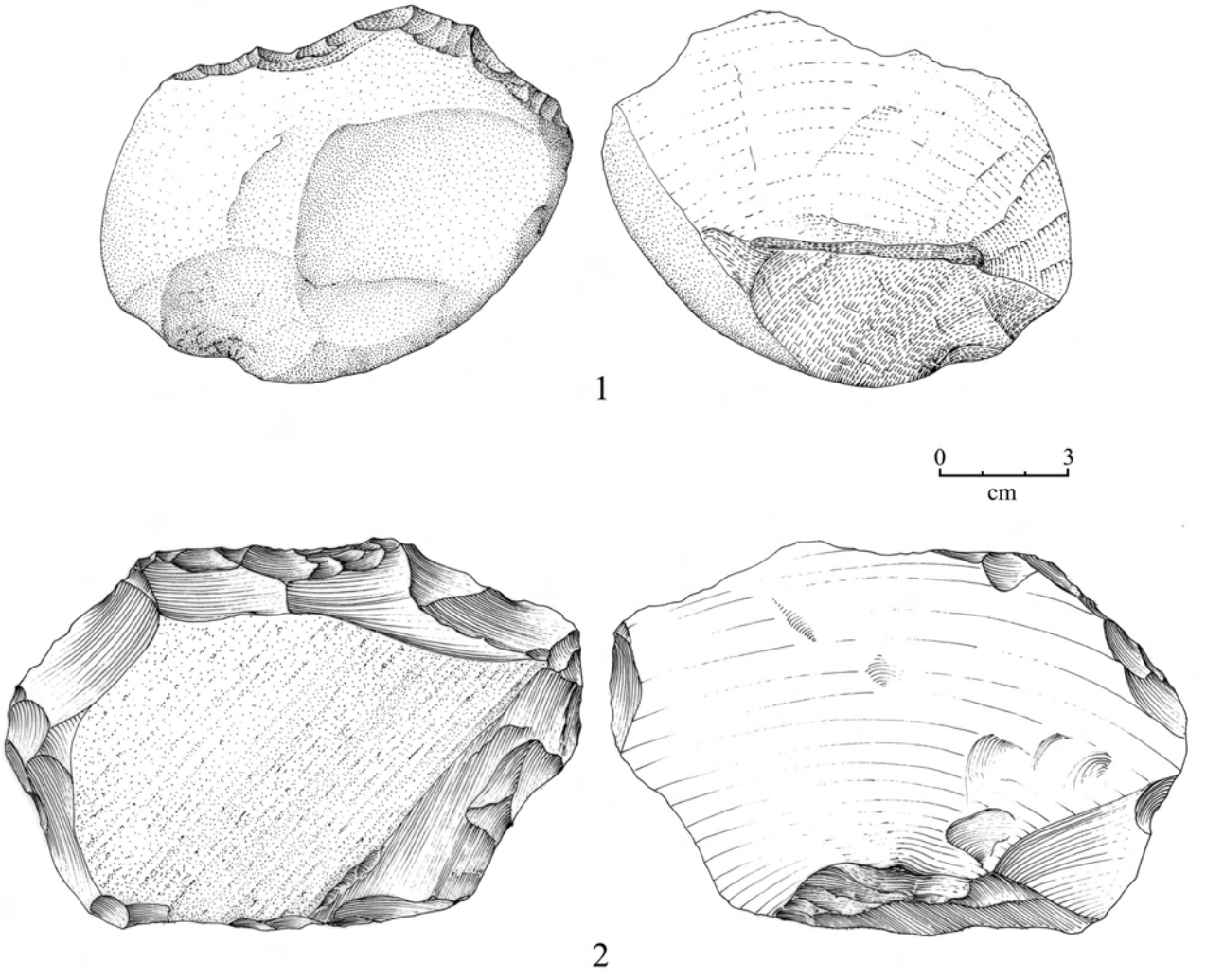


Fig. 26. Garba IV D. 1: transversal side-scraper (MK 8031); 2: déjeté side-scraper (MK 9101). 1: basalt; 2: obsidian. *Drawings by M. Pennacchioni*

Typometry

Obsidian: Minimum length is 27 mm, maximum 65 mm, with a mean of 48.63 mm. Minimum width is 22 mm, maximum 57 mm, with a mean of 36.82 mm. Thickness ranges from 11 mm to 26 mm, with a mean of 17.73 mm. Weight is between 8 g and 56 g, with a mean of 30 g.

Other volcanic rocks: Length is respectively 41 mm and 85 mm, width 28 mm and 75 mm, thickness 16 mm and 31 mm, weight 17 g and 200 g.

Burins

This is a very unusual tool in Level D (Fig. 27, *3*). Of the five burins recognized three have been studied. Two of them, of which one is typical, are of obsidian, the other which is atypical is of basalt; they are obtained from irregularly shaped blanks and the platform is unrecognizable.

The typical burin, on a negative scar, is a flake 58 mm long, 31 mm wide, with a thickness of 18 mm. The atypical burin is 47 mm long, 30 mm wide and 20 mm thick. The only basalt burin is an angle-burin on simple marginal retouch, localized on the proximal portion of the right edge, the blank has a plain platform on a negative scar (length: 47 mm; width: 34 mm; thickness: 14 mm).

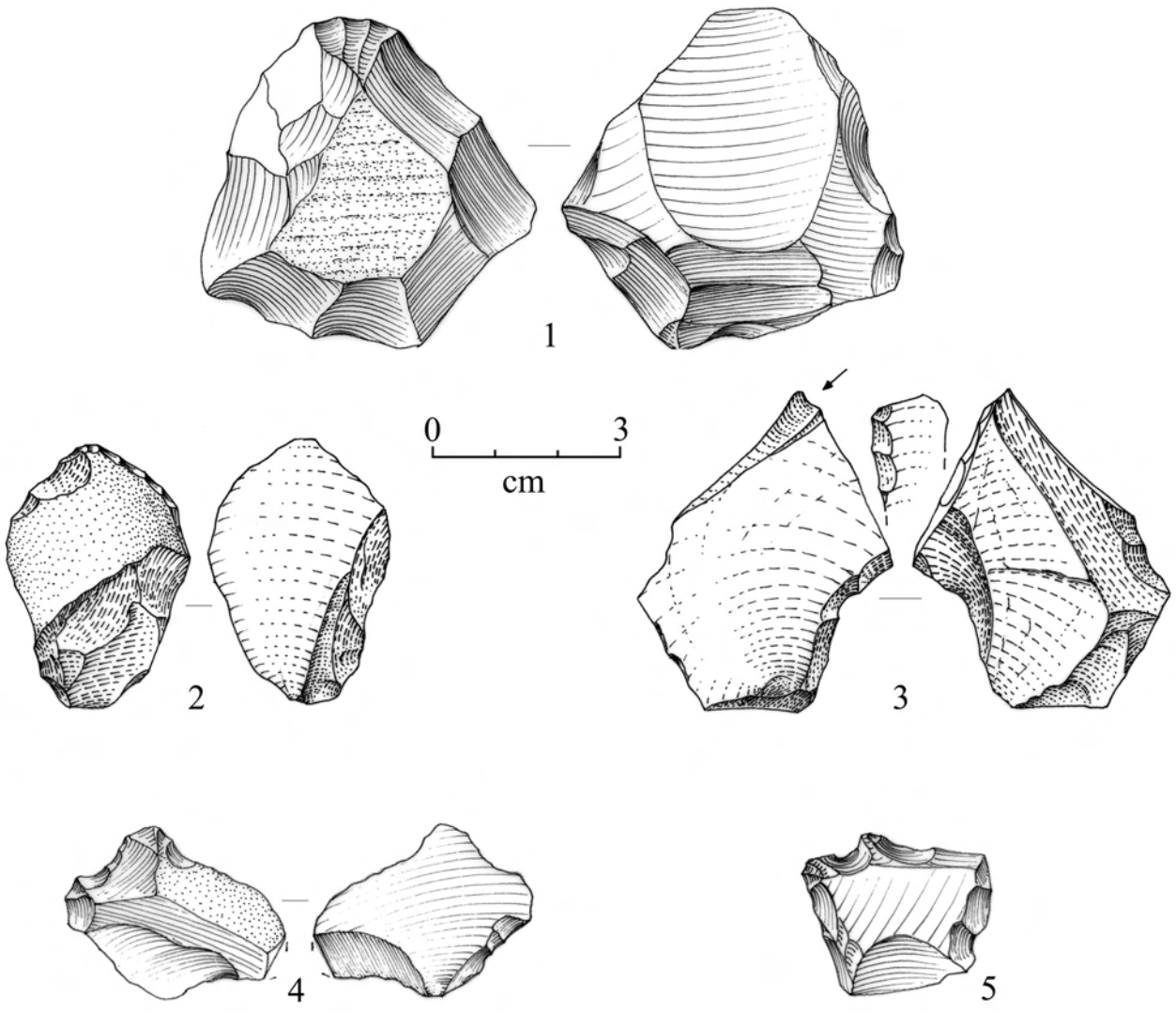


Fig. 27. Garba IV D. 1: atypical end-scraper (MK 7034); 2: frontal end-scraper (MK 314); 3: burin (MK 8897); 4,5: borers [MK 679 (Level C), 8797]. 1, 4, 5: obsidian; 2, 3: basalt. *Drawings by M. Pennacchioni*

Borers

This type is also rare in Level D (Fig. 27, *4*, *5*). The borers analyzed are all on obsidian flakes, except one. Three are atypical, one is déjeté and one is distal. One is associated with a side-scraper. In three cases the platform is plain on a negative scar, in one case it was removed, in two cases it is not recognizable. The minimum length is 25 mm, the maximum 67 mm. The minimum width is 23 mm, the maximum 51 mm. The minimum thickness is 8 mm, the maximum 24 mm. The weight ranges from 4 g to 51 g.

Notches

Of the 104 notches identified, 82 (78.85%) have been studied: 41 are clactonian and 41 retouched.

The similarity between typological and typometrical data on notches and unmodified flakes seems to suggest, as in the case of the side-scrapers, a casual choice of flakes that have been modified later with retouch or by prolonged use.

Raw material

Most of the notches (77.88%) are on obsidian blanks, the remaining 22.11% are on other volcanic rocks.

Clactonian notches

Raw material

Of the 41 clactonian notches analyzed, 33 are of obsidian, 8 of basalt (Figs. 28, *2-4*; 29, *1*, *2*).

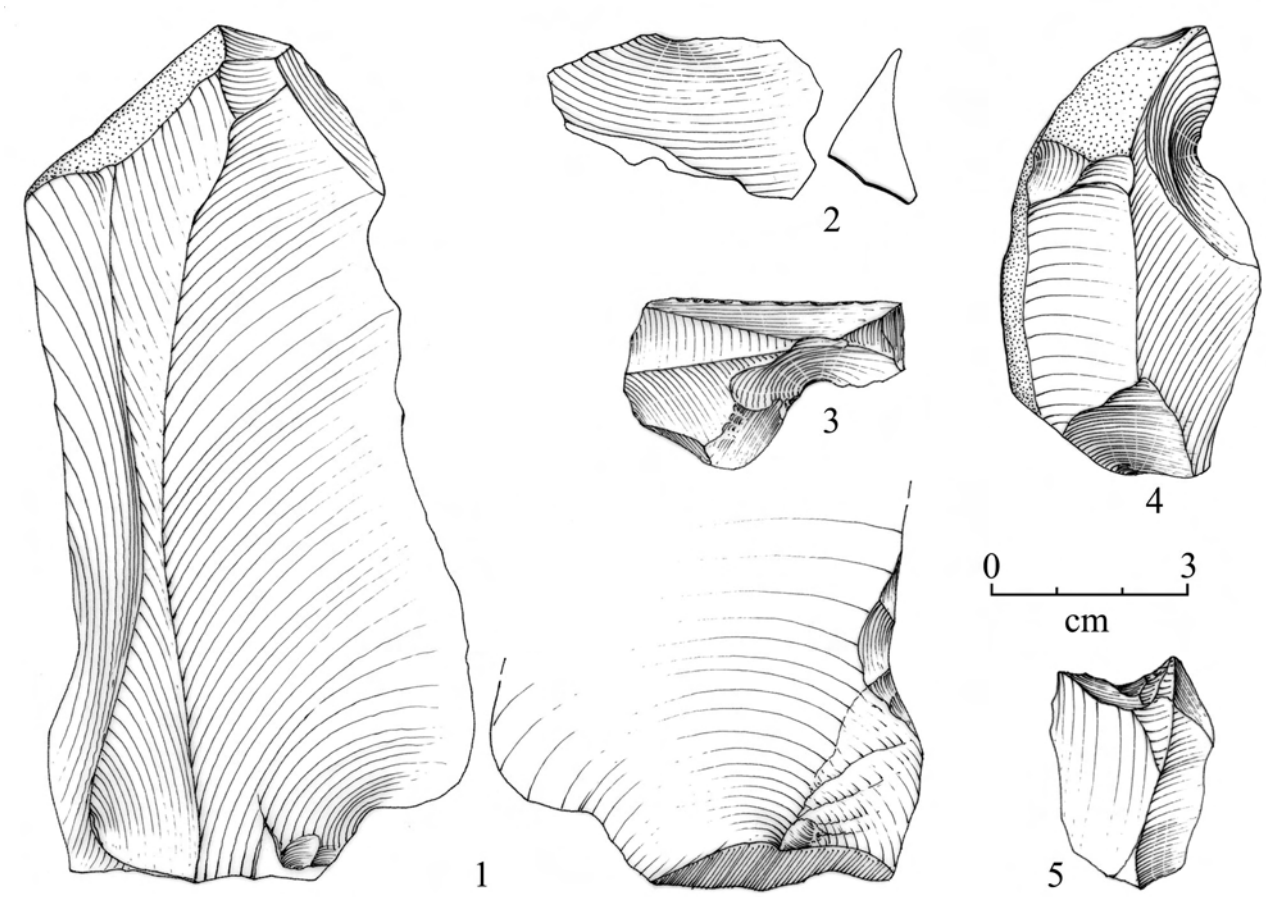


Fig. 28. Garba IV D. 1, 5: retouched notches (MK 9221, 6149); 2-4: clactonian notches (MK 6755, 3426, 40591). Obsidian. *Drawings by M. Pennacchioni*

Preservation

The basalt clactonian notches are all complete. Among the obsidian ones, 30 are complete and eight are fragmentary.

Striking platform

Among the obsidian notches the plain platforms on negative scars are most common (36.36%) followed by those on an edge (18.18%); among those made of other volcanic rocks 62.50% have plain platforms on a negative scar that, with the exception of a flake with a plain platform on cortex, is the only type of recognizable platform.

Removals

Of the obsidian notches, 69.69% are obtained from blanks with two, three or four removals on the dorsal face; among the flakes of other volcanic rocks two are entirely covered with cortex and four present from two to three dorsal removals.

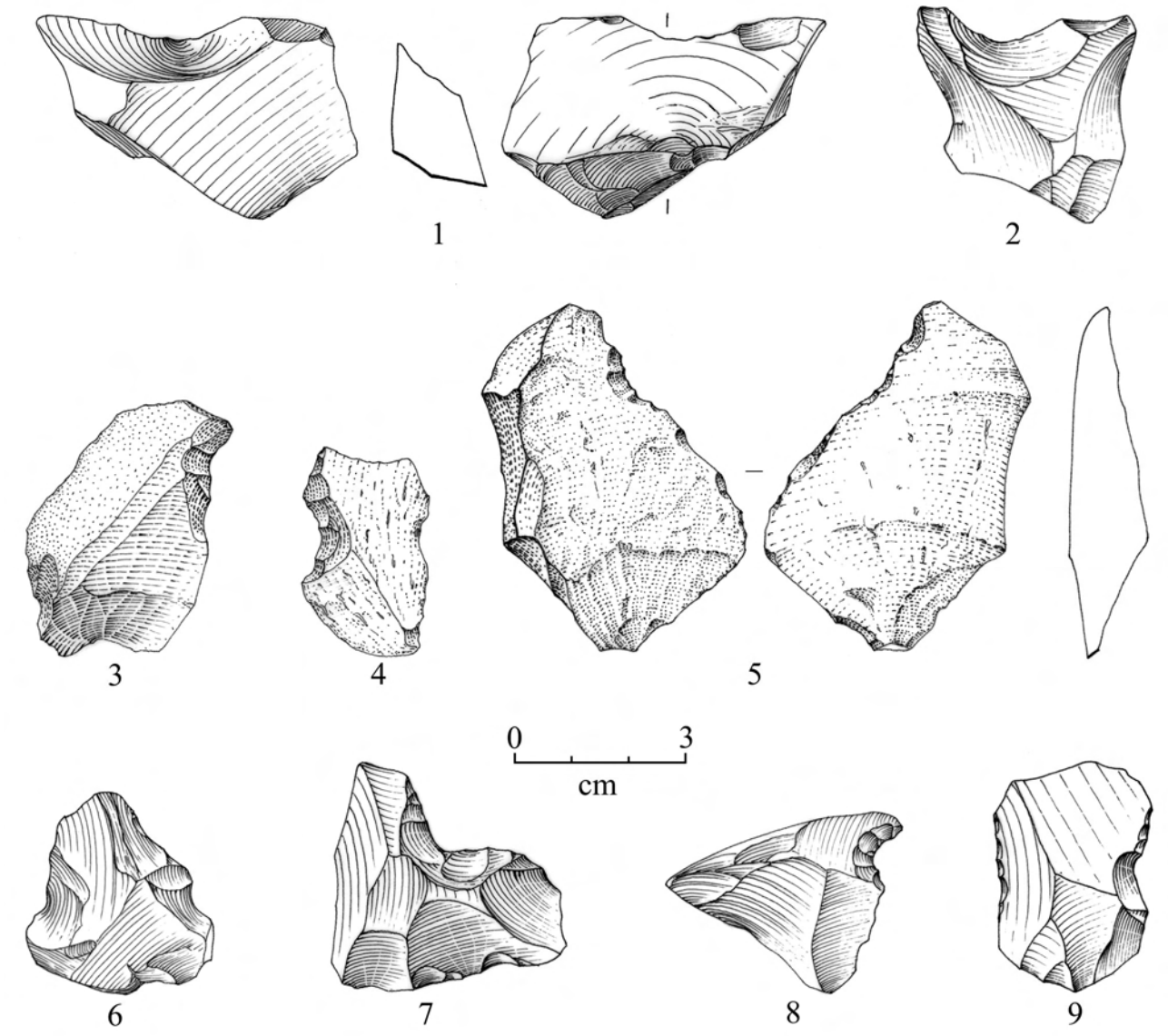


Fig. 29. Garba IV D. 1, 2: clactonian notches (MK 7703, 8716); 3-5, 7-9: retouched notches (MK 8199, 5065, 40553, 9439, 7510, 9515); 6: denticulate (MK 8495); 1-4, 7-9: obsidian; 5: basalt. *Drawings by M. Pennacchioni*

Cortex

Cortex is absent on 73.17% of the clactonian notches, regardless of raw material employed. It is partially preserved on four obsidian notches and one basalt notch; on four other obsidian notches and one of basalt it is preserved on the edge of the blank, while it completely covers the platform of one obsidian flake. One basalt flake is completely covered with cortex.

Localization of the notch

Obsidian

Seventeen are located on the right edge, seven on the left edge, eight on the transversal distal edge, one on the transversal proximal edge.

Other volcanic rocks

Four are located on the right edge, four on the left one.

Retouched notches

Raw material

Of the 41 retouched notches analyzed, 31 are of obsidian, ten of basalt (Figs. 28, *1*, *5*; 29, *3-5*, *7-9*).

Preservation

Among the obsidian ones, 25 are complete, six are fragmentary. Among those of basalt, eight are complete and two are fragmentary.

Striking platform

Regardless of the raw material, plain platforms on a negative scar (53.66%) are prevalent followed by platforms on cortex (7.32%), one dihedral platform and two platforms on edge.

Removals

Only one obsidian flake, compared to six made of other volcanic rocks, is completely covered with cortex. Most of the blanks (51.22%), regardless of the raw material, have from three to four removals on the dorsal face (Tab. 32).

Removals	**Obsidian**		**Other volcanic rocks**		**Total**	
	N	%	N	%	N	%
0	1	3.23	6	60.00	7	17.07
1	4	12.90			4	9.76
2	2	6.45	1	10.00	3	7.32
3	14	45.16	1	10.00	15	36.59
4	5	16.13	1	10.00	6	14.63
5	2	6.45			2	4.88
6	1	3.23			1	2.44
<6	1	3.23			1	2.44
Indeterminable	1	3.23	1	10.00	2	4.88
Total	**31**		**10**		**41**	

Tab. 32. Number of removals of notches.

Cortex

There are 75.61% of flakes without cortex. Only six basalt flakes are completely covered with cortex; three obsidian flakes have partial cortex; and on two obsidian flakes the cortex is preserved on the edge.

Retouch

Obsidian

The notches are located on the right edge (12), on the left edge (10), on the transversal distal one (7), and on the transversal proximal edge (2). The retouch is in most cases abrupt invasive, followed by the simple invasive and by simple marginal. Direct retouch is most common (23), followed by inverse (8).

Other volcanic rocks

The notches are located on the right edge (4), on the left edge (3) and on the transversal distal one (3).

The retouch is usually abrupt invasive, followed by simple marginal and simple invasive.

Direct retouch is most common (7), followed by inverse (2). Only in one case it is alternate.

Typometry of clactonian notches

The typometrical data derive from the pieces analyzed in detail. The three dimensions have been measured on 39 of the 41 clactonian notches.

Forty have been weighed. The length of the platform on 14, the thickness of the platform on 13, and the angle of the platform on 14 clactonian notches have been measured.

Length, width, thickness and weight

Of the obsidian blanks, 77.41% are between 31 mm and 60 mm long and 75% of those of other volcanic rocks are in the same class, with a mean of 45.42 mm and 50.5 mm respectively.

As far as the width is concerned, 93.55% of the obsidian blanks are between 21 and 60 mm with a mean of 40.93 mm; for the blanks made of other volcanic rocks, 87.5% are between 21 mm and 50 mm, with a mean of 40.12 mm. Thickness ranges for most of the pieces (70.97% obsidian and 75% other volcanic rocks), between 11 mm and 20 mm with a mean of 15.06 mm and 16.75 mm respectively.

The weight of most of the clactonian notches (72.72%) is between 2 g and 30 g with a mean of 28.06 g; 57.14% of the notches of other volcanic rocks weigh between 11 g and 30 g with a mean of 14.28 g.

Striking platform length, thickness and angle with the ventral face

Regardless of the raw material, the length of the platform on 85.71% of the pieces is between 11 mm and 40 mm, with a mean of 26.71 mm. The thickness of the platform on 46.15% is between 2 mm and 10 mm, while for 53.85% of the pieces it is between 11 mm and 20 mm.

Of the obsidian clactonian notches, 72.72% have a platform/ventral face angle between 101° and 130° (mean 124.2°); in all the notches of other volcanic rocks the same angle is between 101° and 120° (mean: 103.5°).

Typometry of retouched notches

The three dimensions have been measured on 37 retouched notches out of 41 studied in detail.

Forty retouched notches have been weighed. The length of the platform onf 13 retouched notches has been measured, the thickness of the platform on 12 notches, and the angle of the platform on 15.

Length, width, thickness and weight

Of the obsidian blanks, 66.66% are between 21 mm and 50 mm long with a mean of 49.11 mm. The flakes of other volcanic rocks are usually longer: 90% of them are between 31 mm and 70 mm, with a mean of 56.7 mm. The distribution of width for the obsidian blanks shows a slight tendency for greater variability, with values between 21 mm and 70 mm, compared to the length of the blanks of other volcanic rocks, 80% of which are between 21 mm and 50 mm.

85.18% of the obsidian pieces and 80% of other volcanic rocks, are between 2 mm and 20 mm thick with a mean of 15.74 mm and 19.1 mm respectively.

As far as weight is concerned, obsidian flakes between a few grams and 30 g are more common (66.66%) than among flakes of other volcanic rocks, but there are also some pieces that weigh between 51 g and 300 g. The average is 34.06 g for obsidian flakes and 85.75 for other volcanic rocks.

Striking platform length, thickness and angle with the ventral face

Regardless of the raw material, the length of the platform for retouched notches ranges from 11 mm to 60 mm with a mean of 32.77 mm for obsidian flakes and 23.5 mm for other volcanic rocks. More than 75% of the platforms of the obsidian flakes are between 2 mm and 10 mm thick; the platforms on two of the four retouched notches of other volcanic rocks are between 2 mm and 10 mm; in the other two the thickness is between 11 mm and 20 mm. Most of the platform/ventral face angles (84.61%) of obsidian notches are between 111° and 130° with a mean of 121.08°; in the two measurable cases of notches of other volcanic rocks, the angle is between 111° and 120° with a mean of 113.5°.

Denticulates

Of the 200 denticulates identified in Level D, 157 (78.5%) have been studied (Figs. 30-33). Specimens from the general catalogue have also been considered with regard to the utilization of raw materials.

Raw material

Most of the denticulates (80%) have been obtained from obsidian flakes, while basalt has been employed in 16.56% of the cases and the other volcanic rocks only occasionally. The high frequency of obsidian blanks may be related to a precise functional choice or may depend on the necessity to retouch margins that are less resistant than basalt.

Preservation

Regardless of the raw material employed, whole flakes represent 90.38% of the denticulate blanks.

Striking platform

The percentages of the platform types are not very different from what has been observed in general for the unmodified flakes both for the obsidian denticulates and for those obtained from other volcanic rocks. Just a little bit more than 50% of the cases are plain platforms (on negative scar: 50.64%, on cortex: 8.33%). The other kinds of platform occur in very low percentages.

Removals

Of the obsidian denticulates, 77.52% are obtained from blanks with two to four removals on the dorsal face. For the denticulates of other volcanic rocks it is possible to find a higher frequency of blanks completely covered with cortex (22.22%) or with a single removal (Tab. 33).

Removals	Obsidian		Other volcanic rocks		Total	
	N	%	N	%	N	%
0	1	0.78	6	22.22	7	4.49
1	11	8.53	5	18.52	16	10.26
2	27	20.93	4	14.81	31	19.87
3	30	23.26	4	14.81	34	21.79
4	24	18.60	2	7.41	26	16.67
5	19	14.73	2	7.41	21	13.46
6	1	0.78			1	0.64
7	2	1.55			2	1.28
>7	5	3.88	1	3.70	6	3.85
Indeterminable	9	6.98	3	11.11	12	7.69
Total	**129**		**27**		**156**	

Tab. 33. Number of removals of denticulates.

Cortex

Cortex is absent on 75.19% of the obsidian denticulates and on 48.15% of those of other volcanic rocks. No obsidian denticulate is on a flake completely covered with cortex compared to 18.52% of those of other volcanic rocks. Cortex is partially preserved on the dorsal face on 13.23% of the obsidian denticulates and on 14.81% of those of other volcanic rocks, and, in statistically non-significant cases, on the edge or on the platform.

Composite character

Four obsidian denticulates and one of basalt are associated with a clactonian notch, three obsidian denticulates with a retouched notch and another obsidian one with a borer.

Retouch

Obsidian

Of the 129 denticulates, 53 have retouch on the right edge. The retouch is continuous in three cases, discontinuous in 18, on the proximal portion in two cases, in four on the medial portion, in one on the distal portion, and in one on both the proximal and medial portions. In most cases the retouch is simple invasive (20), followed by simple marginal (16) and by abrupt (10). In 46 cases the retouch is direct (15 edges have a rectilinear outline, 15 concave, four convex, seven sinuous), in eight cases it is inverse, mainly with a rectilinear outline (5), then convex (2) or sinuous (1), in two cases it is alternate and in one case alternating.

Fifty-four denticulates are retouched on the left lateral edge. In three cases the retouch covers the whole edge, in two cases it is localized on the proximal part, in three on the medial part, in three others on the distal part, in one case it is on the proximal medial portion, in one other case on the distal medial portion. The retouch is simple marginal in 19 cases, simple invasive in another 19, abrupt marginal in one, abrupt invasive in eight, raised marginal lamellar in one. In 46 cases the retouch is direct with rectilinear (15), concave (15) convex (7) or sinuous (9) outline; in four cases it is inverse with rectilinear (2) or concave (2) outline; in two cases it is alternate with rectilinear or sinuous outline; in two cases it alternates with a convex or sinuous outline.

Thirty-nine denticulates are retouched on the distal edge, for two of them the retouch is discontinuous, for 14 continuous, in one case the retouch is localized on the proximal portion, in two cases on the medial portion, in two on the distal one, in one case both on the proximal and medial portions, in one case

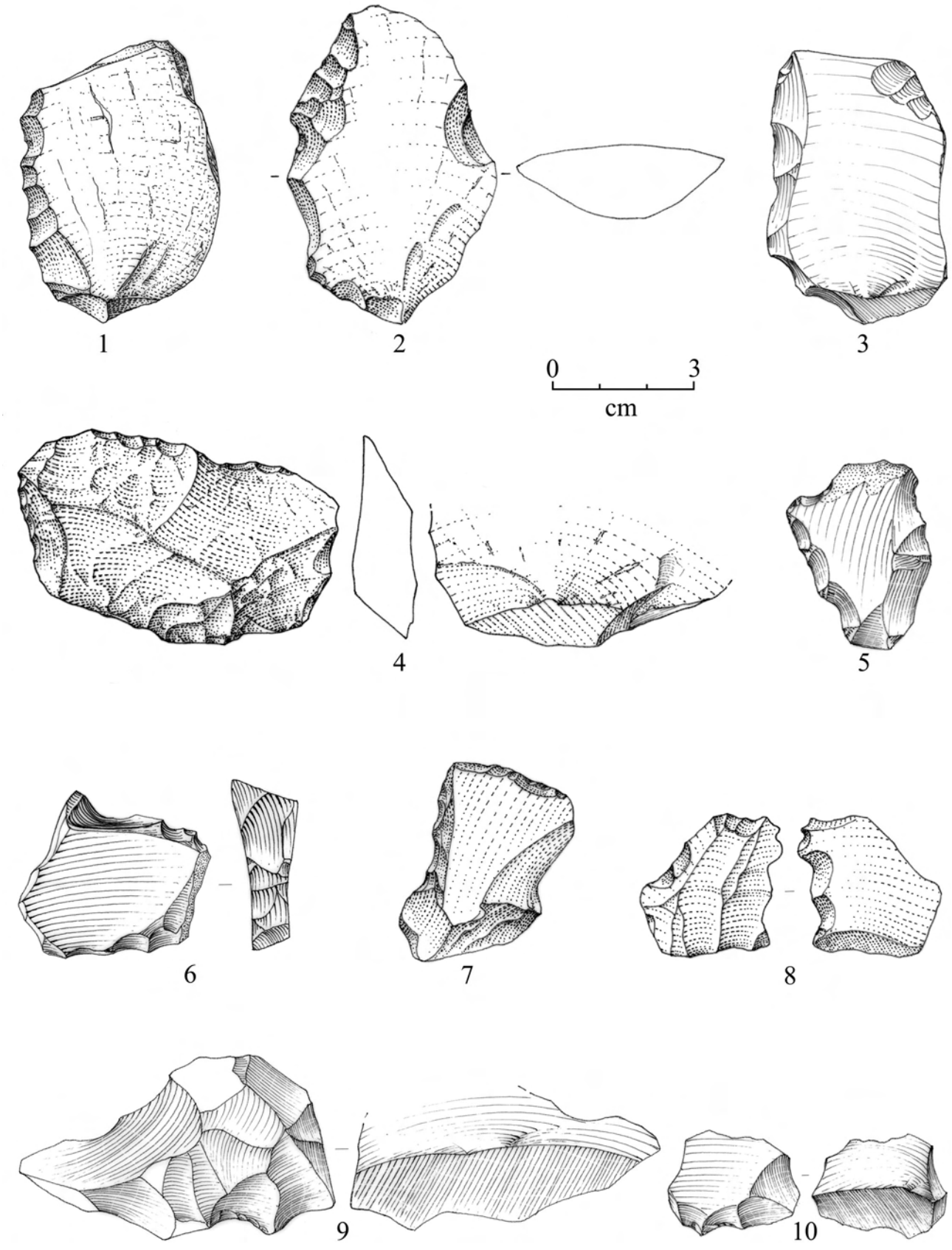


Fig. 30. Garba IV D. Denticulates [MK 5576, 9080, 3442, 9582, 1196, 1504, 7959, 8997, 5673, 548 (Level C)]. 1, 2, 4, 7, 8: basalt; 3, 5, 6, 9, 10: obsidian. *Drawings by M. Pennacchioni*

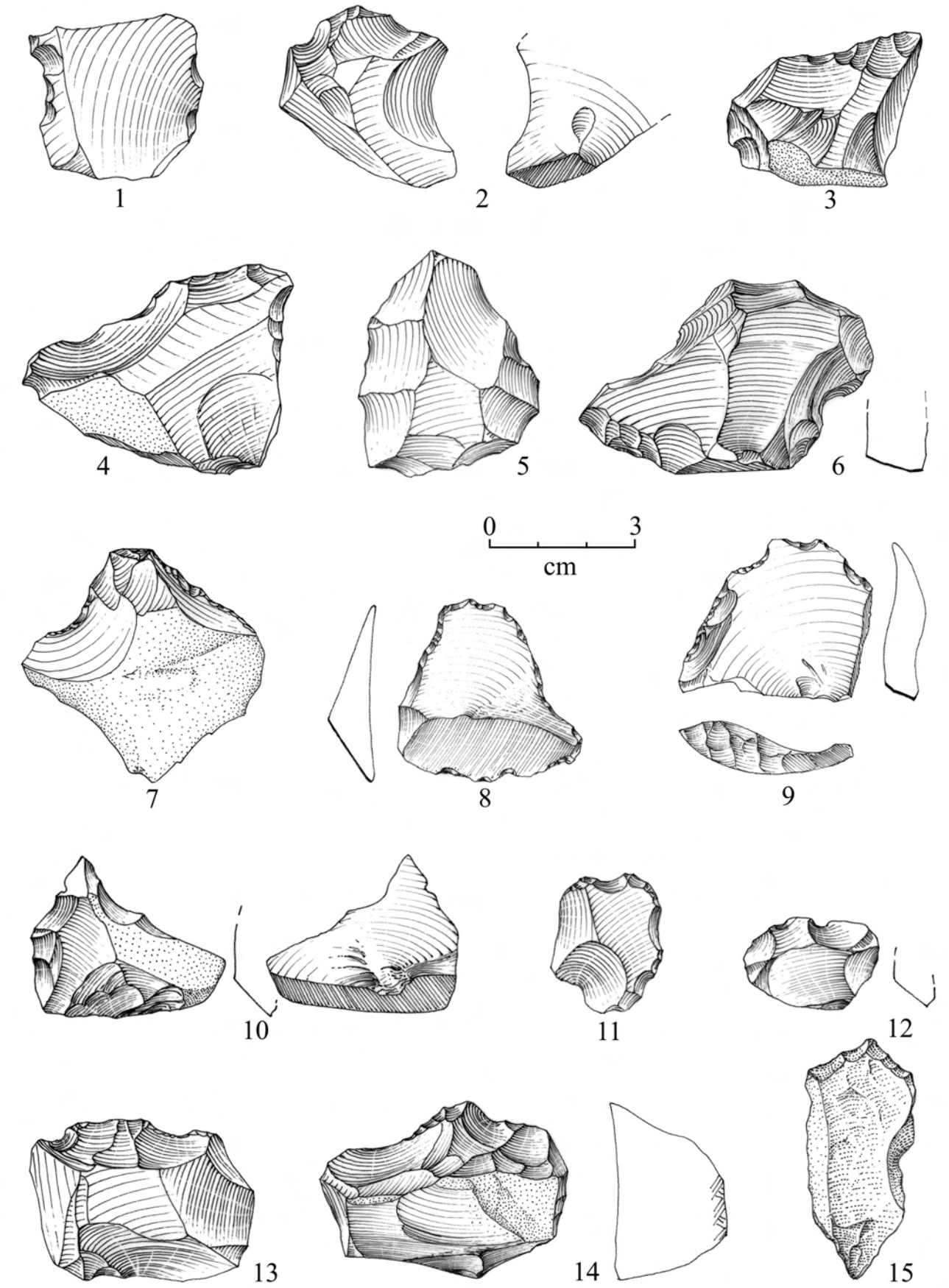


Fig. 31. Garba IV D. 1-15: denticulates [MK 9395, 479, 3714, 3414, 4186, 3164, 9632, 8041, 7987, 5907, 761 (Level C), 809 (Level C), 5912, 9603, 9177]. Obsidian. *Drawings by M. Pennacchioni*

both on the distal and medial portions. In eleven cases the retouch is simple marginal, in 15 it is simple invasive, in two it is abrupt marginal, in five abrupt invasive, in two raised. In 33 cases the position of the retouch is direct, with a rectilinear (18), concave (4), alternate (4) or alternating (7) outline; in five cases it is inverse with rectilinear (3), convex (1) or sinuous (1) outline.

Nine denticulates are retouched on the transversal proximal edge. In seven cases the retouch is discontinuous, in one case it is localized on the proximal portion, on one case on the distal one. The retouch is simple marginal in three cases, simple invasive in one, abrupt invasive in four. The retouch is direct in five cases (rectilinear in two, concave in one, sinuous in two), in four cases it is inverse (in two rectilinear, in two convex, in one sinuous).

Other volcanic rocks

Of the 27 denticulates studied, 11 are retouched on the right edge. In five cases the retouch is continuous, in two it is localized on the medial portion, in two it is both on the proximal and medial portions, in two it is both on the distal and medial portions. The retouch is simple marginal in three cases, simple invasive in four, abrupt in four others. In six cases the retouch is direct, with a rectilinear outline in three cases, concave in one, convex in one, sinuous in one; in four cases it is inverse, with rectilinear (2), concave (1), or sinuous (1) outline; in one case it is alternate rectilinear, in one alternating rectilinear.

Ten denticulates present the retouch on the left lateral edge. In four cases it is localized on the whole edge, in two cases it is localized on the proximal portion, in one case on the medial portion, in one on the distal part, in one on both the distal and medial portions. Three denticulates have simple marginal retouch, five simple invasive retouch, one abrupt invasive retouch. In five cases the retouch is direct with a rectilinear outline in one case, a concave outline in two cases or a sinuous one (2); in four cases it is inverse, with rectilinear (2) or convex (2) outline.

Nine denticulates are retouched on the distal transversal edge, five totally, one on the proximal part, one on the distal portion, two both on the distal and medial portions. The retouch is simple marginal in three cases, simple invasive in four, abrupt invasive in two. In seven cases the retouch is direct with rectilinear (1), concave (2), alternate (1) or sinuous (3) outline; in two cases the retouch is inverse with concave outline in one case, sinuous in the other.

Typometry

The three dimensions have been measured for 149 denticulates out of the 157 studied in detail. 154 have been weighed. The length of the platform on 47 denticulates has been measured, the thickness of the platform on 56 notches, and the angle of the platform on 53.

Length, width, thickness and weight

Of the obsidian blanks, 85.37% are between 21 mm and 60 mm long (mean 43.87 mm). The blanks of the denticulates of other volcanic rocks are slightly longer, with 84.6% between 31 mm and 80 mm (mean 56.61 mm).

As far as the width is concerned, 84.56% of the blanks of obsidian and of other volcanic rocks are between 21 mm and 60 mm. The blanks of other volcanic rocks are on the average slightly wider (48.96 mm) than the obsidian ones (40.75 mm).

The thickness of 89.43% of the blanks of the obsidian denticulates is between 2 mm and 20 mm; the blanks of other volcanic rocks are slightly thicker with 92.31% of the pieces between 2 mm and 30 mm.

Most of the obsidian denticulates are on flakes weighing between 2 g and 40 g with a mean of 25.36 g; the weight of 50% of the denticulates of other volcanic rocks is between 2 g and 30 g with a mean of 62.08 g.

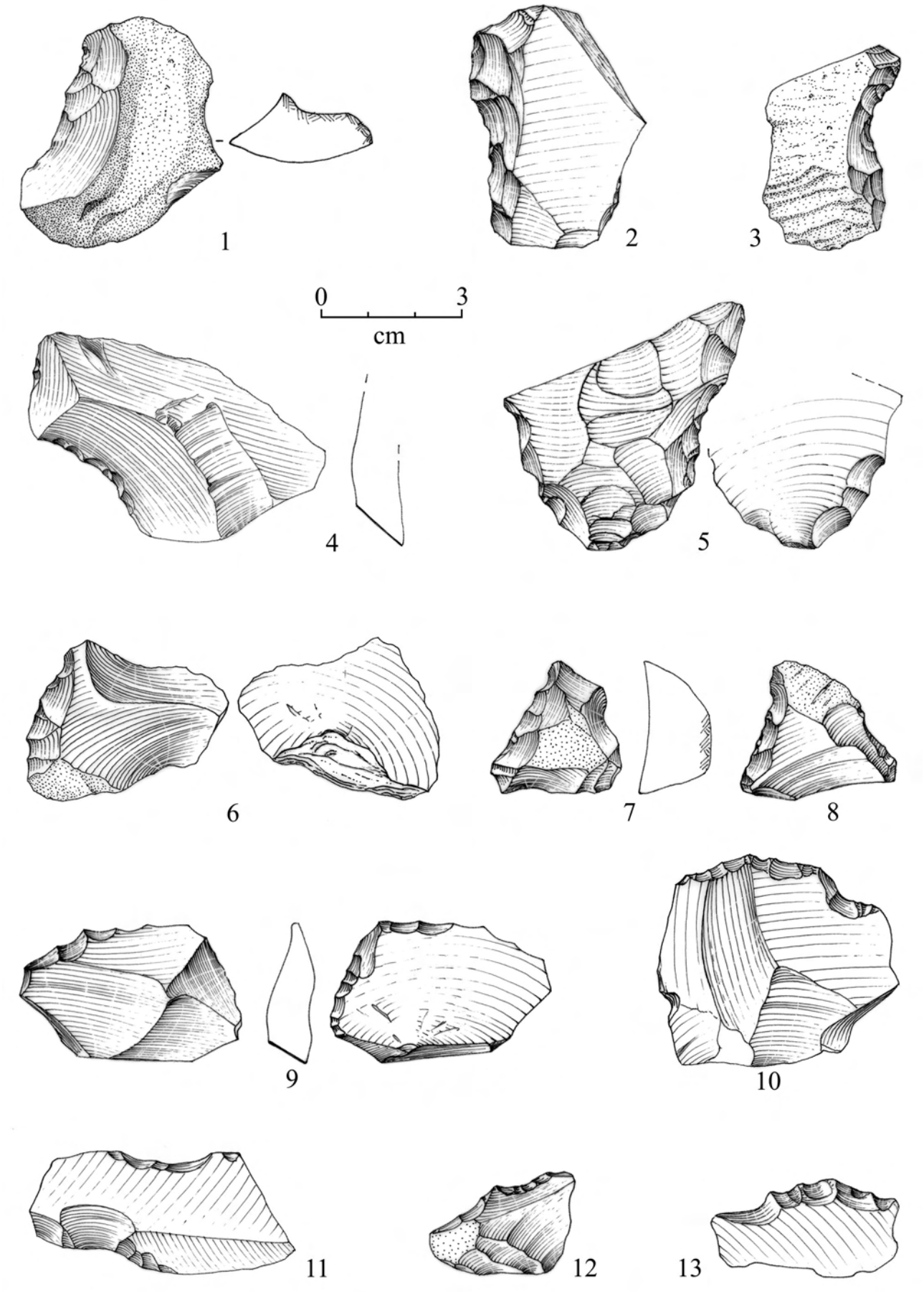


Fig. 32. Garba IV D. 1-13: denticulates (MK 3301, 40601, 9276, 40683, 2715, 9623, 9479, 6123, 5373, 3004, 3675, 7271, 894). Obsidian. *Drawings by M. Pennacchioni*

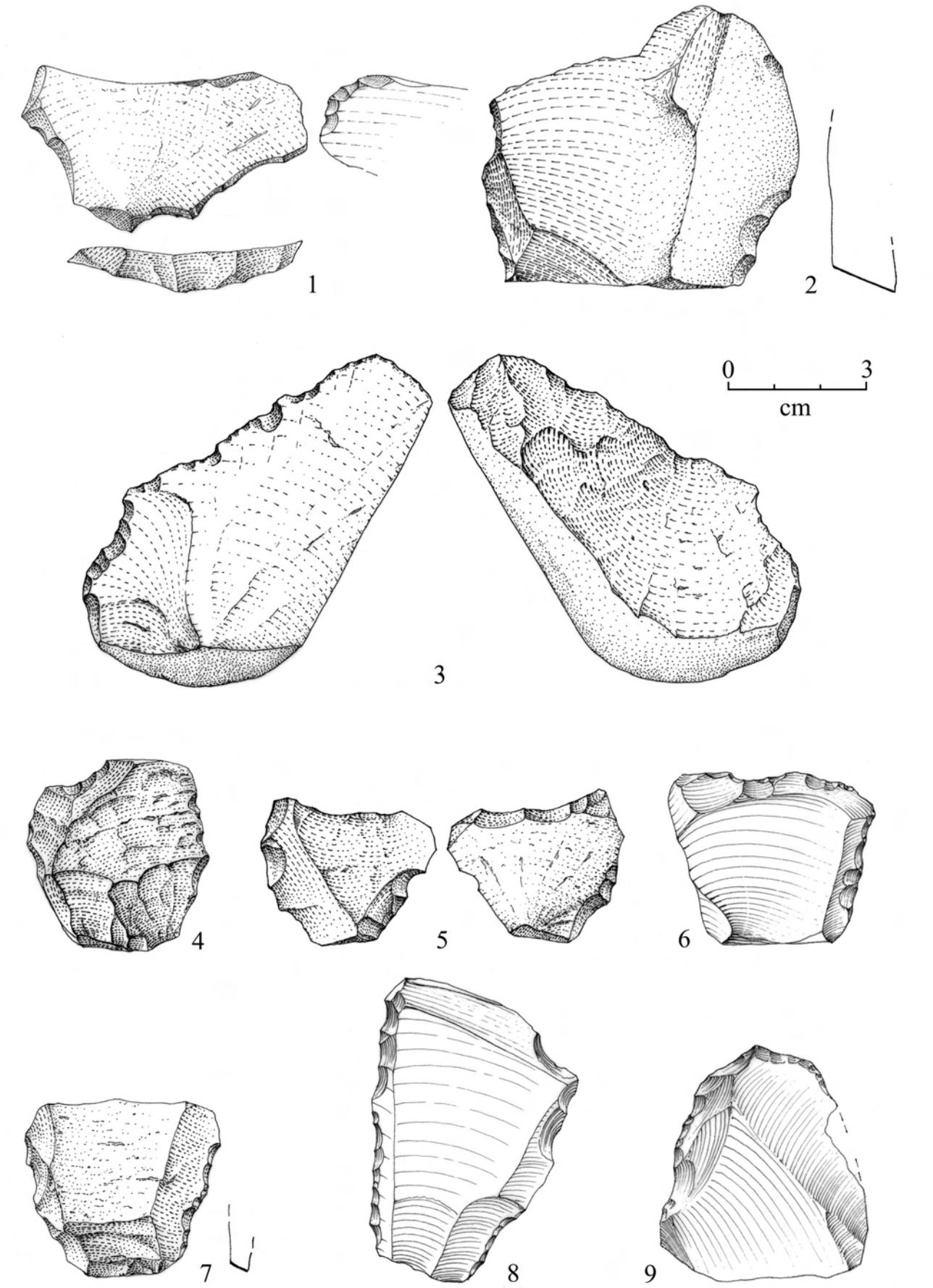


Fig. 33. Garba IV D. 1-9: denticulates (MK 2595, 4953, 40534, 3108, 5196, 3432, 2508, 8140, 1453). 1-6: basalt; 7-9: obsidian. *Drawings by M. Pennacchioni*

Striking platform length, thickness and angle with the ventral face

Regardless of the raw material, 78.57% of the blanks have platforms that are between 11 mm and 40 mm long. There are 68.25% with platforms between 2 mm and 10 mm thick; for the remaining 30.16% of the measured cases, the thickness of the platform is between 11 mm and 20 mm. The platform/ventral face angle, for 82.33% of the obsidian blanks (mean: 116,8°) and for all the blanks of other volcanic rocks (mean: 109.64°), is between 91° and 130°, with more than 50% of the obsidian blanks between 111° and 130° and 65% of the blanks of other volcanic rocks between 91° and 110°.

Spatial distribution

Tools on flake represent the only category, if we discount indeterminable fragments, with a higher number of specimens in ES (265, 51.36%) than in WS (251, 48.64%).

In WS, they show no significant concentrations, and they appear rather dispersed, especially in the northern part. A similar dispersal is observable in the lower half of ES, while in the upper half there are two areas with higher densities near two basalt blocks. One straddles squares 8-9E/6N, the other squares 11-12E/5-6N (Plate 8).

This distribution trend, especially in ES, is strongly influenced by the concentration and dispersal of obsidian tools, since those of other volcanic rocks are numerically insignificant and their distribution shows no distinctive spatial patterns. Furthermore, considering exclusively obsidian, the different frequency between ES and WS is even more accentuated (245 specimens, 60.49%, in ES, 160 specimens, 39.51%, in WS (Plate 9).

Fragments

In this group we have included 635 shapeless fragments with one or more small removals, fragments of flakes which cannot be oriented and small fragments of pebbles. Tab. 34 synthesizes the frequency of raw material.

Raw material	**Catalogue**		**Studied material**	
	N	%	N	%
Obsidian	414	65.20	251	100
Basalt	200	31.50		
Trachyte	10	1.57		
Trachybasalt	3	0.47		
Tuff	7	1.10		
Others	1	0.16		
Total	**635**		**251**	

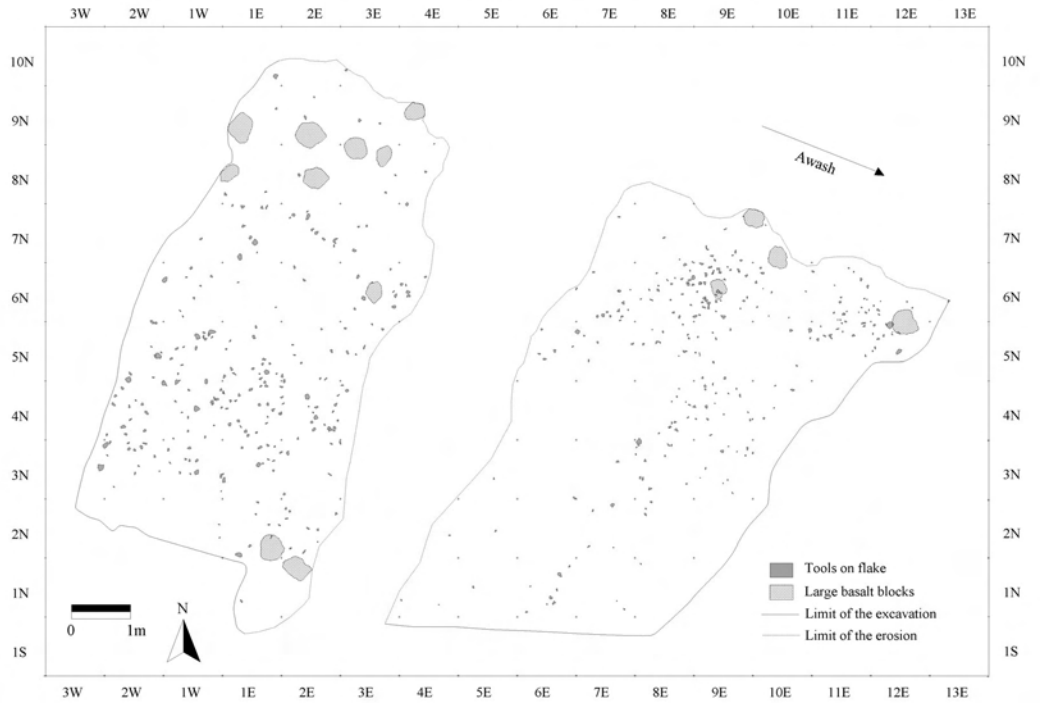
Tab. 34. Frequency of various raw materials of fragments.

Typometry

251 (39,53%) obsidian fragments have been studied and measured. Most of them (155) do not have cortex; 40 fragments have been slightly utilized, while a more regular retouch is present on 10 of them.

Length

The length of most of the obsidian fragments reaches values between 21 mm and 60 mm, while length of basalt fragments is slightly higher (Tabs. 35, 36).



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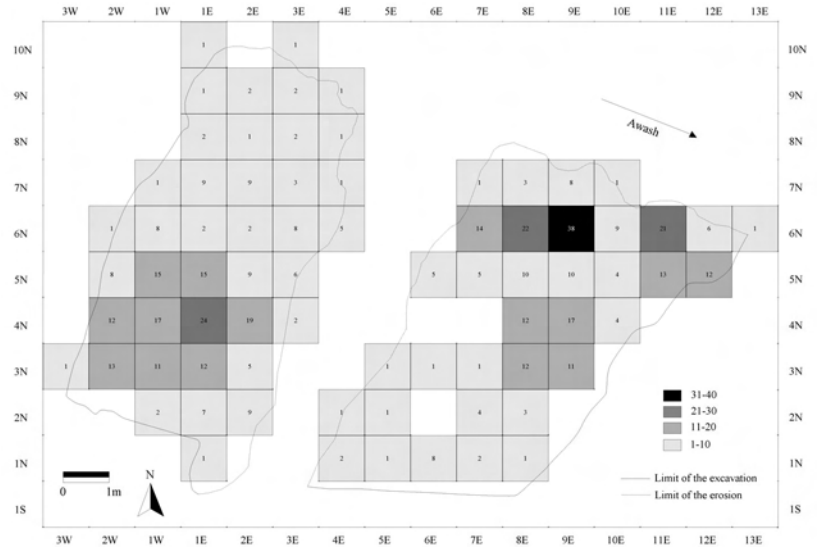

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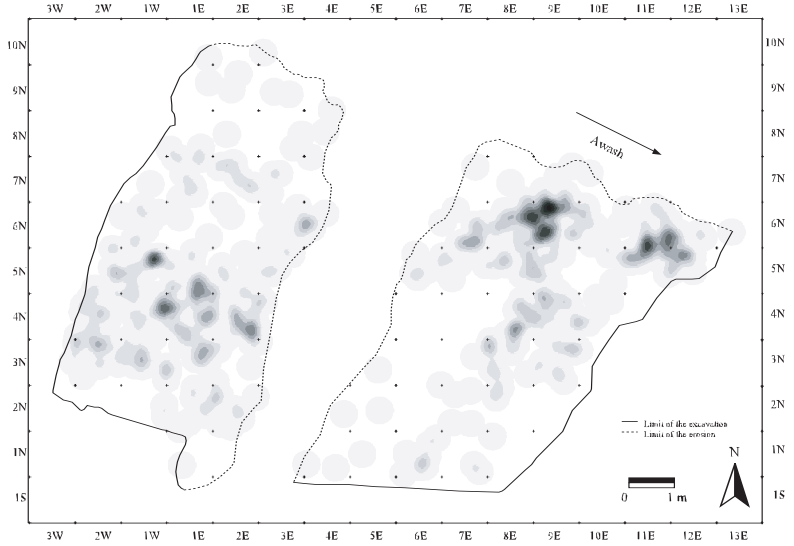

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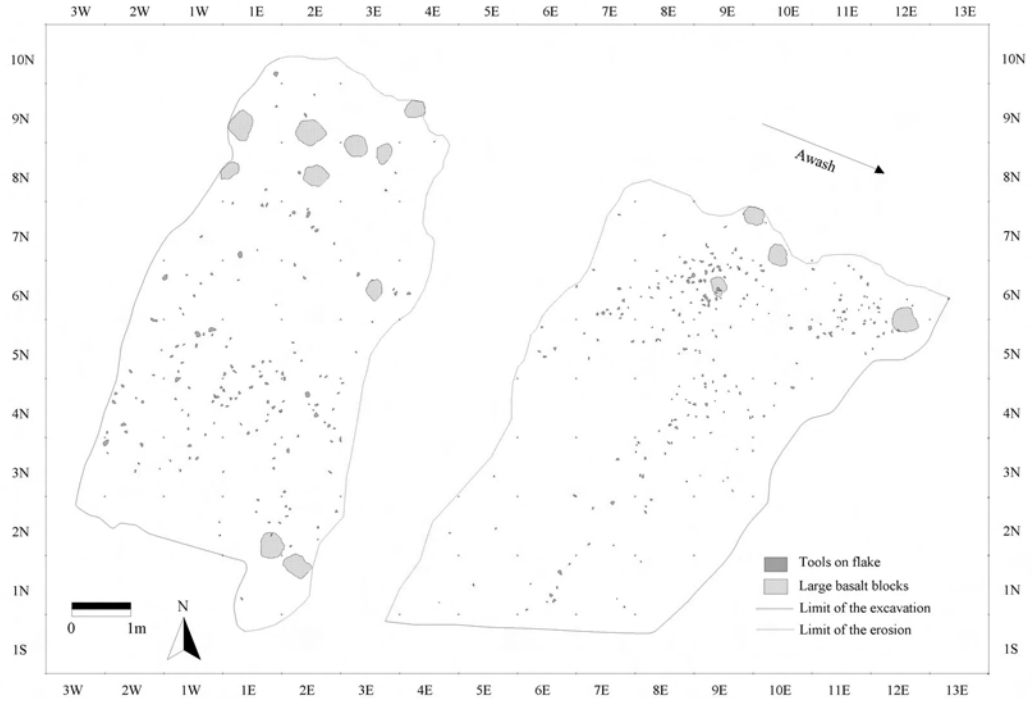
Plate 8. Garba IV D. 1. Plan of tools on flake. (*Original plan by G. M. Bulgarelli and M. Piperno, digital map by R. Gallotti*) 2. Frequency of tools on flake. 3. Density areas of tools on flake.



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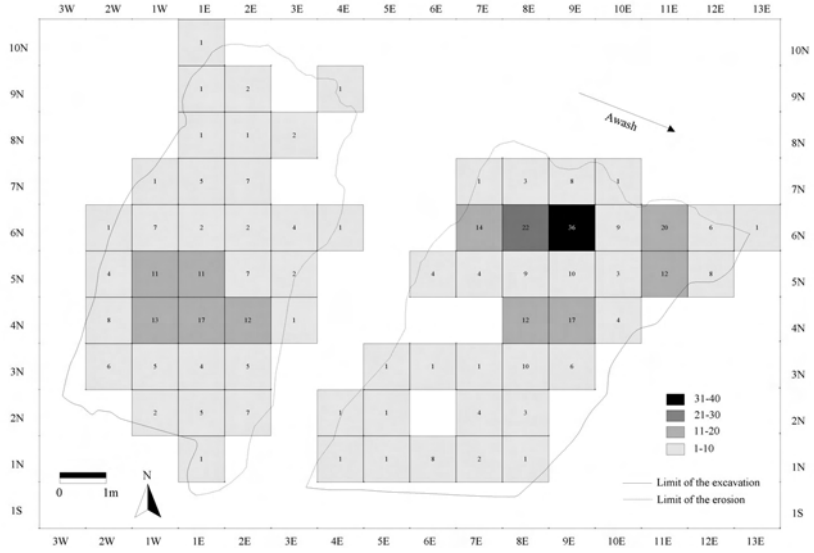

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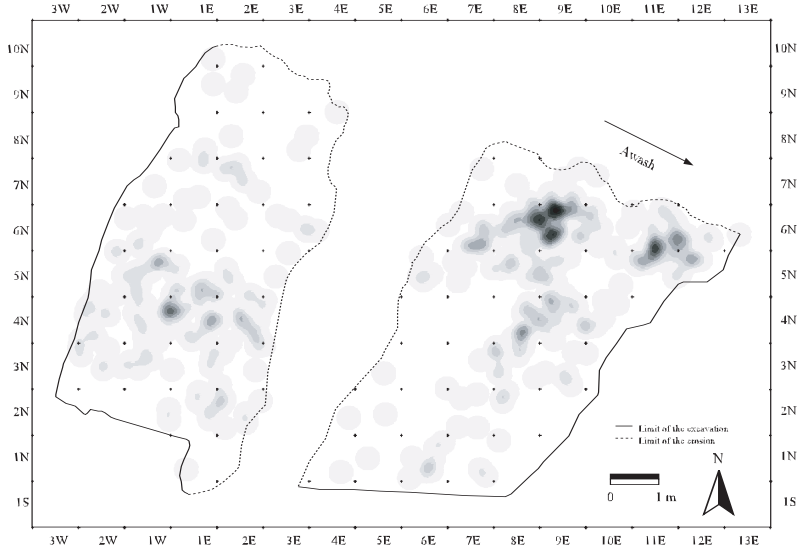

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Plate 9. Garba IV D. 1. Plan of obsidian tools on flake. (*Original plan by G. M. Bulgarelli and M. Piperno, digital map by R. Gallotti*) 2. Frequency of obsidian tools on flake. 3. Density areas of obsidian tools on flake.

	Catalogue					
Length (mm)	**Obsidian**		**Other volcanic rocks**		**Total**	
	N	%	N	%	N	%
11\20	5	1.35	2	1.13	7	1.28
21\30	88	23.78	16	9.04	104	19.01
31\40	113	30.54	57	32.20	170	31.08
41\50	85	22.97	49	27.68	134	24.50
51\60	47	12.70	20	11.30	67	12.25
61\70	19	5.14	21	11.86	40	7.31
71\80	5	1.35	9	5.08	14	2.56
81\90	4	1.08	3	1.69	7	1.28
91\100						0.00
101\110	3	0.81			3	0.55
111\120	1	0.27			1	0.18
Totale	**370**		**177**		**547**	

Tab. 35. Distribution of length of fragments.

	Catalogue		Studied material
Lenght (mm)	**Obsidian**	**Other volcanic rocks**	**Obsidian**
Min	15	14	20
Max	113	88	113
Mean	40.90	46.14	41.36

Tab. 36. Minimum and maximum length of fragments.

Width

The width of most of the fragments is comprised between 11 mm and 40 mm with few exceptions reaching more than 60 mm (Tabs. 37, 38).

	Catalogue					
Width (mm)	**Obsidian**		**Other volcanic rocks**		**Total**	
	N	%	N	%	N	%
1\10	2	0.54			2	0.37
11\20	70	18.92	15	8.47	85	15.54
21\30	158	42.70	86	48.59	244	44.61
31\40	97	26.22	48	27.12	145	26.51
41\50	34	9.19	17	9.60	51	9.32
51\60	9	2.43	8	4.52	17	3.11
61\70			2	1.13	2	0.37
71\80			1	0.56	1	0.18
Total	**370**		**177**		**547**	

Tab. 37. Distribution of width of fragments.

	Catalogue		Studied material
Width (mm)	**Obsidian**	**Other volcanic rocks**	**Obsidian**
Min	9	14	13
Max	58	78	57
Mean	28.76	32.01	29.73

Tab. 38. Minimum and maximum width of fragments.

Thickness

The thickness of most of the fragments is comprised between 2 mm and 30 mm, with a higher frequency of fragments whose thickness varies between 10 and 20 mm (Tabs. 39, 40).

Thickness (mm)	Catalogue: Obsidian N	Obsidian %	Other volcanic rocks N	Other volcanic rocks %	Total N	Total %
1\10	97	26.22	8	4.52	105	19.20
11\20	222	60.00	101	57.06	323	59.05
21\30	44	11.89	51	28.81	95	17.37
31\40	7	1.89	15	8.47	22	4.02
41\50			2	1.13	2	0.37
Total	**370**		**177**		**547**	

Tab. 39. Distribution of thickness of fragments.

Thickness (mm)	Catalogue: Obsidian	Catalogue: Other volcanic rocks	Studied material: Obsidian
Min	4	5	4
Max	37	48	37
Mean	14.53	20.23	14.35

Tab. 40. Minimum and maximum thickness of fragments.

Weight

The weight of most of the fragments reaches values between few grams and 20 g (Tabs. 41, 42).

Weight (g)	Catalogue: Obsidian N	Obsidian %	Other volcanic rocks N	Other volcanic rocks %	Total N	Total %
1\10	163	44.05	15	8.47	178	32.54
11\20	100	27.03	67	37.85	167	30.53
21\30	35	9.46	35	19.77	70	12.80
31\40	36	9.73	15	8.47	51	9.32
41\50	10	2.70	11	6.21	21	3.84
51\60	11	2.97	7	3.95	18	3.29
61\70	5	1.35	6	3.39	11	2.01
71\80	4	1.08	3	1.69	7	1.28
81\90	1	0.27	2	1.13	3	0.55
91\100			3	1.69	3	0.55
101\200	5	1.35	11	6.21	16	2.93
201\300			1	0.56	1	0.18
301\400			1	0.56	1	0.18
Total	**370**		**177**		**547**	

Tab. 41. Distribution of weight of fragments.

Weight (g)	Catalogue: Obsidian	Catalogue: Various volcanic rocks	Studied material: Obsidian
Min	1	2	1
Max	160	320	160
Mean	18.89	37.85	19.63

Tab. 42. Minimum and maximum weight of fragments.

Spatial distribution

Indeterminable fragments, like tools on flake, are more frequent in ES (326 specimens, 51.34%) than in WS (309, 48.66%). They are more numerous in the lower half of WS, especially to the west. Their highest frequency is observable in square 2W/4N (39 specimens), their highest concentrations are in

square 1W/4N (31 specimens) and the central part of the upper half of ES, straddling squares 8E/7N and 8-9E/6N (with, respectively, 24, 37 and 44 specimens). One of the large basalt blocks is in this latter area (Plate 10).

The number of indeterminable obsidian fragments in ES (290, 70.05%) is considerably higher than in WS (124, 29.95%). Their distribution in the latter sector is far from homogeneous; the fragments are concentrated in the central area, between squares 1W/5N, 2W-1E/4N, and are very scarce on the rest of the paleosurface of the same sector. In ES, where the maximum concentration is, again, in the north-central part of the sector, their frequency is noticeably higher, reaching a peak in squares 8-9E/6N (Plate 11).

The distribution of indeterminable fragments of other volcanic rocks shows completely different characteristics. They are much more abundant in WS (184, 83.64%) than in ES (36, 16.36%). In WS, they are more numerous in the lower half, with the highest frequency in square 2W/4N (25 specimens). This area is separated from the upper portion, where they are more dispersed, by a central zone where they are especially scarce. In ES, they are found almost exclusively along the northern limit of the eroded area (Plate 12).

Cleavers

Two cleavers have been recovered from Level D at Garba IV: one is of tuff the other of basalt. The first one (Chavaillon and Piperno 1975) is a cleaver with a thick body and an oblique cutting edge, obtained from a large flake (length: 190 mm; width: 91 mm: thickness: 59 mm) with a ventral face that has been almost completely taken away by large inverse removals (Fig. 34).

The second one is a large cleaver on a basalt flake with a thick body and a relatively small cutting edge (length: 190 mm; width: 94 mm; thickness: 65 mm; weight: 370 g). Large portions of the ventral face have been taken away by some invasive removals (Fig. 35).

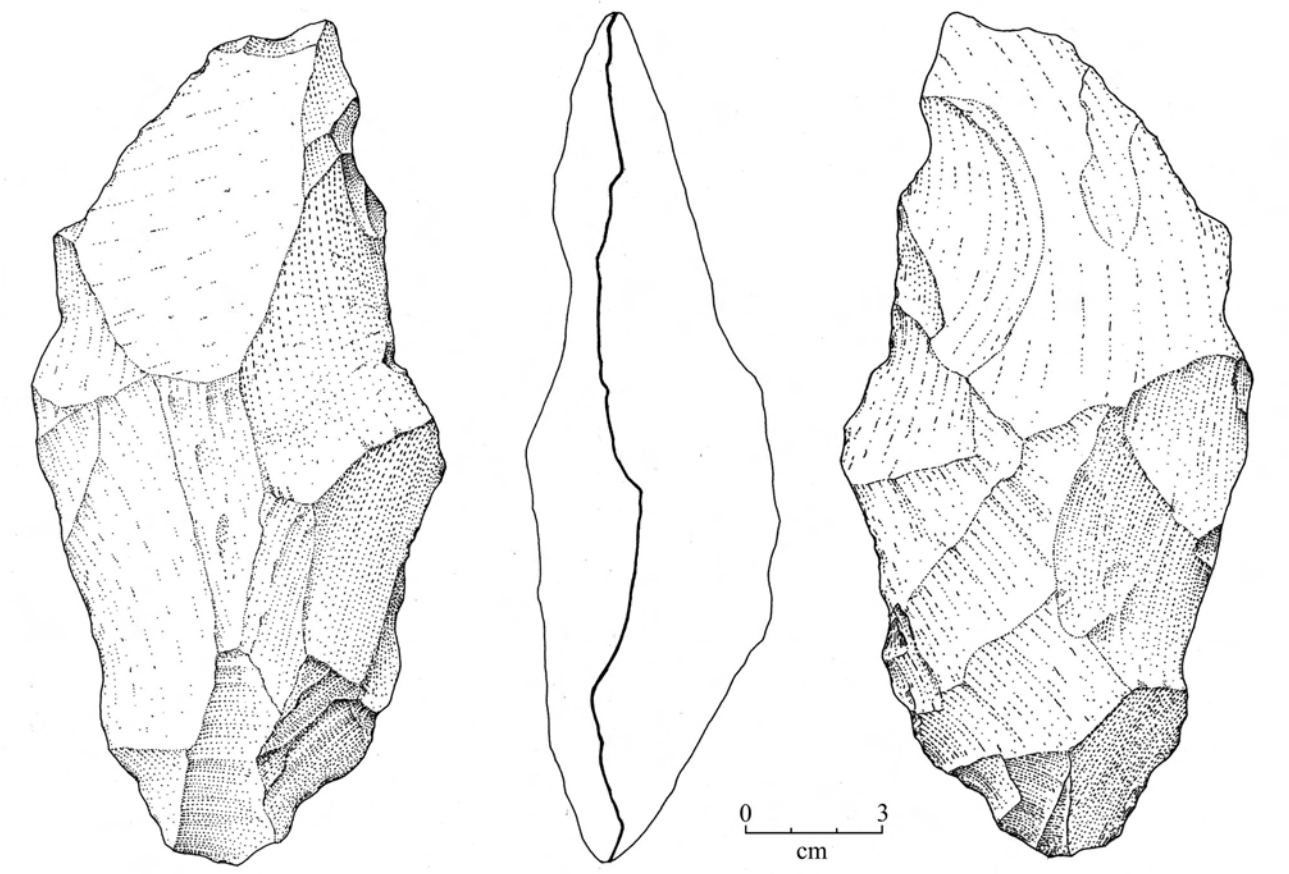
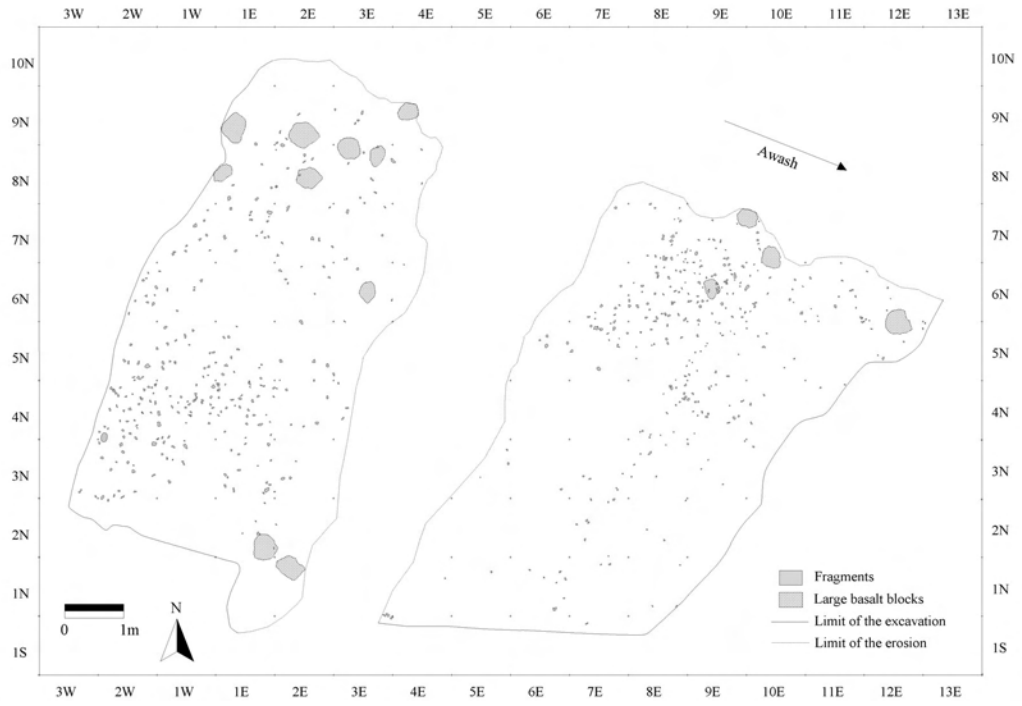


Fig. 34. Garba IV D. Cleaver on a large flake (MK 2659). Tuf. *Drawings by M. Pennacchioni*



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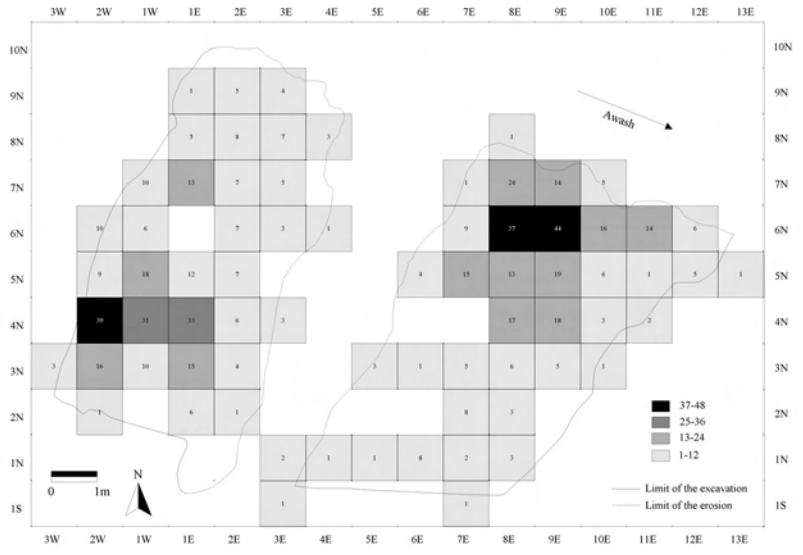

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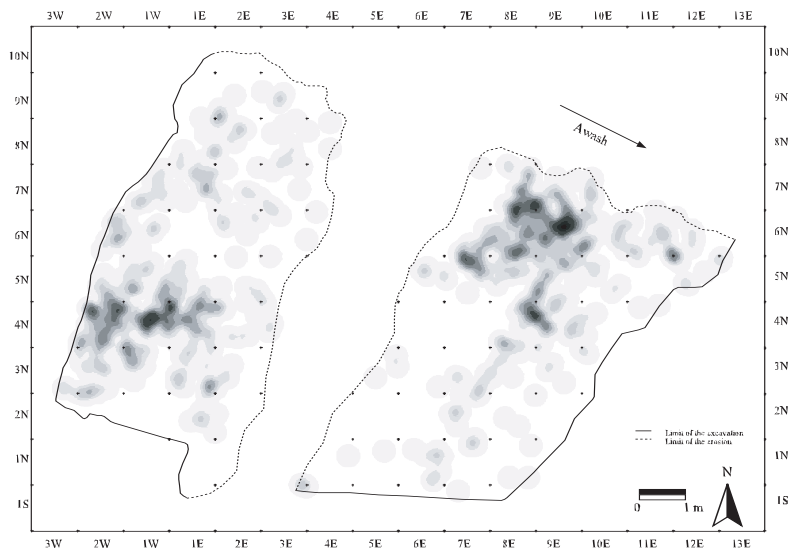

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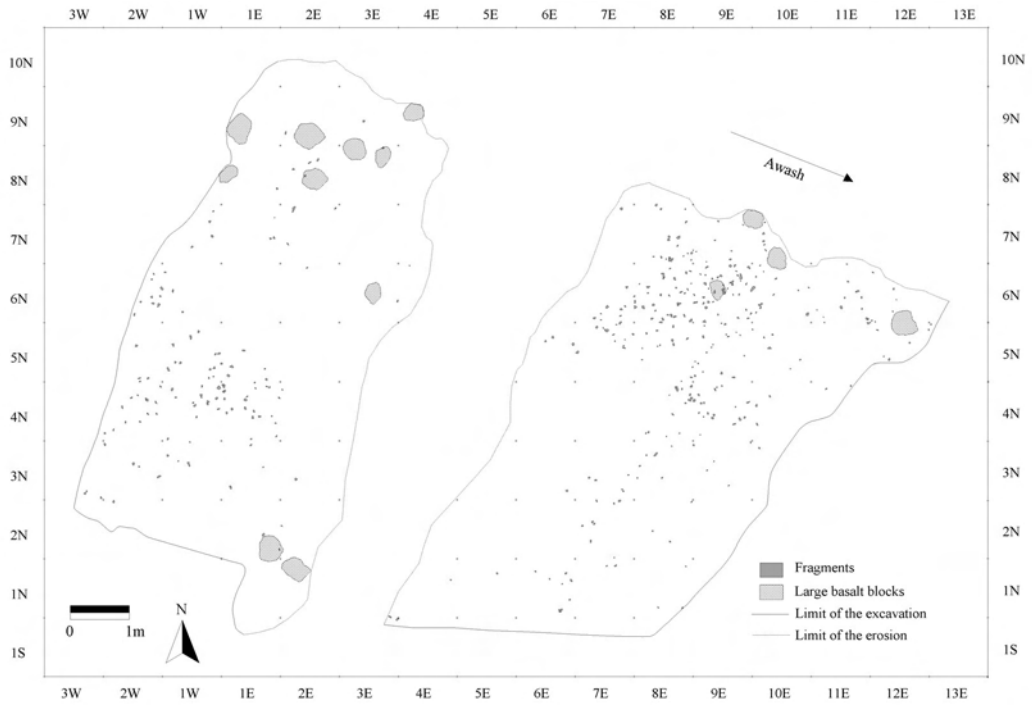
Plate 10. Garba IV D. 1. Plan of fragments. (*Original plan by G. M. Bulgarelli and M. Piperno, digital map by R. Gallotti*) 2. Frequency of fragments. 3. Density areas of fragments.



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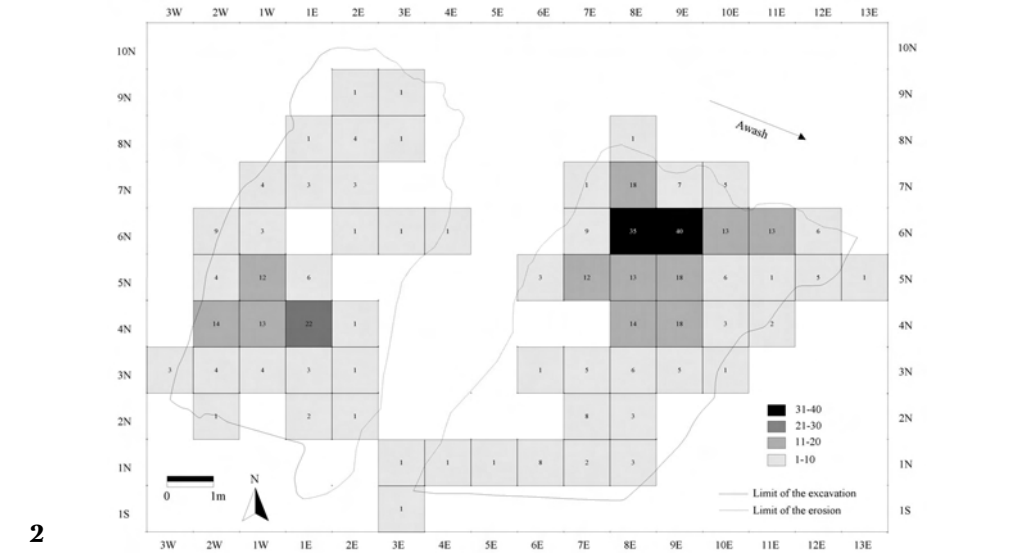

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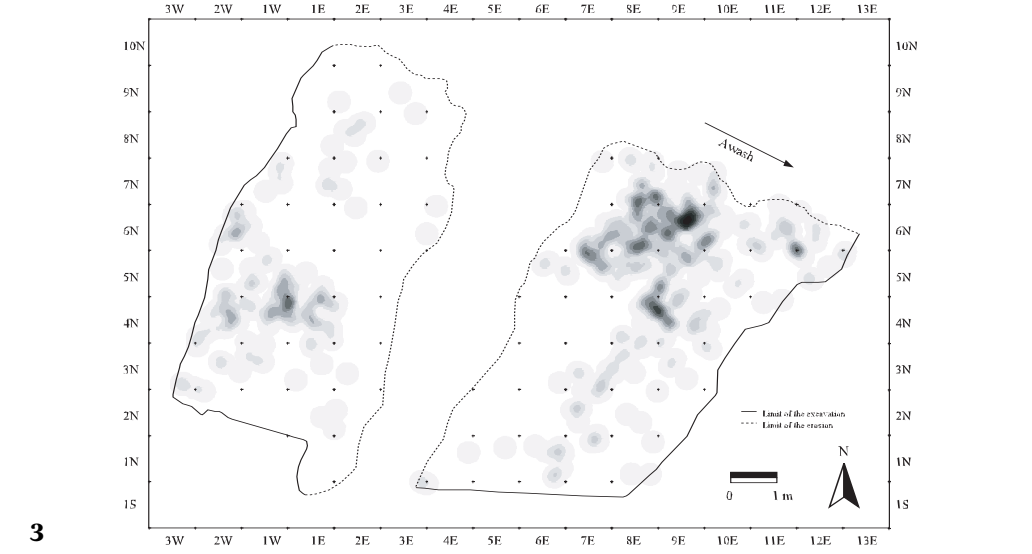

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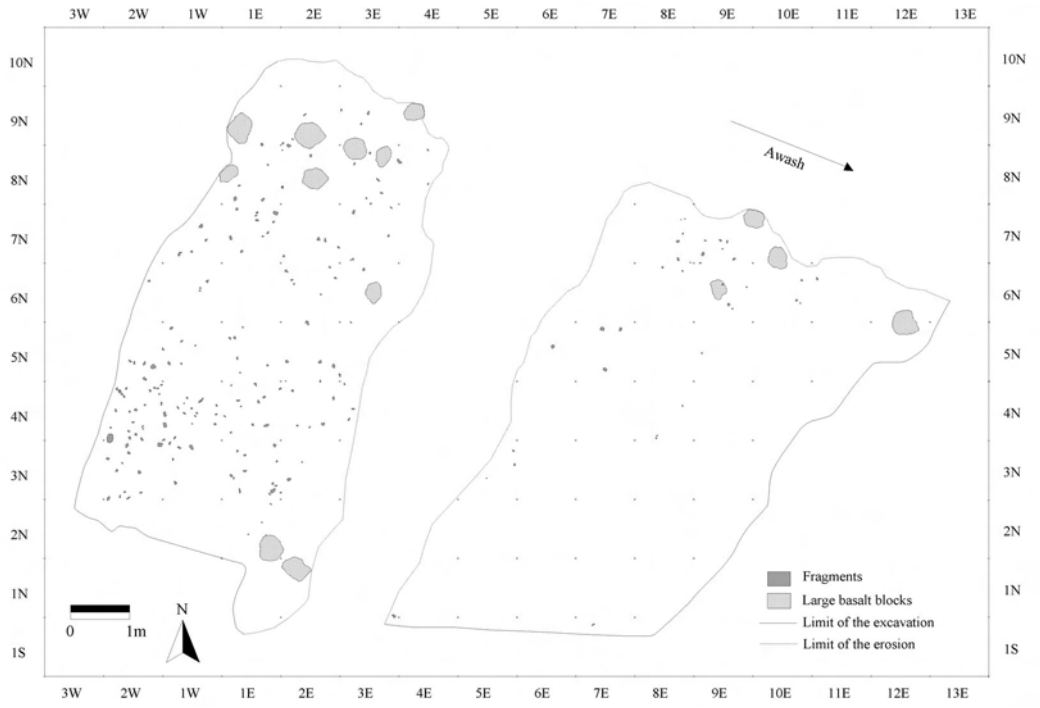
Plate 11. Garba IV D. 1. Plan of obsidian fragments. (*Original plan by G. M. Bulgarelli and M. Piperno, digital map by R. Gallotti*) 2. Frequency of obsidian fragments. 3. Density areas of obsidian fragments.



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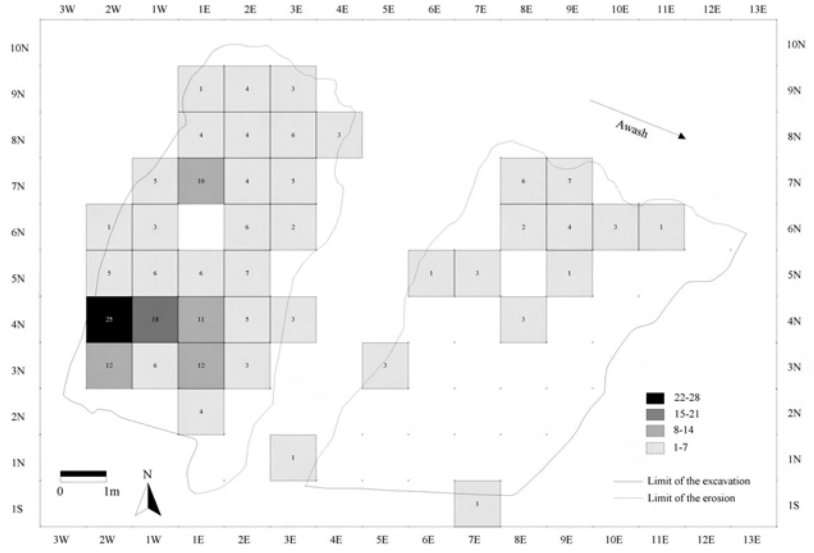

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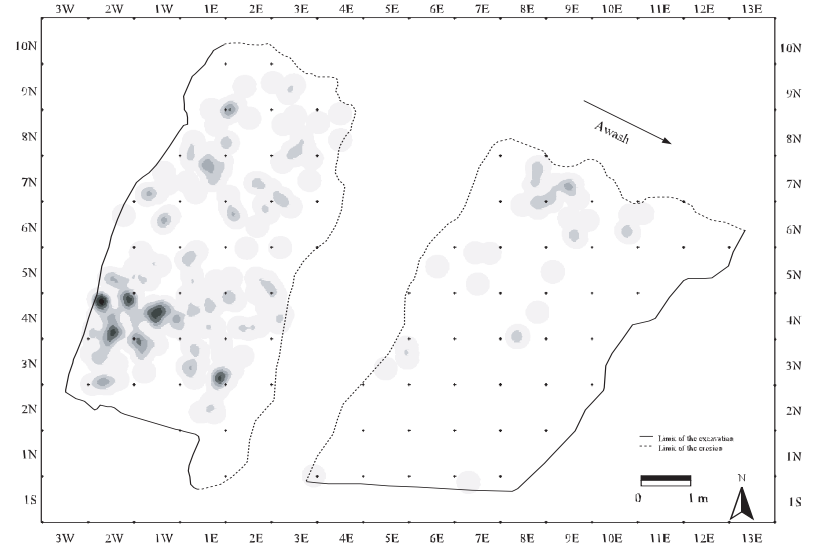

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Plate 12. Garba IV D. 1. Plan of fragments on various volcanic rocks. (*Original plan by G. M. Bulgarelli and M. Piperno, digital map by R. Gallotti*) 2. Frequency of fragments on various volcanic rocks. 3. Density areas of fragments on various volcanic rocks.

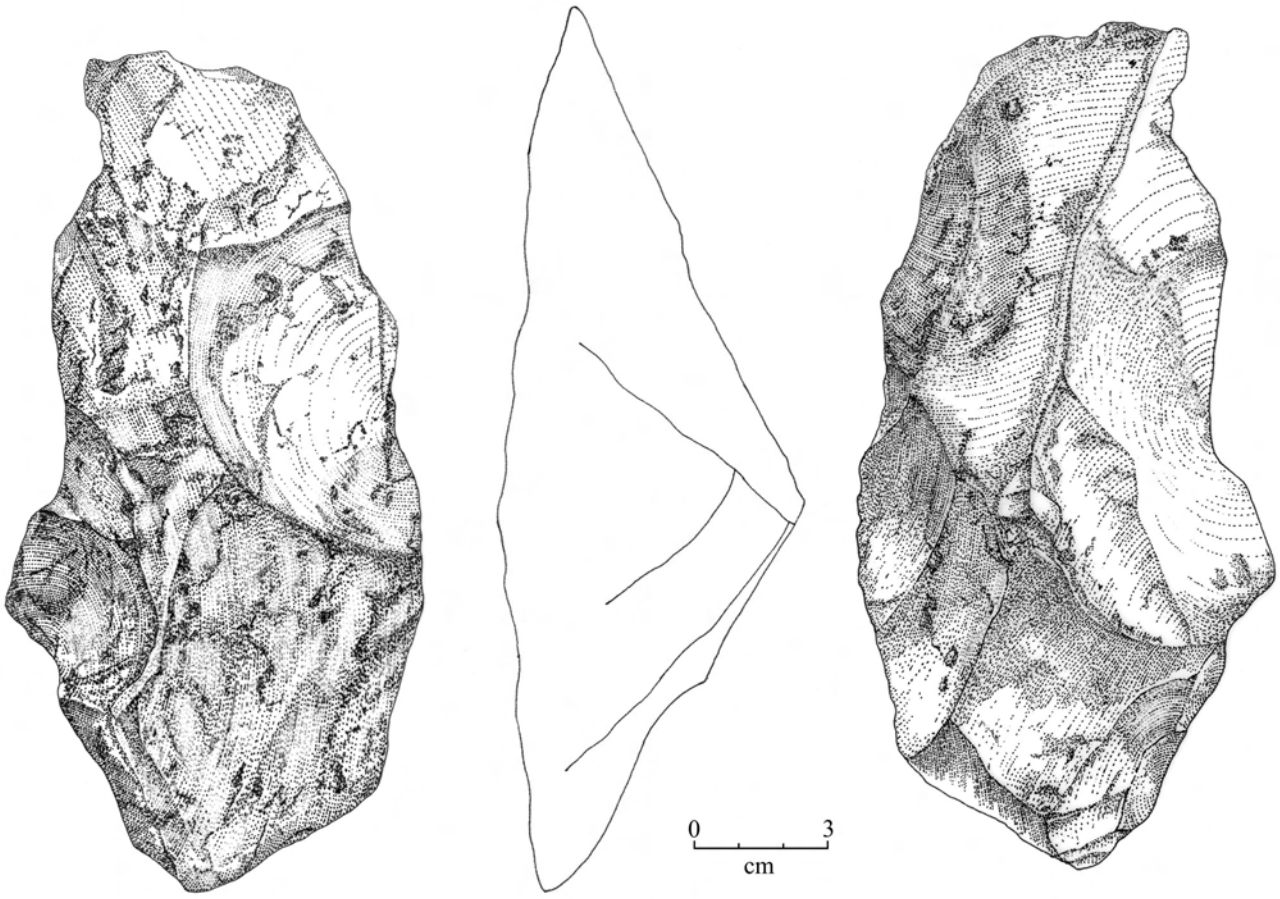

Fig. 35. Garba IV D. Cleaver on a large flake (MK 7216). Basalt. *Drawings by J. Jaubert*

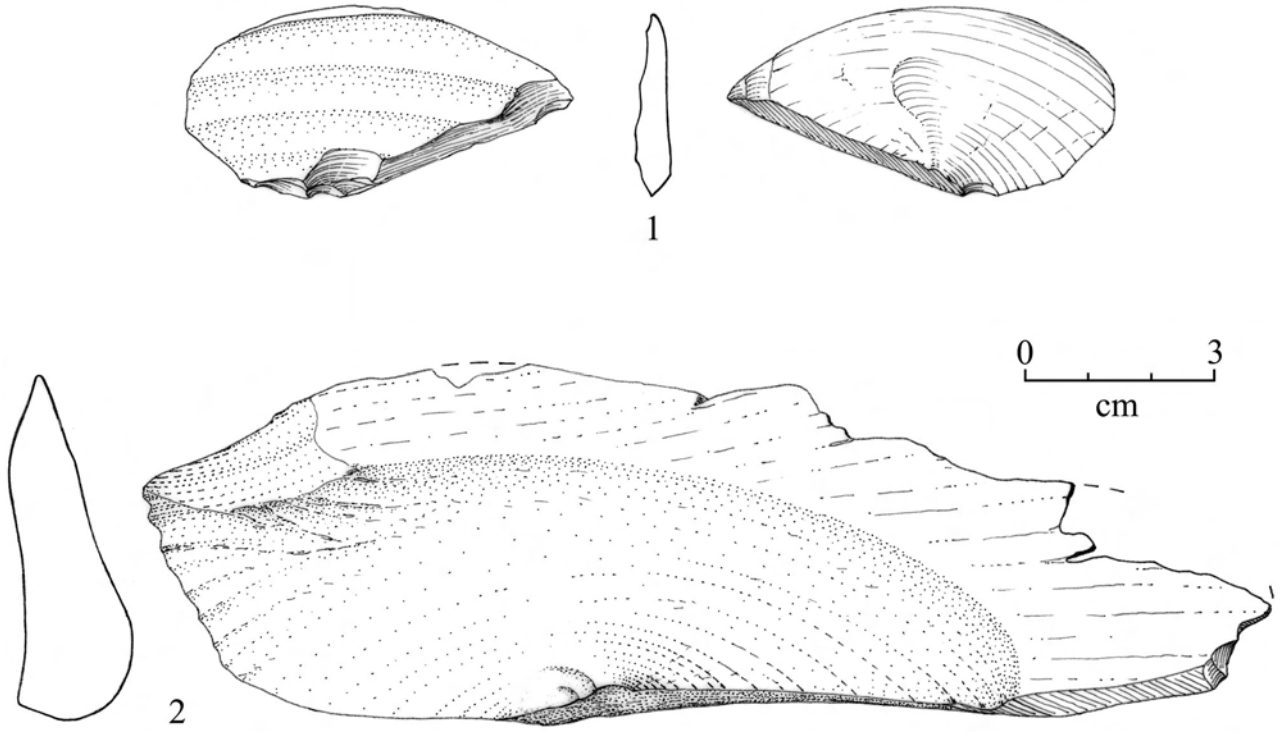

Fig. 36. Garba IV D. 1: flake cut on a hippopotamus canine tooth (MK 0046); 2: flake cut on an indeterminable bone fragment (MK 12020). *Drawings by M. Pennacchioni*

The first cleaver was found on the upper portion of Level D, while the second was recovered at the base of the same level in association with numerous small obsidian and basalt flakes, antelope teeth and fragments of hippopotamus canines.

These two cleavers from Garba IV are among the oldest so far known from East Africa. However, in contrast to the handaxes from the same level, these are typical, and in particular the first one shows clear evidence of chipping due to use on the cutting edge.

Bone and tooth flakes

A few worked bones from Garba IV D have been already published some years ago (Piperno and Bulgarelli 1975). One more flake cut on an indeterminable bone fragment and one flake from a hippopotamus canine tooth have been also found in the same level (Fig. 36). For more detailed analysis see Tagliacozzo, Fiore in this volume.

Cores

Cores

In Level D at Garba IV 613 cores have been identified, 228 of them (37.19%) have been studied in detail (Fig. 37). As is known, several choppers and polyhedrons may have also been cores.

The difficulty of making such distinctions in Early Stone Age complexes suggested to several authors the introduction of the term "chopper/cores", providing a functional indication that is difficult to control in many of the sites considered.

Morpho-technical aspects

The morpho-technical aspects presented derive from the elaboration of data obtained from the cores analyzed in detail. Although most of the cores are of irregular shape, there are also different types of cores, but with very low percentages (Tab. 44).

Cores	**Obsidian**		**Basalt**		**Total**	
	N	%	N	%	N	%
Prismatic	5	2.54	3	9.68	8	3.51
Pyramidal	4	2.03	2	6.45	6	2.63
Polyhedral	9	4.57	4	12.90	13	5.70
Globular	19	9.64	1	3.23	20	8.77
Formless	149	75.63	20	64.52	169	74.12
With preferential cutting edge	11	5.58	1	3.23	12	5.26
Total	**197**		**31**		**228**	

Tab. 44. Typological variability of cores.

Raw material

About half (55.14%) of the cores identified are of obsidian, compared to 43.39% of basalt. The cores made of other volcanic rocks, different from basalt, are rare (Tab. 43).

Raw material	Catalogue		Studied material	
	N	%	N	%
Obsidian	338	55.14	197	86.40
Basalt	266	43.39	31	13.60
Trachyte	1	0.16		
Trachybasalt	2	0.33		
Tuff	3	0.49		
Others	3	0.49		
Total	**613**		**228**	

Tab. 43. Frequency of different raw materials utilized for cores.

Prismatic cores

Obsidian

The five obsidian prismatic cores analyzed are all on pebbles with preserved cortex. They all have a single striking platform and present more than three removals. The respective dimensions and weight are summarized in Tab. 45.

Length	Width	Thickness	Weight
78	61	45	230
53	41	38	80
60	48	28	82
40	27	21	25
57	49	28	69

Tab. 45. Dimensions and weight of obsidian prismatic cores.

Basalt

The three basalt prismatic cores are also on pebbles and have a single striking platform. One presents two removals, the other two have more than three removals. The cortex is present on all three. The dimensions and the weight are indicated in Tab. 46.

Length	Width	Thickness	Weight
79	82	70	630
112	70	67	660
99	97	81	1320

Tab. 46. Dimensions and weight of basalt prismatic cores.

Pyramidal cores

Obsidian

It is not possible to determine the blank of the four pyramidal cores analyzed. Cortex is present in two cases, in the other two it is absent. Two have a single striking platform, two present multiple striking platforms. All present more than three removals. The respective dimensions and the weight are indicated in Tab. 47.

Length	Width	Thickness	Weight
89	58	49	230
32	26	25	15
73	53	38	117
44	38	25	40

Tab. 47. Dimensions and weight of obsidian pyramidal cores.

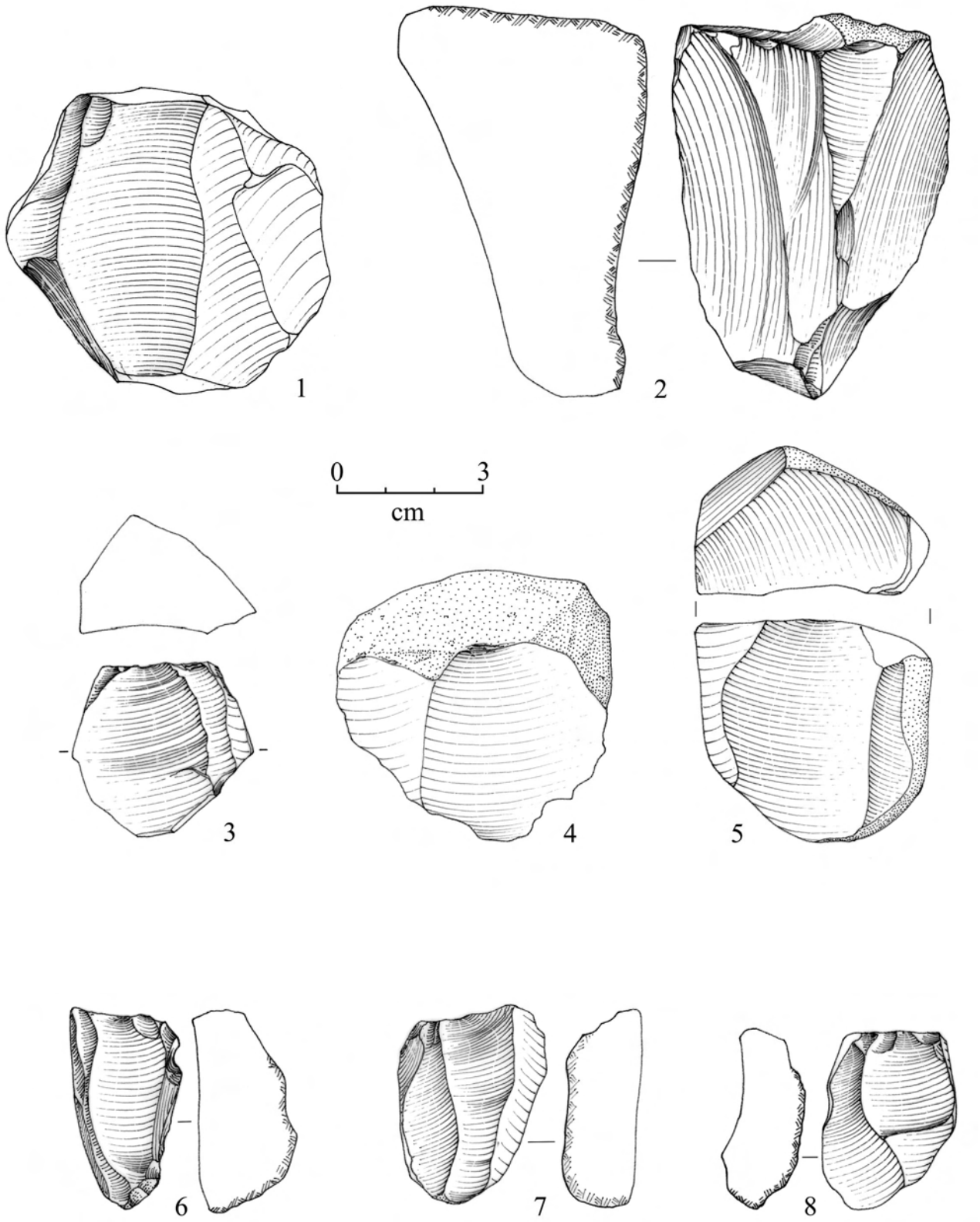

Fig. 37. Garba IV D.1-8: cores (MK 9768, 9396, 1278, 8985, 9726, 6476, 8353, 3157). Obsidian. *Drawings by M. Pennacchioni*

Basalt

The two basalt pyramidal cores are on pebbles, and present a single striking platform. One presents three removals, the other has more than three removals. Cortex is present on both. The dimensions and the weight are indicated in Tab. 48.

Length	Width	Thickness	Weight
105	91	75	760
44	31	16	26

Tab. 48. Dimensions and weight of basalt pyramidal cores.

Polyhedral cores

Obsidian

Of the nine obsidian polyhedral cores analyzed, three are on pebbles, while it is not possible to determine the blank of the others. Four have cortex. They all have a single striking platform and present more than three removals (Fig. 38). A rabot is present on one core.

The respective dimensions and the weight are indicated in Tab. 49.

Length	Width	Thickness	Weight
36	35	22	26
49	47	40	103
86	83	63	600
39	36	26	38
49	39	37	60
60	53	42	144
73	66	58	280
60	51	40	106
47	35	33	55

Tab. 49. Dimensions and weight of obsidian polyhedral cores.

Basalt

The four basalt polyhedral cores analyzed are on pebbles and present a single striking platform. They all present more than three removals. Cortex is present on two of them. The dimensions and the weight are indicated in Tab. 50.

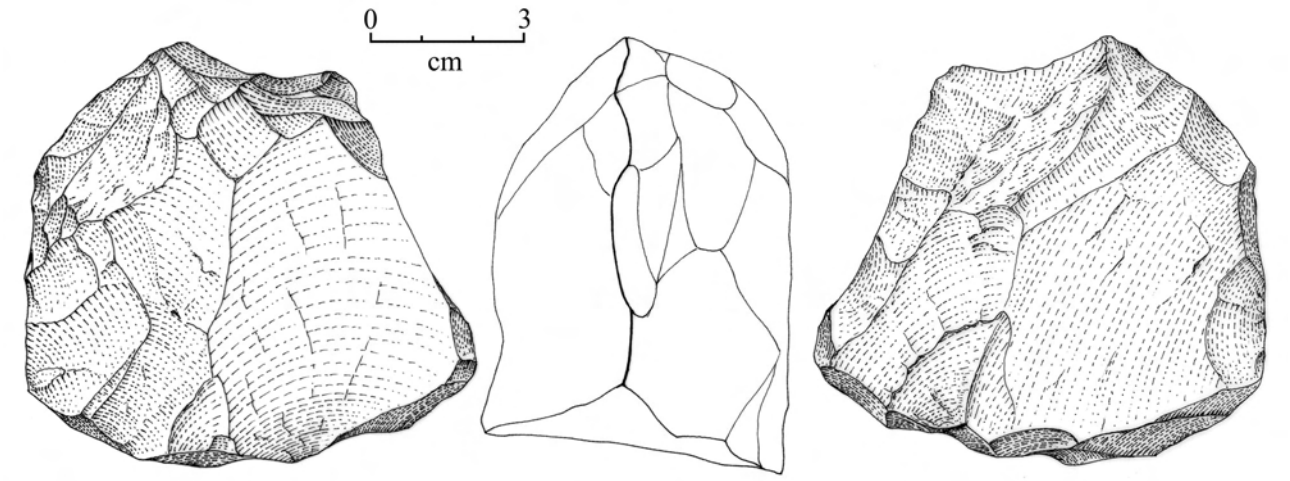

Fig. 38. Garba IV D. 1: polyhedral core (MK 4719). Basalt. *Drawings by M. Pennacchioni*

Length	Width	Thickness	Weight
89	88	86	1060
113	96	90	1060
87	84	84	900
127	98	99	1460

Tab. 50. Dimensions and weight of basalt polyhedral cores.

Globular cores

Obsidian

Of the 19 obsidian globular cores analyzed, eight are on pebbles and for the others it was impossible to determine the blank. Seven have cortex. Four have a single striking platform, the others present multiple striking platforms. One presents two removals, all the others have more than three removals.

The dimensions and the weight are indicated in Tab. 51A-D.

Basalt

The basalt globular core is on a pebble, with preserved cortex; it presents several striking platforms and more than three removals. Its measurements are: length: 98 mm; width: 101 mm; thickness: 84 mm; weight: 1474 g.

Formless cores

Obsidian

Of the 149 obsidian formless cores analyzed, 53 are on pebbles, 12 on blocks and 84 on uncertain blanks. Cortex is absent in 103 cases and it is present in 46 cases. Twenty-seven present a single striking platform, six present two striking platforms, the remaining ones (116) have multiple striking platforms. Nine have a single removal, nine two removals, 13 three removals, 118 present more than three removals.

Length (mm)	N	%
21\30	1	5.26
31\40	9	47.37
41\50	5	26.32
51\60	3	15.79
61\70		
71\80		
81\90	1	5.26
Total	**19**	

A

Width (mm)	N	%
21\30	1	5.26
31\40	9	47.37
41\50	5	26.32
51\60	3	15.79
61\70		
Total	**19**	

B

Thickness (mm)	N	%
11\20	3	15.79
21\30	7	36.84
31\40	7	36.84
41\50	1	5.26
51\60	0	0.00
61\70	1	5.26
Total	**19**	

C

Weight (g)	N	%
11\20	3	15.79
21\30	3	15.79
31\40	2	10.53
41\50	2	10.53
51\60	4	21.05
61\70	0	0.00
71\80	0	0.00
81\90	1	5.26
91\100	1	5.26
101\400	3	15.79
Total	**19**	

D

Tab. 51. Length (A), width (B), thickness (C) and weight (D) of obsidian globular cores.

Basalt

The basalt formless cores are on pebbles, except for one on an uncertain blank. Cortex is always present. Two cores present a single striking platform, three present two striking platforms, the remaining ones (15) have multiple striking platforms. One core presents a single removal, one presents three removals, the others have more than three removals.

Typometry

Length

The data on the length of formless cores are reported in Tab. 52. Obsidian cores are generally much smaller than basalt ones. The mean length of the obsidian formless cores is 54.77 mm compared to 100.7 mm for the formless cores made of other volcanic rocks.

Length (mm)	**Obsidian**		**Basalt**		**Total**	
	N	%	N	%	N	%
21\30	5	3.36			5	2.96
31\40	27	18.12	1	5.00	28	16.57
41\50	36	24.16			36	21.30
51\60	34	22.82	2	10.00	36	21.30
61\70	27	18.12	1	5.00	28	16.57
71\80	8	5.37			8	4.73
81\90	6	4.03	2	10.00	8	4.73
91\100	4	2.68	1	5.00	5	2.96
101\110			5	25.00	5	2.96
111\120	2	1.34	4	20.00	6	3.55
121\130			2	10.00	2	1.18
131\140			1	5.00	1	0.59
141\150			1	5.00	1	0.59
Total	**149**		**20**		**169**	

Tab. 52. Length of formless cores.

Width

The data on the width of formless cores are reported in Tab. 53. The mean width of obsidian formless cores is 41.22 mm compared to 88.2 mm of the formless cores made of other volcanic rocks.

Width (mm)	**Obsidian**		**Basalt**		**Total**	
	N	%	N	%	N	%
11\20	2	1.34			2	1.18
21\30	25	16.78			25	14.79
31\40	45	30.20	2	10.00	47	27.81
41\50	52	34.90			52	30.77
51\60	19	12.75	1	5.00	20	11.83
61\70	4	2.68	1	5.00	5	2.96
71\80	1	0.67	1	5.00	2	1.18
81\90			4	20.00	4	2.37
91\100	1	0.67	6	30.00	7	4.14
101\110			3	15.00	3	1.78
111\120			1	5.00	1	0.59
121\130						
131\140			1	5.00	1	0.59
Total	**149**		**20**		**169**	

Tab. 53. Width of formless cores.

Thickness

The data on the thickness of formless cores are reported in Tab. 54. The mean thickness of obsidian formless cores is 27.54 mm compared to 70.6 mm for the formless cores made of other volcanic rocks.

Thickness (mm)	Obsidian		Basalt		Total	
	N	%	N	%	N	%
11\20	24	16.11			24	14.20
21\30	85	57.05	2	10.00	87	51.48
31\40	27	18.12	1	5.00	28	16.57
41\50	11	7.38	1	5.00	12	7.10
51\60	2	1.34	3	15.00	5	2.96
61\70			2	10.00	2	1.18
71\80			4	20.00	4	2.37
81\90			5	25.00	5	2.96
91\100			1	5.00	1	0.59
101\130			1	5.00	1	0.59
Total	**149**		**20**		**169**	

Tab. 54. Thickness of formless cores.

Weight

The data on the weight of formless cores are reported in Tab. 55. The mean weight of obsidian formless cores is 66.58 g compared to 995.55 g of the formless cores made of other volcanic rocks.

Weight (g)	Obsidian		Basalt		Total	
	N	%	N	%	N	%
1\10	2	1.34			2	1.18
11\20	12	8.05			12	7.10
21\30	28	18.79			28	16.57
31\40	19	12.75	1	5.00	20	11.83
41\50	15	10.07	1	5.00	16	9.47
51\60	20	13.42			20	11.83
61\70	12	8.05			12	7.10
71\80	5	3.36			5	2.96
81\90	10	6.71			10	5.92
91\100	2	1.34			2	1.18
101\200	18	12.08	1	5.00	19	11.24
201\500	5	3.36	1	5.00	6	3.55
501\1000	1	0.67	6	30.00	7	4.14
1001\2500			10	50.00	10	5.92
Total	**149**		**20**		**169**	

Tab. 55. Weight of formless cores.

Cores with preferred cutting edge

Obsidian

Of the eleven cores with a preferred cutting edge, two are on uncertain blanks and all the others are on pebbles. Cortex is absent in only one case. Four present a single striking platform, two present two striking platforms, five multiple striking platforms. One core presents two removals, three cores present three removals, the others have more than three removals. The dimensions and the weight are summarized in Tab. 56.

Length	Width	Thickness	Weight
65	40	30	70
80	58	49	230
68	84	52	342
77	95	57	415
70	46	39	108
58	47	33	64
66	42	31	84
73	44	35	108
52	72	53	182
49	78	51	220
55	68	48	210

Tab. 56. Dimensions and weight of obsidian cores with preferred cutting edge.

Basalt

The basalt core with a preferred cutting edge is on a pebble. It preserves portions of cortex, has a single striking platform and presents more than three removals (length: 33 mm; width: 45 mm; thickness: 27 mm; weight: 45 g).

Spatial distribution

Cores were distributed quite homogeneously in WS (413 specimens, 67.37%), while in ES (200 specimens, 32.63%) they were concentrated in a SW-NE strip where the highest frequency and density are observable in the immediate vicinity of a large basalt block.

The distribution of cores in the two sectors varies with the material they are made of. In the case of obsidian cores, the difference between the two sectors is less than for cores in general (60.06% in WS, 39.94% in ES). In WS, they appear to be rather dispersed, while in ES the density appears higher in the above-mentioned strip, and highest (23) near one of the large basalt blocks in square 9E/6N.

The frequency of cores of other volcanic rocks is much higher in WS (208, 71.97%) than in ES (64, 22.15%). Their distribution is similar to that of cores in general, with the only difference that their concentration in the north-eastern part of ES is less significant than that of obsidian cores.