Archaeological excavations in prehistoric sites of the Blue Nile area, Central Sudan

Excavaciones arqueológicas en yacimientos prehistóricos del Nilo Azul, Sudán Central

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ABSTRACT

Extensive excavations were carried out in two Mesolithic sites, in the river area (Sheikh Mustafa-1, radiocarbon dated to c. 7930-7600 bp) and in the Wadi Soba zone (El Mahalab, c. 7705-6940 bp), and at a wadi Early Neolithic site (Sheikh el Amin, c. 5555-4590 bp). The results of comprehensive analysis of stratigraphical conditions, pottery and lithic material and other cultural types are presented. Multivariate methods such as principal component and rotated factor analysis have been applied to quantitative data from excavated sectors and squares at the three sites. Even though the Mesolithic sites are partially deflated, significant information was gathered on the cultural evolution in the area during the 8th – 5th millennia bp. The inferred scenario presents several change trends: from specifically Nilotic pottery decoration (incised wavy line) to Saharan types such as impressed rocker and dotted wavy line, from lithic backed points and narrow lunates, used for fishing and hunting big game, to wide lunates for the hunting of smaller game. Fishing importance decreased along the whole period of the three sites. Plant gathering, deduced from grinders frequency, increased to a maximum during the Neolithic but a decrease is inferable for the latter phases of this period when the transition begun to a pastoralist way of life.

KEY WORDS
Multivariate analysis, Khartoum Mesolithic and Neolithic, Prehistoric economy, Holocene, Central Sudan

RESUMEN

Resultados de las excavaciones en dos yacimientos mesolíticos, uno de la zona del río (Sheikh Mustafa-1, fechado por carbono-14 en c. 7705-7600 bp) y otro en Wadi Soba (El Mahalab, c. 7705-6940 bp), y un yacimiento neolítico inicial del wadi (Sheikh el Amin, c. 5555-4590 bp), con análisis exhaustivos de estratigrafías, cerámicas, materiales líticos y otros hallazgos, usando métodos multivariantes (componentes principales, análisis factorial). Aunque la erosión ha afectado parcialmente a los sitios mesolíticos, se recuperaron importantes datos sobre la evolución cultural regional del VIII al V milenio bp, cuyas líneas de cambio van desde cerámicas nilóticas con líneas onduladas incisas a tipos saharianos con impresiones de líneas rectas y punteadas, y desde puntas de dorso y segmentos estrechos a segmentos anchos que reflejan el paso de la pesca y caza mayor a la caza menor. La pesca pierde importancia progresivamente a lo largo del periodo de los tres yacimientos, mientras que la recolección vegetal, inferible a partir de los morteros, aumenta continuadamente para empezar a decrecer al final antes del paso a una economía pastoril nómada.

PALABRAS CLAVE
Análisis multivariante, Mesolítico y Neolítico de Jartum, Economía prehistórica, Holoceno, Sudán Central

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1. Excavating the sites

The Mesolithic Site of Sheikh Mustafa

The site, labelled Sheikh Mustafa-1 (no. 13) in the survey gazetteer published in this volume (Fernández *et al.* 2003), is situated immediately at the southern end of the village of Sheikh Mustafa el Fadni, some 200 m from the last buildings. The geographical co-ordinates of the site are 15º 29' 27'' N / 32º 45' 55''. It consists of a low mound, about one meter above its surrounding plain. All the region around this and neighbouring villages is spotted with acacia trees, which are less concentrated just in the site area (Figure 1). The extension of the cultural remains over the surface makes up an approximately squared shape of c. 100 x 80 m (c. 8000 m^2). As we observed during the excavation, flooding, seasonal rains and the subsequent deflation processes have washed the occupation debris over a larger area than that of the original settlement, which probably occupied only an area of about 40 x 30 metres. The site was excavated in January 15th, 1993, from January 29th to February 5th 1994, from November 12th to December 6th 1994 and from January 20th to February 7th 1996.

Figure 1.- The Sheikh Mustafa site before excavation. Abundant white quartz stones can be seen in the foreground, being characteristic at the bigger Mesolithic sites in this area.

The whole site was divided into a virtual grid of 1x1 m units (Figure 2). The x-base line formed an angle of 30º with the magnetic North as to cut across the longest dimension of the site. The x-units were labelled with upper case letters in the southern half and lower case in the northern one. The perpendicular y-line units were named with even numbers in the western half

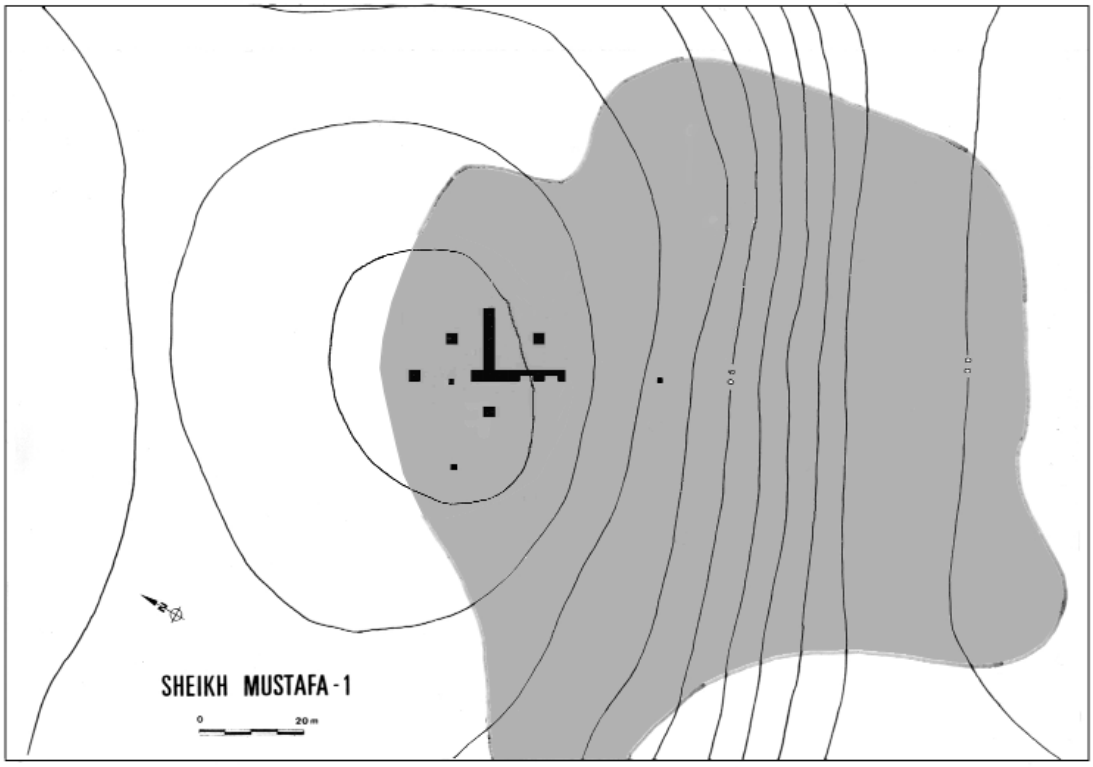

Figure 2.- Sheikh Mustafa: contour map and the excavated sectors; dark area is the surface distribution of artefacts.

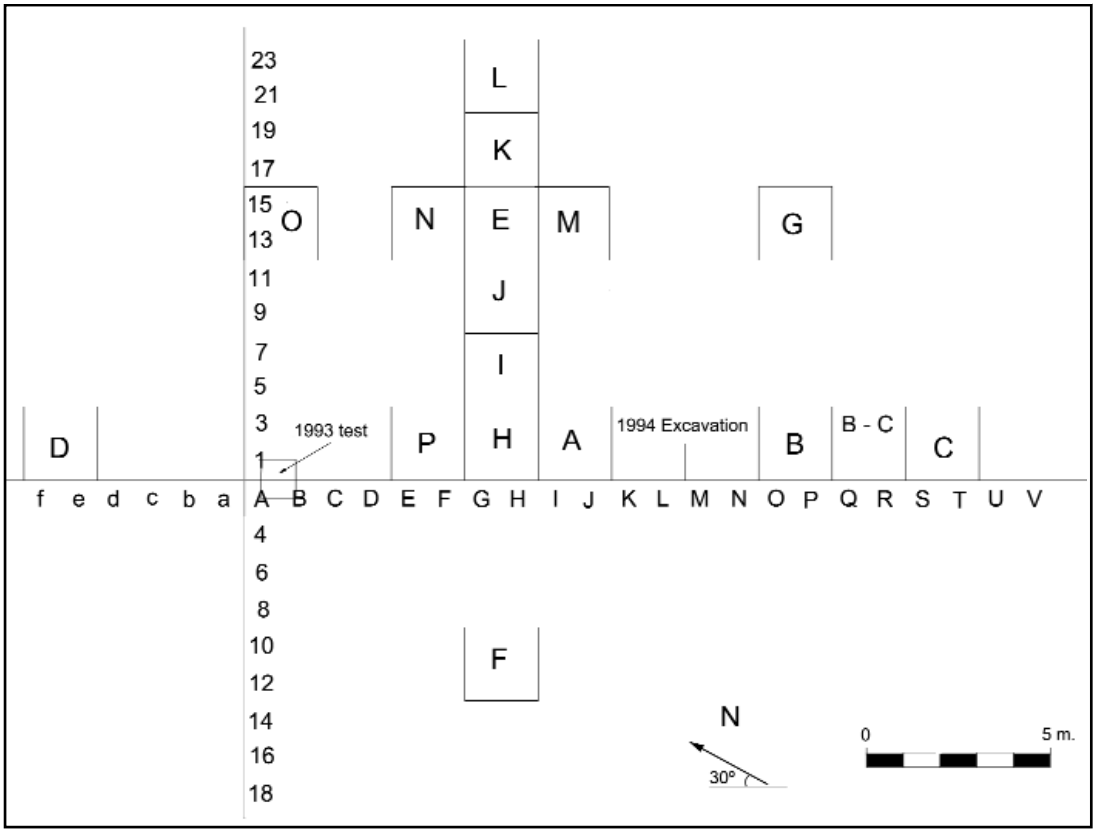

Figure 3.- Sheikh Mustafa: the excavation square meters grid and four-meter sectors system.

and with odd numbers in the eastern part (Figure 3).

The excavation was made in bigger units of 2 x 2 m, called sectors (Spanish *cata*) (Figure 4), that were designated with capital letters starting from the letter A, each of them including four square meters of the original grid (Figure 3). Thus, sector ***A*** was composed of squares I1, J1, I3 and J3, sector ***B*** of O1, P1, O3 and P3, sector ***C*** of S1, T1, S3 and T3, sector ***D*** of e1, f1, e3 and f3, sector ***E*** of G13, H13, G15 and H15, sector ***F*** of G10, H10, G12 and H12, sector ***G*** of O13, P13, O15 and P15, sector ***H*** of G1, G3, H1, H3, sector ***I*** of G5, G7, H5 and H7, sector ***J*** of G9, G11, H9 and H11, sector ***K*** of G17, G19, H17 and H19, sector ***L*** of G21, G23, H21 and H23, sector ***M*** of I13, I15, J13 and J15, sector ***N*** of E13, E15, F13, F15, sector ***O*** of A13, A15, B13 and B15 and finally sector ***P*** of E1, E3, F1 and F3. Squares Q3 and R3 between units B and C (sector B-C) were also dug.

Figure 4.- Sheikh Mustafa: excavating sector A, November 1994.

Sectors A to G were dug in November-December 1994 to check the spatial variation in the site. Sectors H to P were excavated in January-February 1996 to concentrate on the central and denser part of the settlement. Thus three trenches cut across the nuclear area of the site (Figures 5-6). During the previous January-February 1994 season, several squares had been dug, corresponding to the labels K1, K3, L1, L3, M3 and N3 in the central area, and a30 and AO1 in the peripheral parts. Square a30 is situated 15 m south-west, and AO1, 40 m south-east of the datum point. In January 1993, during our second visit to the site,

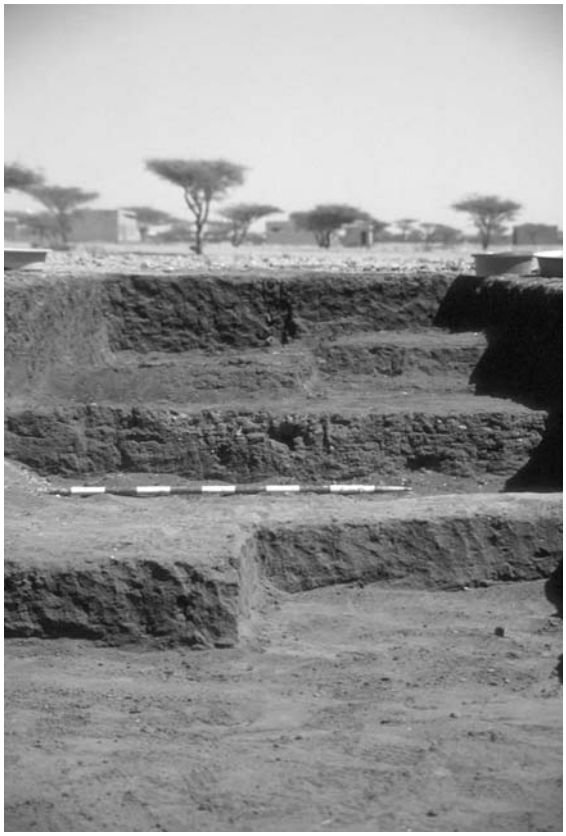

Figure 5.- Sheikh Mustafa: excavation progress in sectors J-L seen from the west.

a meter square test-pit was excavated between A-B/1-2. A total of 75 square metres were excavated in the site during the four field seasons.

Figure 6.- Sheikh Mustafa: the trenches in the central part at the end of excavation in February 1996.

Three levels were distinguished at the beginning of the excavation. The superficial sand sheet forms the surface level, thick of 3-5 cm. Level 1 is a transitional interface between the end of surface level and the level 2. Level 2 is an occupational level or "living floor" with the biggest concentration of artefacts. The sediment in both levels is composed of sand and small pebbles mixed with muddy black organic matter. The sediment of level 2 is slightly denser and darker, and the amount of archaeological finds and bones is also higher than in level 1 (Figures 7-8).

Usually level 2 begins at a depth of 20/30 cm and the natural soil (Umm Ruwaba formation of Nile mud with small gravel pebbles) is reached at between 60 and 90 cm depending on the area.

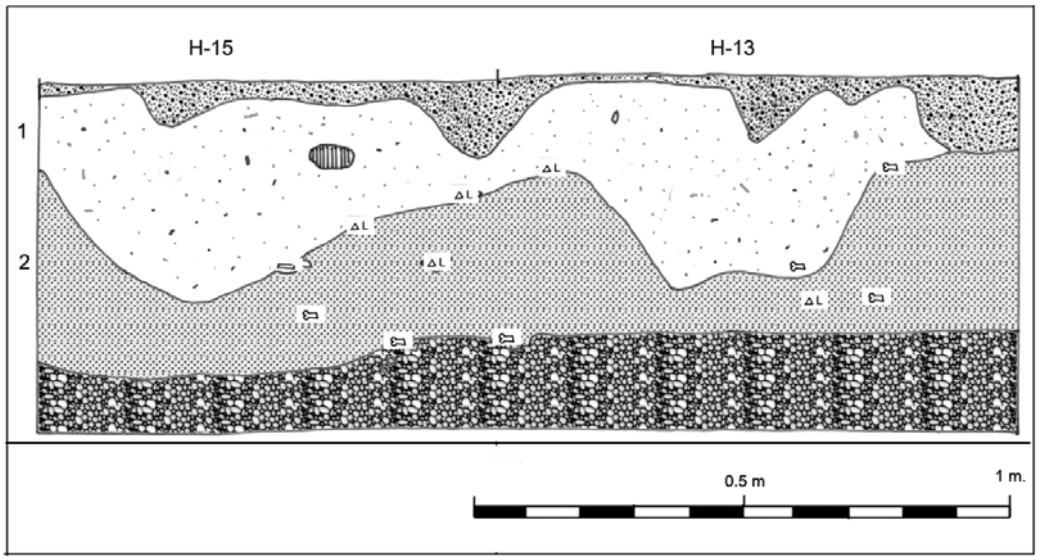

Figure 7.- Sheikh Mustafa: stratrigraphic section of H15-H13 wall at sector E. Here a quite irregular division was apparent between level 1, just under the surface stratum, and level 2 with more artefacts and bones, directly over the natural Umm Ruwaba formation. Burrowing hole in dark, lithics (L) and bones are marked on the section.

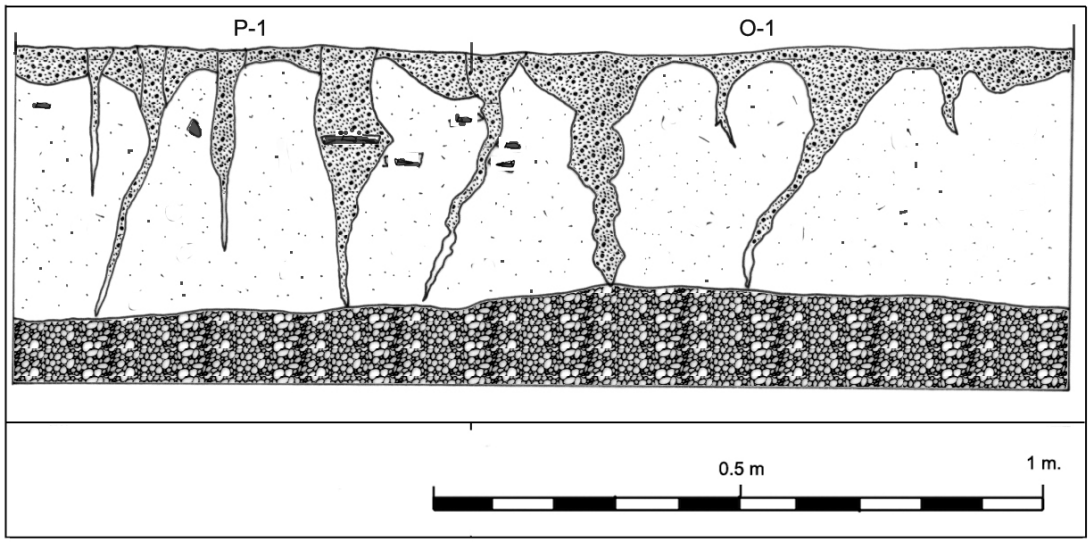

Figure 8.- Sheikh Mustafa: stratrigraphic section of P1-O1 wall at sector B. Here only one archaeological level was perceptible between the surface and natural level. Downward sand filtration through shrinking crevices was intense in this part of the site. Pottery sherds are marked in black.

In a few places we recognised another thin level under level 2 which was called level 3. In each level the excavation was continued following artificial layers of 5-10 cm. As the excavation progressed, however, the separation of levels 1 and 2 became less perceptible, and during the 1996 campaign the site was excavated only according to artificial levels. Actually, in most of the sectors the artefact density seems to increase at an approximately constant pace from surface down to the bottom of level 2, without clear discontinuities within the vertical deposit and horizontally across the site (Figure 8). Apparently the original distribution of the archaeological deposit has been mixed to a certain extent due to the effect of site formation processes and later post-depositional disturbances, especially the ubiquitous animal burrowing that dispersed the artefacts upwards resulting in the current conditions of the place. Another frequent disturbance was caused by human graves, Christian or most probably Muslim, that have been dug through the occupation debris and in its turn are also heavily affected by burrowing and other kinds of erosion. An outcome of all those disturbances was the observed fact that the lower layers produced more small size items (e.g. lithics or little sherds) and the upper more bigger objects (larger sherds and more pottery in general, mortars, etc.). This can be explained by the "size-effect" (Baker 1978): due to friction process, objects of wider section area tend to resist better gravity forces and to "float" more when subjected to water and other uplifting forces.

Figure 9.- Sheikh Mustafa: bone accumulation in square J3.

Figure 10.- Sheikh Mustafa: human bones accumulation during the excavation of square G19.

The concentration of cultural items and especially animal bones in small patches, usually with a darker colour (Figures 9-10) may have been produced by disturbance factors mentioned above. This is evident in several areas (B15, G5, G7, G19, H13, H15, I3, J1, J3, J14, P1, e1, e3), while in other squares the remains were relatively scarce. An alternative origin for this fact would be the original human action, for at least in one case (G15) a side scraper on a primary flake and an unretouched blade, both in quartz, were found associated with a big bone of antelope. The same origin can be confidently postulated for several circular aggregations of artefacts that suggest the presence of small storage or rubbish pits in the site. The concentration in e3 was around 50 cm in diameter, and between O13 and O15 there was another one, 30 cm wide and some 30 cm deep from its beginning in the upper level 2 to the bottom inside the natural soil. A third pit was discovered in the northern corner of P15, but it was less obvious to observe than the previous one. Similar accumulations, cemented with calcium carbonate material (*kankar*), were recorded in the Early Khartoum site, being initially interpreted as coming from an original continuous layer later broken by post-depositional disturbance (Arkell 1949: 4).

Eventually, the overall effect of deflation processes acting on the site was a kind of "dismantling" of the mound originally formed by human action. The two squares dug in the periphery area, a30 and AO1, produced very few cultural remains, their sediments being much more sandy and only 22-25 cm thick. Also the sectors D, F, C and O that are only a few metres apart from the central "core" of the site (located at sectors A-B to E) yielded fewer remains. The lower part of the occupation debris, which was identified as the first original settlement floor (the bottom of level 2), was observed to dip some centimetres from the outer to the inner areas of the site. Our impression is that cultural remains in the external areas were originally situated on the top of the central area, and that wind and rain washed them down the slopes of the site (Figure 11). Significantly, a charcoal sample from sector F (square G10, taken at 40 cm deep) produced the youngest radiocarbon dating, still inside the Mesolithic period, of the whole group of site dates (6295 ± 215 bp) (see table 1). In the lower levels of sectors apart from the central area there seems to be, however, some remnants left of the original occupation

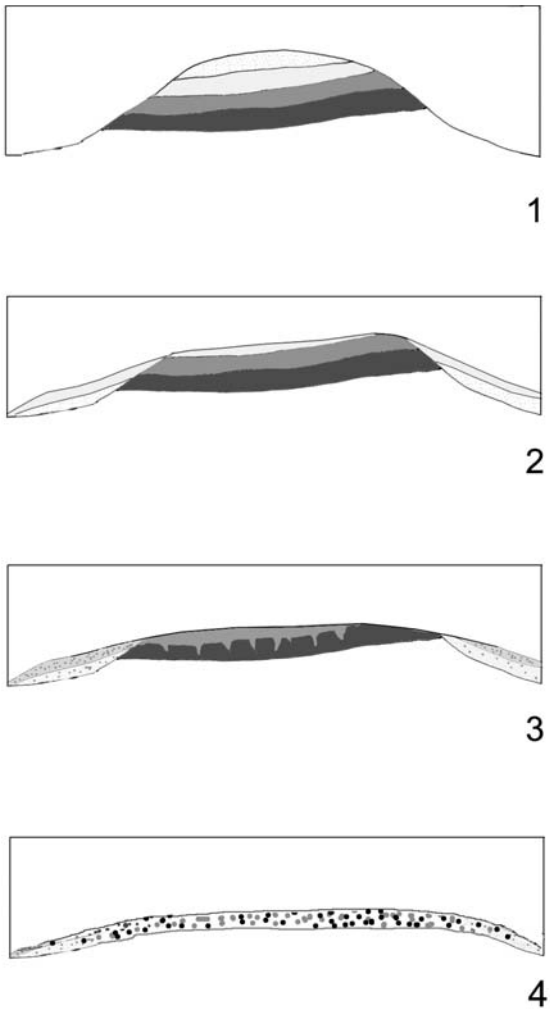

Figure 11.- The subsequent stages of deflation in Wadi Soba Holocene sites. Sheikh Mustafa, El Mahalab and a few other sites were in stage 2-3, but most of the sites found in the survey had reached stage 4.

deposit. Here, contrary to the uniform aspect in the central zone, deposits have a more "patchy" character, with some small concentrations of artefacts and bones surrounded by almost empty areas.

During the excavation of sectors A to G in the 1994 season, once we reached level 2, a system of "cell-frequency" recording was used for the contextual assignation of the artefacts (Johnson 1984). All the artefacts were collected together from small but relatively high-resolution sampling units ('cells' or earth slices of 0.5 x 0.5 x 0.05 m), numbered 1 to 4 inside the square metre unit. The level of accuracy thus obtained is supposed to be enough for most archaeological purposes. The extra-precision of a tri-dimensional location for each artefact is probably measuring only 'noise', such as post-depositional disturbance. This practice is also in accordance with ethnoarchaeological claims for digging "larger units and record less individual detail" (Gamble 1991: 14). Yet, analysis of these data yielded the same results as the square meter data.

Fragments of unburned clay with vegetal imprints on them (Figure 33: 12-17) were found in several places (G12, H12, H15, I3, O1, O13, P1, P3, R3, S3). The vegetal marks are very thin and probably were made by grasses or other kind of small plant, and not with reeds or wooden posts, such as those commonly reinforced by clay plaster in hut walls all over Africa. The same type was recorded in Saggai and interpreted as some kind of platform or support for querns or other type of working surface (Caneva 1983: 18, Fig. 5). In Early Khartoum, they were interpreted as coming from temporary windscreens similar to those used by the Nilotes during the dry season (Arkell 1949: 79, 107-8, pl. 55:1).

The remains of two Mesolithic burials were recorded in the site, in squares G15 and G19. Both had been heavily affected by post-depositional disturbances. The first was in the northern corner of G15, 60 cm deep. It consisted only of the broken remains of the cranium, lower mandible and a few bones of the upper body (fragments of scapula and clavicle) of a probable adult male. The rest of the body had completely vanished (Figure 12). The body was placed, probably in a flexed position, with the head at west looking south. No traces of grave furnishing were observed as in other Mesolithic burials (Haaland 1995b). Only a few WL sherds

Figure 12.- Sheikh Mustafa: Mesolithic human remains from sector E, square G15.

were found not far from the bones, some 50 cm at south-east on a spot where the central part of the body must have been before the disturbance (see Arkell 1949: 31 for a clearer example of this kind of grave good). The bone fragments from this burial were unfortunately lost during the transport of the 1994 season findings for further analysis in Spain. The remains of the second burial were found in the 1996 campaign (see figure 10). They consisted only of several fragments of the upper cranium and three teeth of a young boy eight years old, found in the southern quarter of square G19 at 40 cm deep (see osteological and dietary analysis by Trancho and Robledo 2003). Four small fragmented grinders were found together, 80 cm west of the cranium remains. Both graves were located in an area that has been interpreted as the beginning of the periphery of the camp settlement.

As it has been unfortunately constant in all the Mesolithic settlement sites in Sudan and the Saharan desert, pottery is found only in a form of sherds. No complete pot or reconstructable broken-pot has so far been found (cf. Arkell 1949: 81). The same can be said of the stone grinders, which are always found broken to tiny fragments. This fact made us to assume the idea that they were intentionally fractured. On the basis of ethnographic analogy, they could have been broken to be secondarily re-used to delimit hearth fires (Haaland 1987: 79).

The radiocarbon dates obtained from samples in this site are given in table 1. All the samples are of charcoal since the site did not yield any remain of freshwater mollusc or snails (see Chaix 2003 for a seasonal explanation of this fact).

Square	Deep	Sample	Laboratoy	Method	Lab. ref.	Date	Cal. BC
G-10	50 cm	charcoal	Trondheim	Conventional	T-11920	6295 ± 215 bp	5480-4990
G-3	50 cm	Id.	Groningen	AMS (charcoal)	GrA-10527	5520 ± 70 bp	4460-4250
G-3	50 cm	Id.	Groningen	AMS (alkali extract)	GrA-9836	5790 ± 50 bp	4720-4550
G-9	48 cm	Id.	Groningen	AMS (alkali extract)	GrA-10530	7600 ± 80 bp	6590-6260
H-11	39 cm	Id.	Groningen	AMS (charcoal)	GrA-10529	7720 ± 110 bp	6660-6430
E-15	54 cm	Id.	Groningen	AMS (charcoal)	GrA-9834	7930 ± 50 bp	7030-6690

Table 1.- Radiocarbon dates from the site of Sheikh Mustafa. Calibration has been made using the program OxCal 3.8, Bronk Ramsey 2002 (date ranges are given with 68.2% of probability).

The Mesolithic Site of El Mahalab

The site is situated in the Wadi Soba area, raised about 2 metres over the surrounding plain at the north bank of the wadi (15º 36' 12'' N / 32º 48' 24'' E) (Figure 13). There are two small villages in the nearby, Umm Maishera at north-east and El Mahalab el Dileitab at south-east, this being nearer to the site. The extension of the finds has an approximate circular shape of c. 110-120 m in diameter. This area roughly coincides with the elevation and the smooth encircling slopes. The site was excavated on January 20th 1993, February 5th to 8th 1994 and February 8th to 13th 1996.

The first excavation was one-square meter test-pit in the middle of the site upper flat area. This pit was later chosen as the datum point for the virtual grid over the whole site, with the number x-axis following an E-W direction (even numbers at east, odd at west) and letter y-axis the N-W direction (upper case at south, lower at north). During the 1994 field season the squares A-B/13-15 were excavated, and in the longer season of 1996 the dig was made at the squares A-B/45-47 (sector A), A-B/20-22 (sector B) and N-O/2-4 (sector C). A total of 17 square meters were excavated on the site.

The two pits excavated in the central part of the site (first test and squares A-B/13-15) had an

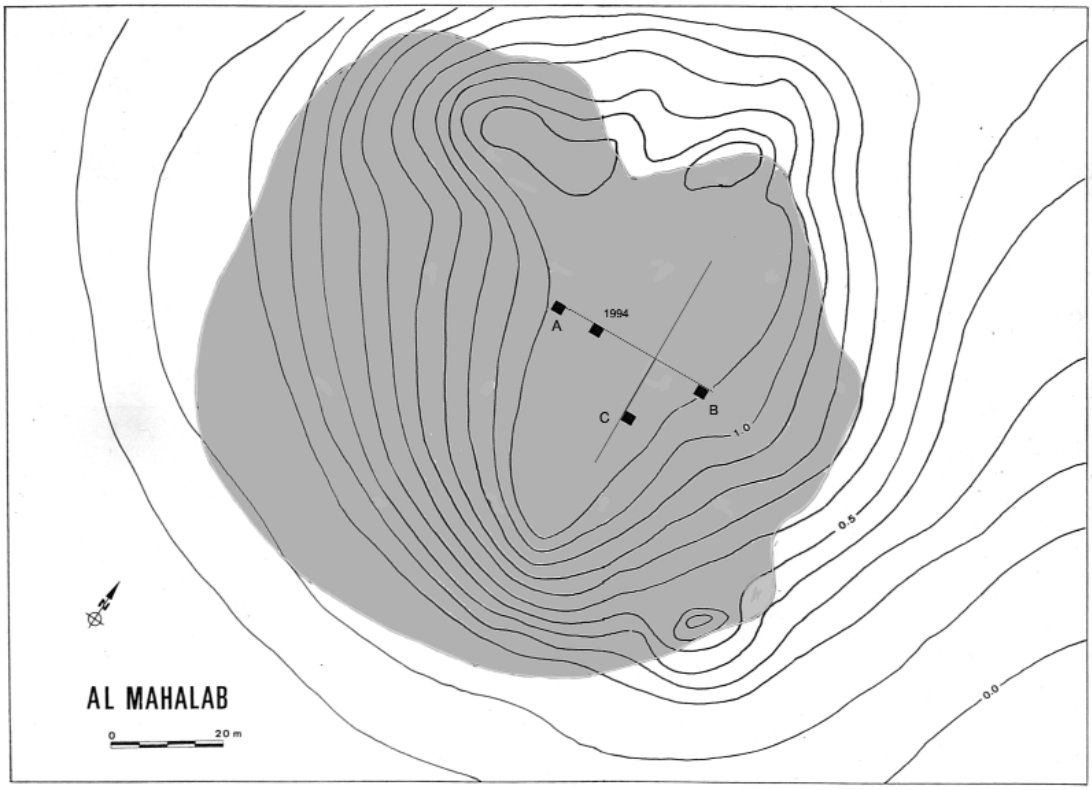

Figure 13.- El Mahalab: contour map and excavated sectors. Dark area indicates the surface distribution of artefacts.

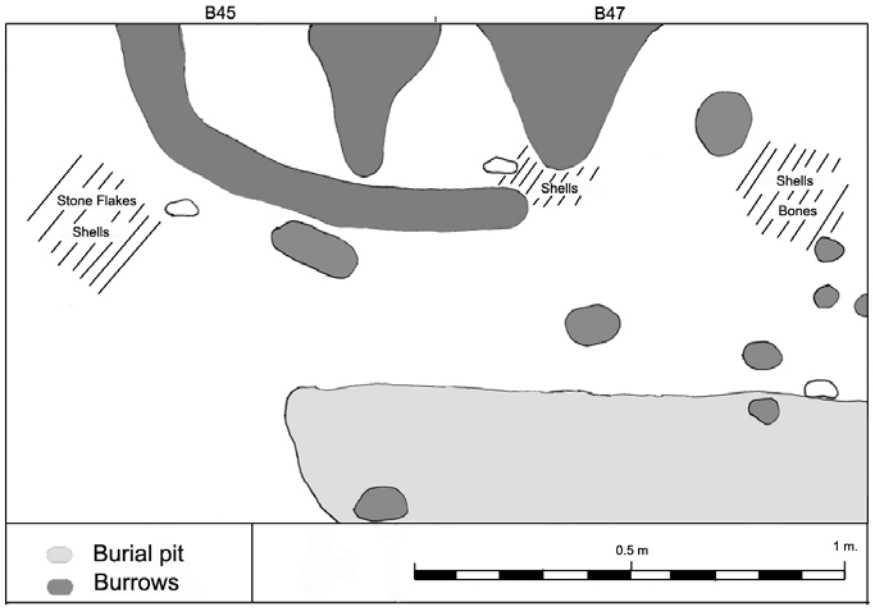

Figure 14.- El Mahalab: southern vertical section (B45/47 wall) of sector A, with the burrowing tunnels and the burial pit entering the wall (down).

acceptably intact occupation debris, while the other sectors were much more disturbed by post-depositional processes. Out of the three sectors excavated in 1996, the first two (A and B) were heavily affected by burrowing. The burrowing tunnels were found everywhere, usually with a medium diameter of 20 cm. The deposit in sector A was mostly sandy because of this disturbance. Also a recent human grave was found in this sector (squares B-45/B-47) (Figures 14-15). The bones had been removed and only the legs were in the original position. The body was extended along an E-W direction, with the head at east looking north, as far as it could be inferred from the few bones left (Christian period?). An oval pit had been dug for the burial of 165 x 60 cm, 80 cm deep under the site surface. Four stones had been laid to mark the northern limit of the hole. Only the sector C (N-O/2-4), which was opened near the southern end of the elevation, had its occupation debris less disturbed. A quite acceptable sample of well-preserved animal bones was recovered from this sector, divided into two artificial levels (see Chaix 2003).

In the test square excavated in 1993 (Fernández *et al*. 2003: section 1, Figures 8 & 13), we could distinguish a clear stratigraphy divided in the following levels, starting from the upper part (Lario *et al*. 1997). Level f: aeolian sands (present sand sheet). Level e: ochre sands similar to level c, with remains of vertebrate bones and pottery (WL, DWL and RK types). Level d: aeolian sands, sterile in faunal and archaeological content. Level c: ochre sands with remains of vertebrate fauna, abundant pottery. Level b: grey sands with silts, remains of vertebrate bones and

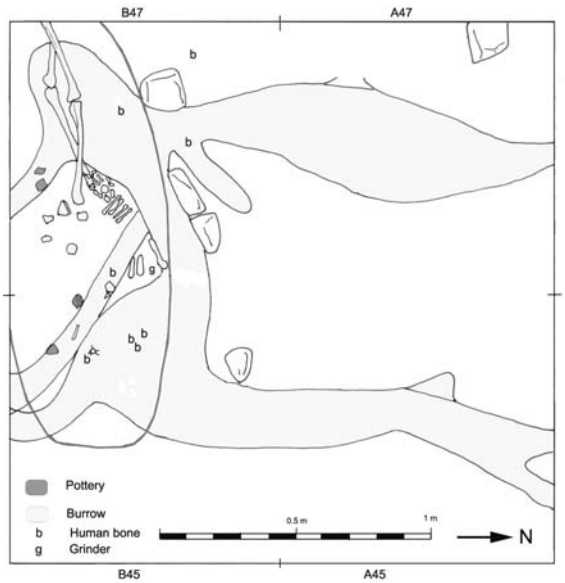

Figure 15.- El Mahalab: plan of sector A with the pit and disturbed human burial of Christian (?) age at left.

Level	Deep	Sample	Lab. ref.	Date	Cal. BC
e	17 cm	Shell	T-10949	6940 ± 85 bp	5900-5720
c	53 cm	Shell	T-10948	7470 ± 60 bp	6400-6250
b	78 cm	Shell	T-10946	7705 ± 145 bp	6750-6390

Table 2.- Radiocarbon dates from the site of El Mahalab. Calibration has been made using the program OxCal 3.8, Bronk Ramsey 2002 (date ranges are given with 68.2% of probability).

WL and DWL pottery, RK variety being less abundant. Level a: grey silts and marly-silts originated by a flooding event of the Nile; archaeologically sterile. The levels e, c and b were radiocarbon dated by the conventional method as in table 2.

The Neolithic Site of Sheikh el Amin

The site is located on the south bank of the Wadi Soba course, about 1.8 km north of the village of Sheikh el Amin Balla, whose *gubbas* can be seen from the place. It is formed by eight *kôms* made of archaeological debris that are elevated between 1 and 1.8 m over the surrounding plain (15º 34' 46'' N / 32º 49' 39'' S) (Figure 16). The excavation was made on February, 1st 1993, from January, 25th to February 19th 1997, and from January 24th to February 15th 1998. The surface distribution of archaeological artefacts extends over an area of roughly 250 x 240 m. Subsequent excavations showed that the mounds have the bigger concentration of occupation debris, while the gullies and flat areas in-between are usually void of them.

A first square meter test-pit was excavated in 1993, on the top of the mound where later sector B was opened. It produced a lot of material, mostly of Early Neolithic (Shaheinab) chronology yet including some sherds of Dotted Wavy Line in its lower part (see later, pottery analysis). A whole shell from the lower levels was analysed in the Trondheim radiocarbon laboratory using the conventional method. It yielded a date of 5555 ± 60 bp (T-10950), calibrated 4460-4340 BC (see Fernández *et al*. 2003: table 2).

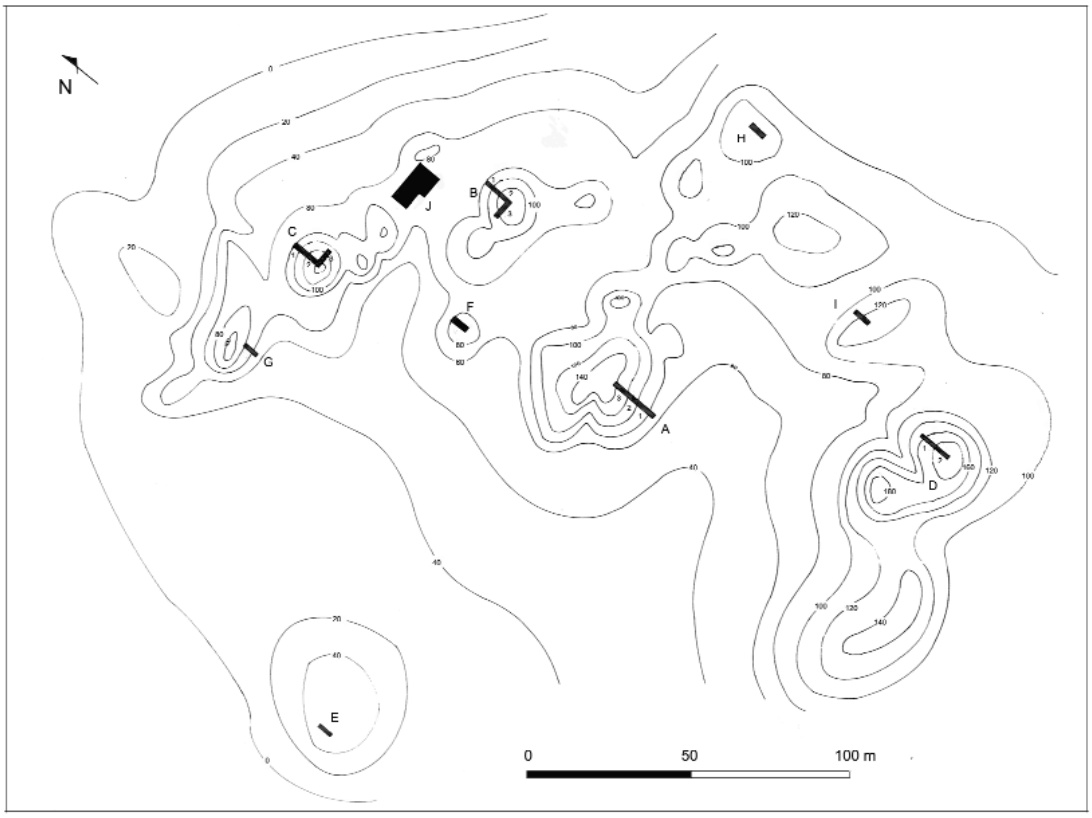

Figure 16.- Sheikh el Amin: contour map and the excavated sectors (A-J). Contour lines every 20 cm.

Figure 17.- Sheikh el Amin: sector A at the end of excavation. A big burrowing tunnel can be seen at the bottom of the dig.

Figure 18.- Sheikh el Amin: excavation of level 3 in sector J-1. Pottery sherds from the intact level can be seen on the excavated surface.

The date roughly coincides with the middle point of the conventional Early Neolithic period, between 6000 and 5000 bp (Hassan 1986).

In the 1997 field season, ten excavation sectors were dug on every one of the principal mounds and in between some of them: sectors A to J (Figures 16 & 17). The sectors consisted of one trench of 5 x 1 m (sectors E, F, G, H, I), 5 x 2 m (sector J-1), 10 x 1 m (sector D), 15 x 1 m (sector A), 10 x 1 and 5 x 1 m forming a right angle (sector C), 9 x 1 and 5 x 1 forming a right angle (sector B) (Figure 17). For contextual assignation of the artefacts, the bigger sectors are divided in sub-sectors of 5 x 1 meters (e.g. A1, A2 and A3). The 1998 season was entirely dedicated to the excavation of the presumably intact archaeological floor that had been discovered during the previous season in sector J (Figure 18), covering an area of 50 m^2 (called sector J-2) so this sector was finally excavated in an area of 60 m^2. In total, 140 square meters were excavated in the site.

With the exception of sector J that will be dealt with later, all the other areas had the same stratigraphic composition. Bellow a surface level of variable thickness (sand sheet) there is only one archaeological deposit level until the natural soil, the Umm Ruwaba formation, at 90-130 cm deep. Artefacts and bones seemed to be almost completely mixed without any indication of chronological arrangement. As we will see later, there is no evidence of cultural evolution from bottom to top. The pottery decoration types, for instance, were present in approximately the same proportions along the whole sequence (see later pottery analysis, table 12). As it is usual at many sites in Central Sudan, post-depositional disturbances are considered to have been the principal agent of this unfortunate mixing effect. Animal burrows had intensively hollowed out some of the mounds (Figures 17, 19). In some of them, for example near sector D, the earth was so soft that it caved in when walking on it. Moreover, some of the mounds had been chosen as burial

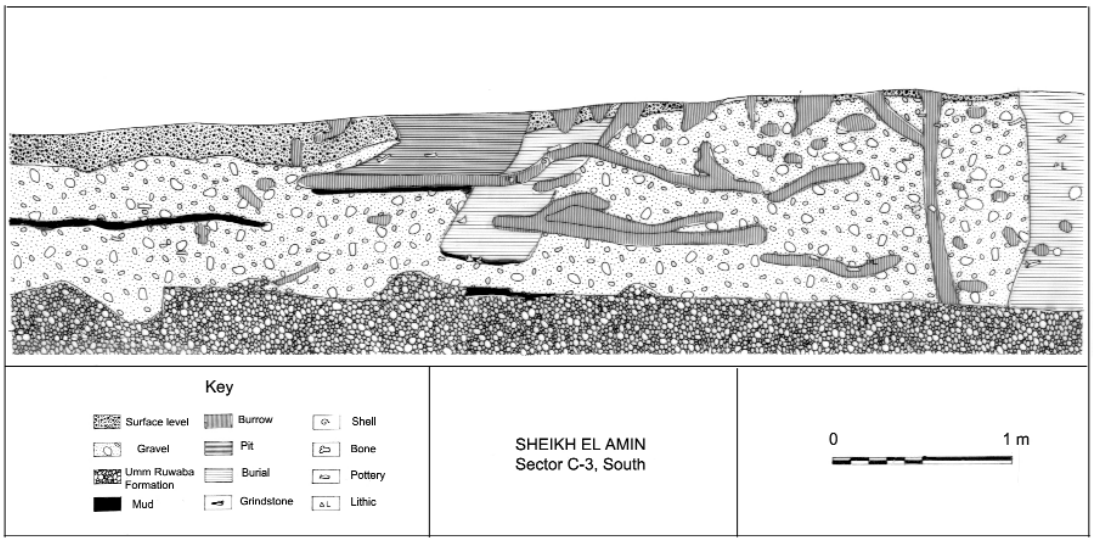

Figure 19.- Sheikh el Amin: stratigraphical section of the southern wall of sector C-3.

places in old and recent times, resulting in quite a large number of human bones being found in the deposit. One Meroitic burnished black pot was found in sector C-3 (Figure 47: 10), suggesting that some of the remains were buried at that period. In sector B the abundance of human bones, usually disturbed and mixed with other debris, was almost the typical of a true cemetery. The reason to choose these mounds for burial ground was maybe its elevated position over the plain.

In table 3 a comparison is made between the maximum depth attained in the excavated sectors, from surface to the beginning of the natural soil, and the height of the corresponding mound as compared with its surrounding plain. Both values roughly agree, what can be interpreted as the mounds having been erected by the effect of accumulated human action over an originally flat area.

Sector	Natural level depth (cm)	Height over plain (cm)
A	130	120
B	70-80	70
C	100-120	100
F	60	60
G	70-90	80
H	70	70
I	60	50
J	40-50	50

Table 3.- The Sheikh el Amin site: depth of natural level in the excavation and height over the surrounding plain in the different sectors.

The sectors excavated in the lower areas, such as E, F and H, produced fewer artefacts and their sediment was composed mostly of sand with less gravel than in the other sectors. This could indicate that the sediment is formed as a result of flooding and surface wash by erosion from the higher mounds. In sector E the Nubian Sandstone formation was reached at 90 cm deep. One exception was sector J, which was excavated in a relatively flat area between the two highest mounds, B and C. The height of this area over the plain situated at north is of 50-60 cm. Here the soil is more homogeneous than in the nearby mounds. There were very few burrow tunnels and no human skeletal remains were found. The cause of this especial condition is that a hard layer on the top of the deposit, 10-25 cm thick and made up of mud and gravel, is sealing the archaeological levels. This layer is archaeologically sterile, so it was not washed down by erosion from nearby mounds as it possibly occurred in sectors E and F. Its origin could be the annual water flooding from the close Wadi Soba. Maybe the protected location of this zone between two higher areas was also the cause of its current intact situation in spite of intensive recent erosion in the whole territory.

The stratigraphic sequence of sector J is as follows (Figure 20). The first upper 2-3 cm correspond to the surface level, composed of the present sand sheet and a fine mud layer from recent flooding. The level 1, 10 to 25 cm thick depending on the places, is an archaeologically

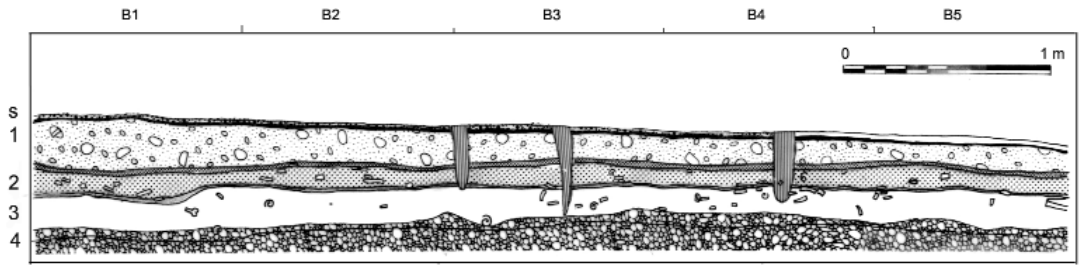

Figure 20.- Sheikh el Amin: stratigraphical section of sector J. Levels (Surface and 1-4) are indicated at left. See Figure 19 for key.

sterile muddy gravel and was excavated together with the previous one. The first archaeological level, level 2, comes next with more but still scarce archaeological material randomly distributed horizontally and vertically. This material probably came from the level 3 by the effects of burrowing, water uplifting and other post-depositional disturbances. Its thickness varies from 10 to 15 cm. Level 3 is the original occupation level of this part of the site, with a very dense concentration of artefacts in its 15-20 cm thickness. Hundreds of pottery sherds were, though in the usual fragmentary condition, deposited in horizontal position as they had probably been laid when the soil was formed (Figures 18, 21-23). Artificial sub-levels, thick of 5 cm, were used during the excavation of this level, thus dividing the occupation deposit in four vertical components: 3A, 3B, 3C and 3D. The second and the third sub-level contained more artefacts and seemed to be in a better preserved condition, so all the items excavated in them were drawn in their exact tridimensional position as they were uncovered. The plots can be seen in figures 24 and 25. Level 4 is the natural soil of the Umm Ruwaba formation, but some artefacts are still present in its first part (e.g. some stone grinders).

To excavate this area a virtual grid of square meters using letters (E-W direction) and numbers (N-S) was used. A total of 60 m^2 were dug,

Figure 21.- Sheikh el Amin: detail of pottery sherds in level 3 of sector J.

Figure 22.- Sheikh el Amin: excavating sector J (1998).

Figure 23.- Sheikh el Amin: Drawing the position of finds of level 3 in Sector J (1998).

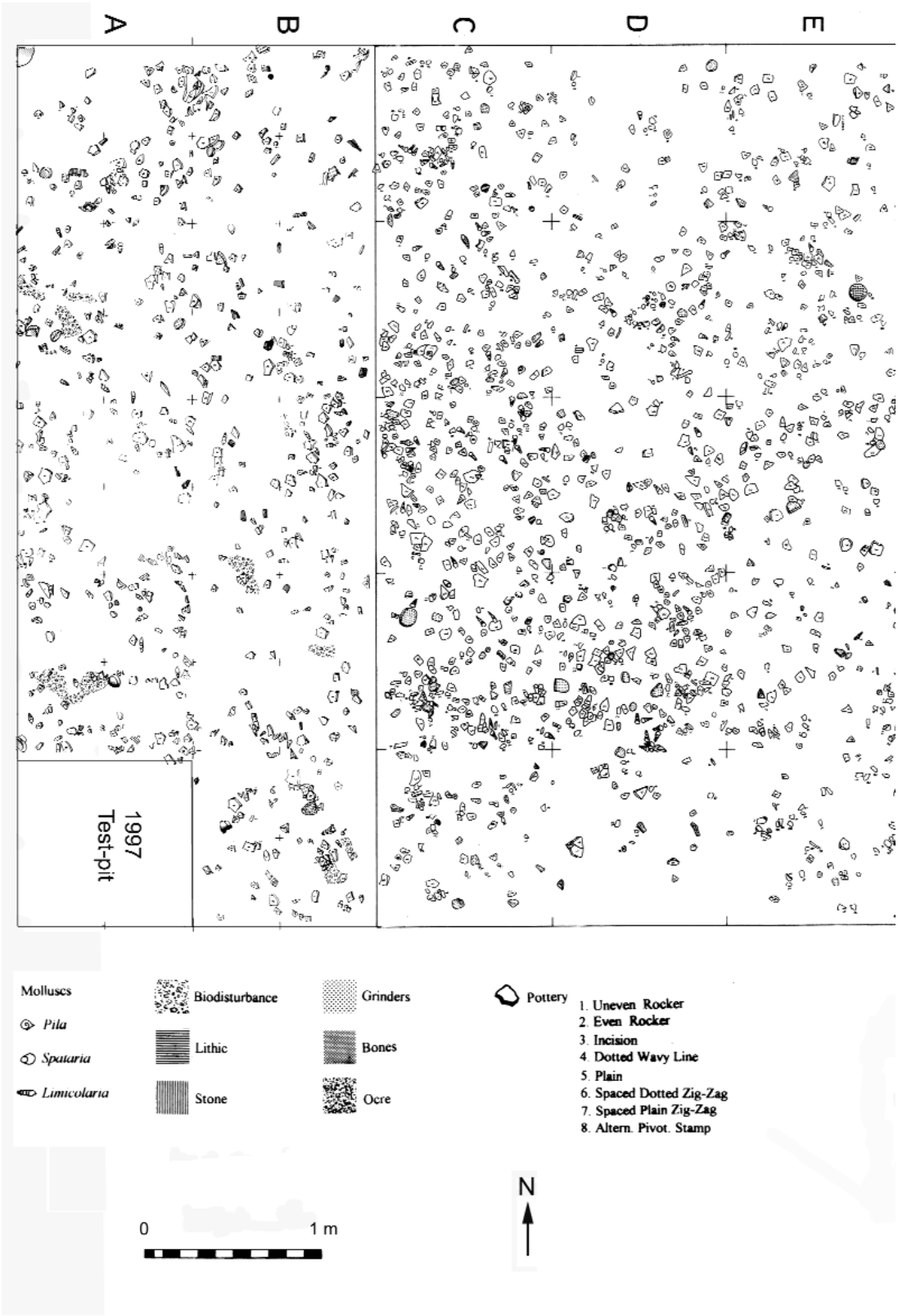

Figure 24.- Sheikh el Amin: plan of level 3B of sector J-1/2.

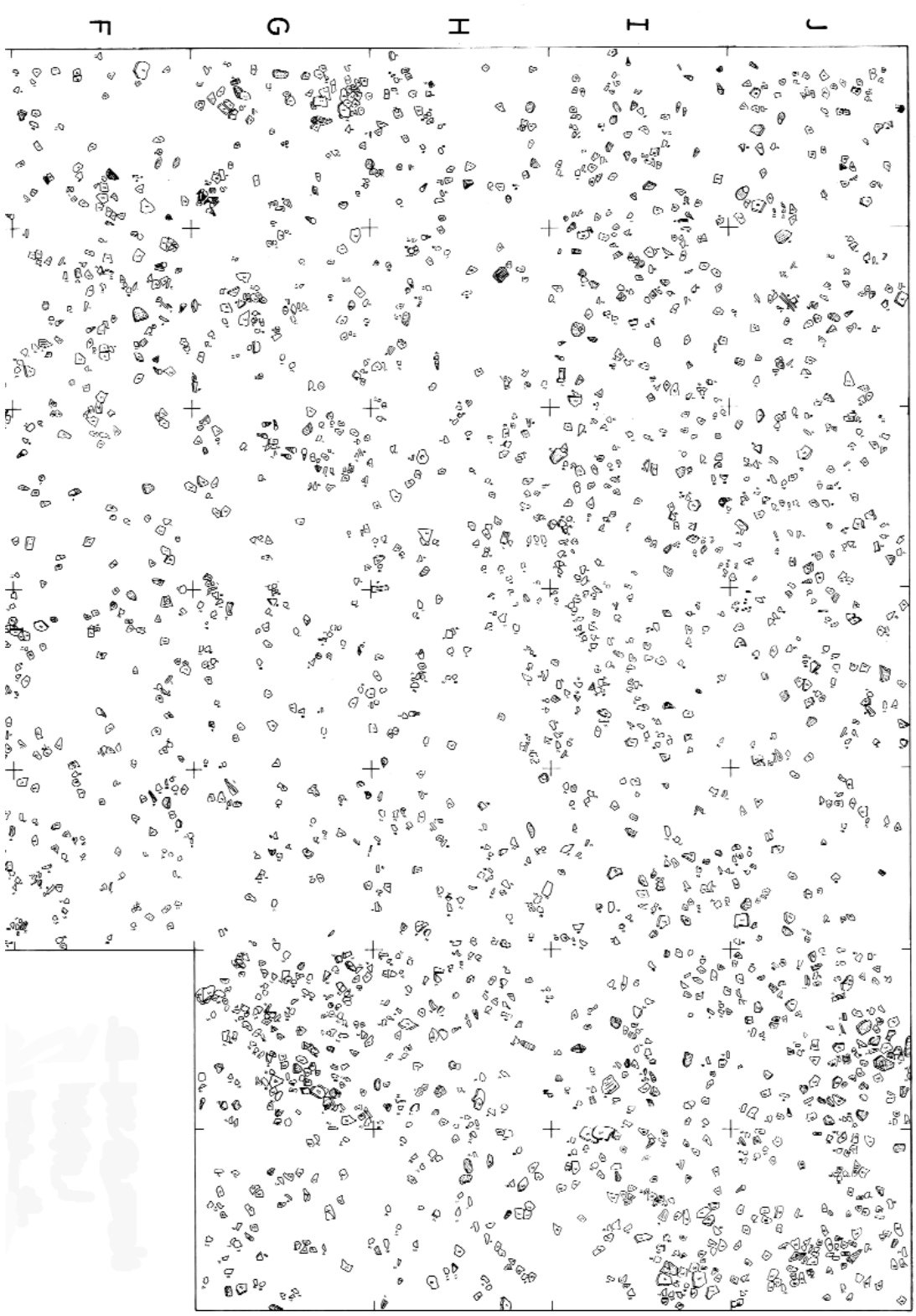

Figure 24.- Continuation.

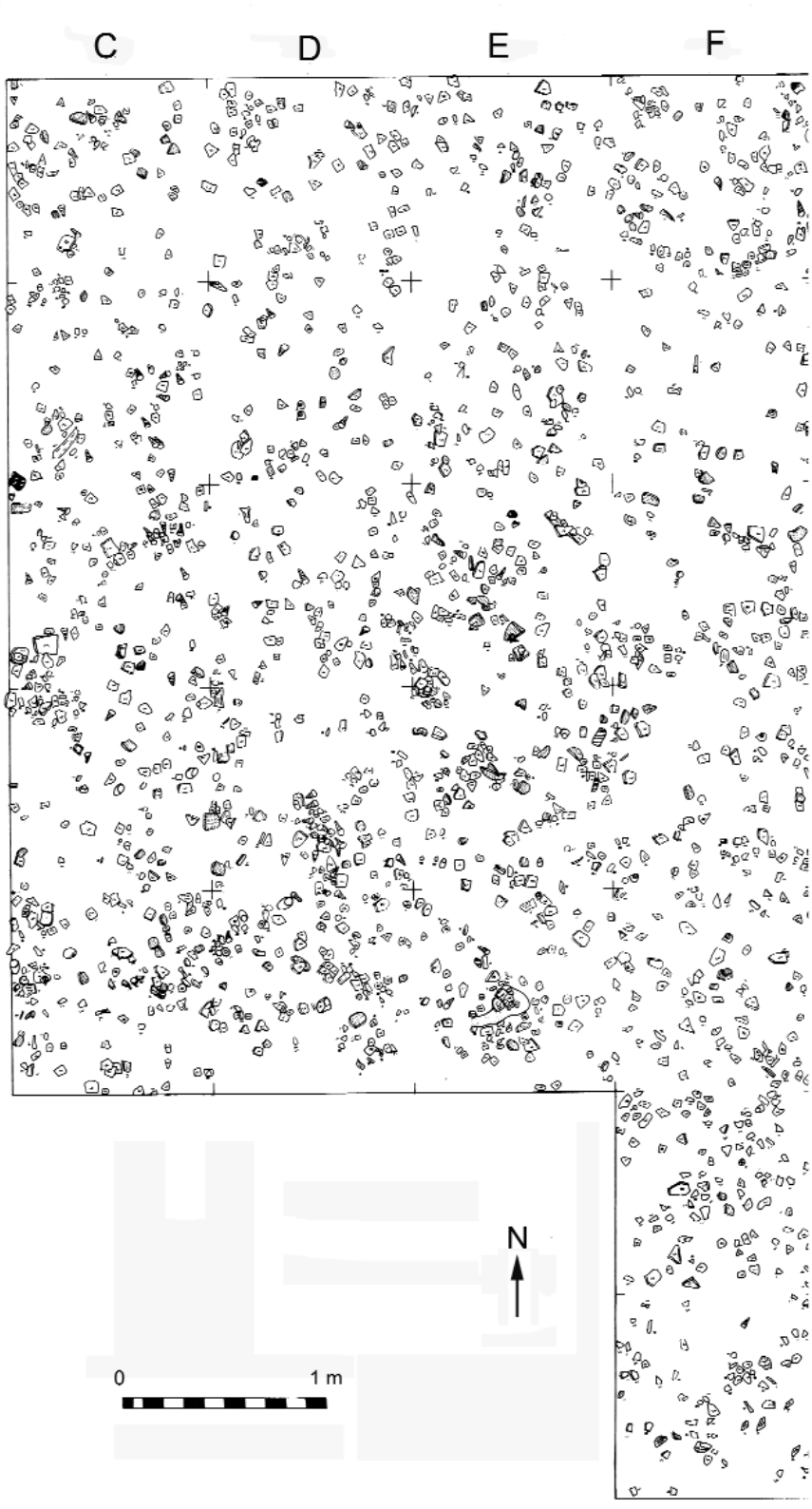

Figure 25.- Sheikh el Amin: plan of level 3C of sector J-2. Legend as in Figure 24.

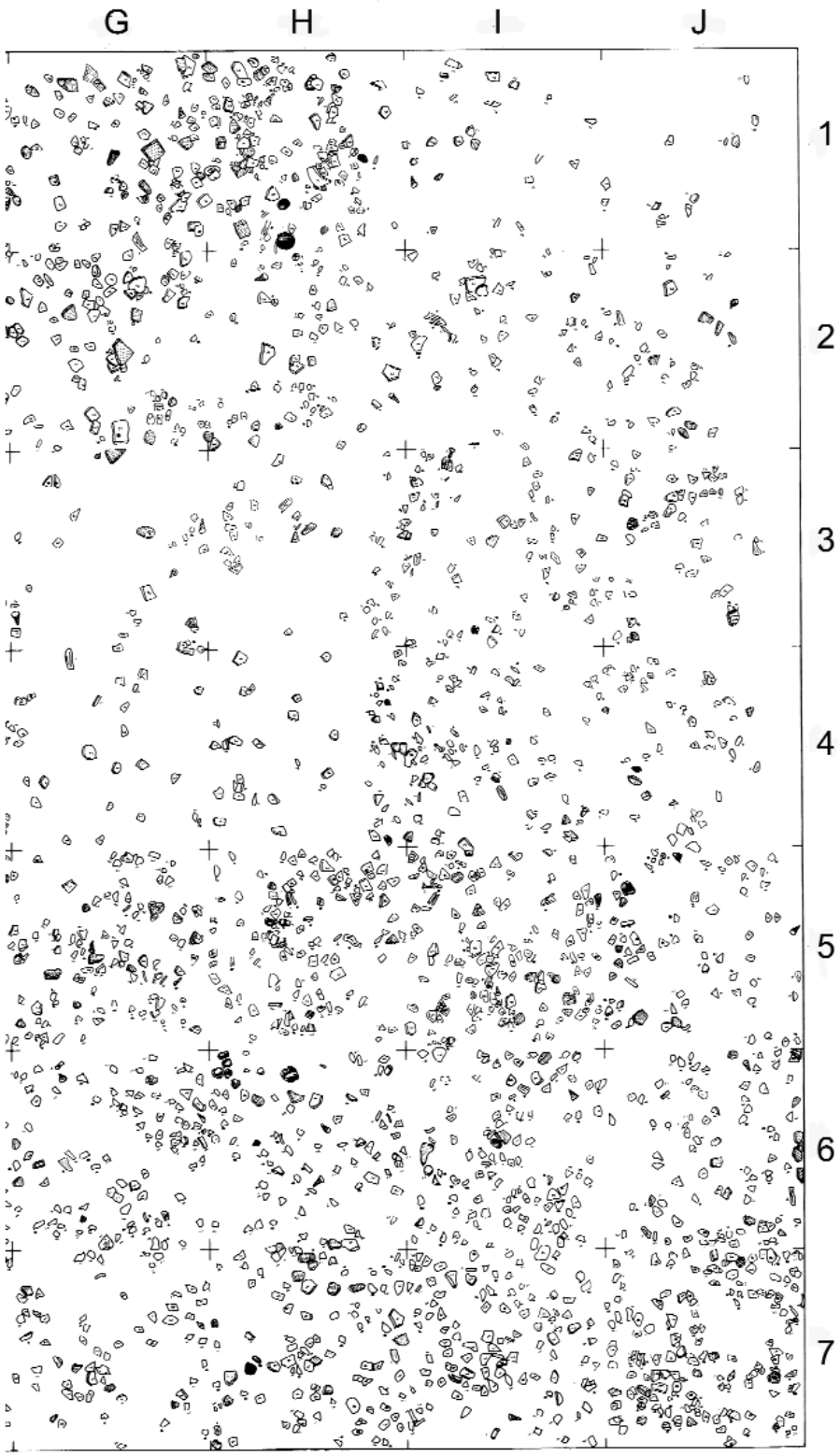

Figure 25.- Continuation.

namely A-E/1-5 and F-J/1-7. A-B/1-5 were excavated in the 1997 season, and the rest in 1998 (Figures 24-25). In the next sections, dedicated to pottery and lithic analysis, the results will be shown of the spatial analysis carried out with this sector data. A freshwater mollusc (bivalve) shell from level 3B in square B-5 was radiocarbon dated in the laboratory of the University of Uppsala, using AMS method, yielding a date of 4590 ± 45 bp (Ua-20415) (see Fernández *et al.* 2003: table 2).

2. The pottery

The pottery of Sheikh Mustafa (Figures 26-34)

More than 7000 pottery sherds were recovered during the excavation of the site. They were classified according to the method proposed by Isabella Caneva (1983, 1988; Caneva and Marks 1990). As far as we could observe, the fabric is essentially the same for all the sherds. Temper is mainly mineral, composed of white and coloured quartz and black particles such as it was already observed in the Mesolithic pottery from the other surveyed sites (Fernández *et al.* 2003: section 6). In some fragments mineral particles were fairly abundant and clearly visible on the vessel surface (Figure 26). Most probably the material was quarried from clayey deposits at the same region, as it has been reported from other Sudanese sites (Hays and Hassan 1974). Since many of the fragments were of small size and often their outer surface was eroded, it was difficult to ascribe them to the different subtypes of the classification. Thus the sherds were assorted only on the basis of the general classes of decoration techniques: incised wavy line (WL) (Figures 26-28, 30-31), rocker impression (RK) (Figures 29, 32), alternately pivoting stamp (APS) (Figures 29, 33), dotted wavy line (DWL) (Figures 28, 33) and plain without any decoration (PLA).

Figure 26.- Sheikh Mustafa: Mineral temper is clearly visible in the surface of this WL sherd.

Out of the six types of WL decoration distinguished by Mohammed-Ali and Khabir (2003: Fig. 2), only the "serpentine" decoration has not been recognised in our sherds. From a representative sample of 120 selected WL sherds, 58 were classified as of "classical", undulating waves (48,3%) (Figure 27: 1-18; Figure 30), 13 as of "angular" waves (10,8%) (Figures 26; 27: 19-24; 31: 4, 6, 8), 28 as of "mild" or lineal waves (23,3%) (Figures 27: 25-29; 31: 1, 5), 9 as of "arched" waves (7,5%) (Figures 28: 1-8; 31: 7, 9), and 12 as of "composite" waves (10%) (Figures 28: 9-15, 18-19; 31: 2-3). Some cases combining WL and RK decoration were registered (Figure 28: 16-7). A curious case was seen in a sherd of a vessel wholly decorated with rocker impressed technique. The potter incised some soft, shallow WL lines in a narrow band area between two big zones with impressed points, probably to avoid a decoration-free area (Figure 34; see a similar example in Arkell 1949: pl. 68: 2). A few sherds of DWL type are shown in the Figures (Fig. 28: 20-22; 33: 1-5), including a rare example of dish shape (figs. 28: 20; 33: 1). One open bowl with WL decoration has a composite pattern outside the vessel, i.e. in the lower part, and some classical WL designs on the interior surface, i.e. the area that is directly visible when using the dish (Figure 28: 18). Examples of rivet or suspension holes on sherds can be seen in Figures 30: 10-12 and 32: 10. Some sherds had been rubbed into palettes (Figure 30: 13), perhaps to be used in shaping the pots (Arkell 1949: 91) or as "spade-sherds" such are typical in later Nubian and Sudanese sites (Myers 1956).

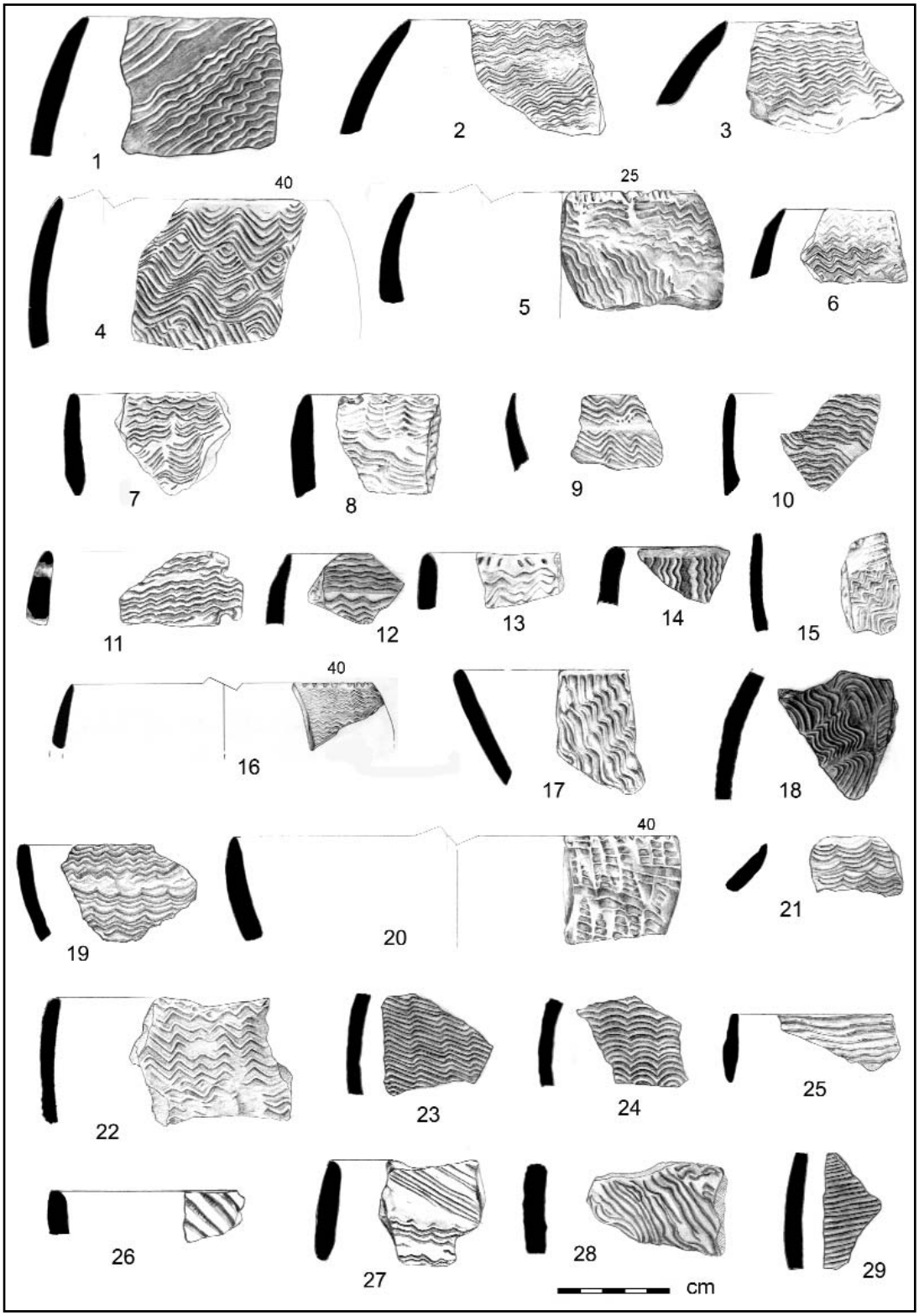

Figure 27.- Sheikh Mustafa: A selection of pottery sherds with Wavy Line decoration. 1-18, "classical" undulating waves; 19-24, angular waves; 25-29, linear waves. Numbers over some sherd drawings refer to the rim diameter in cm.

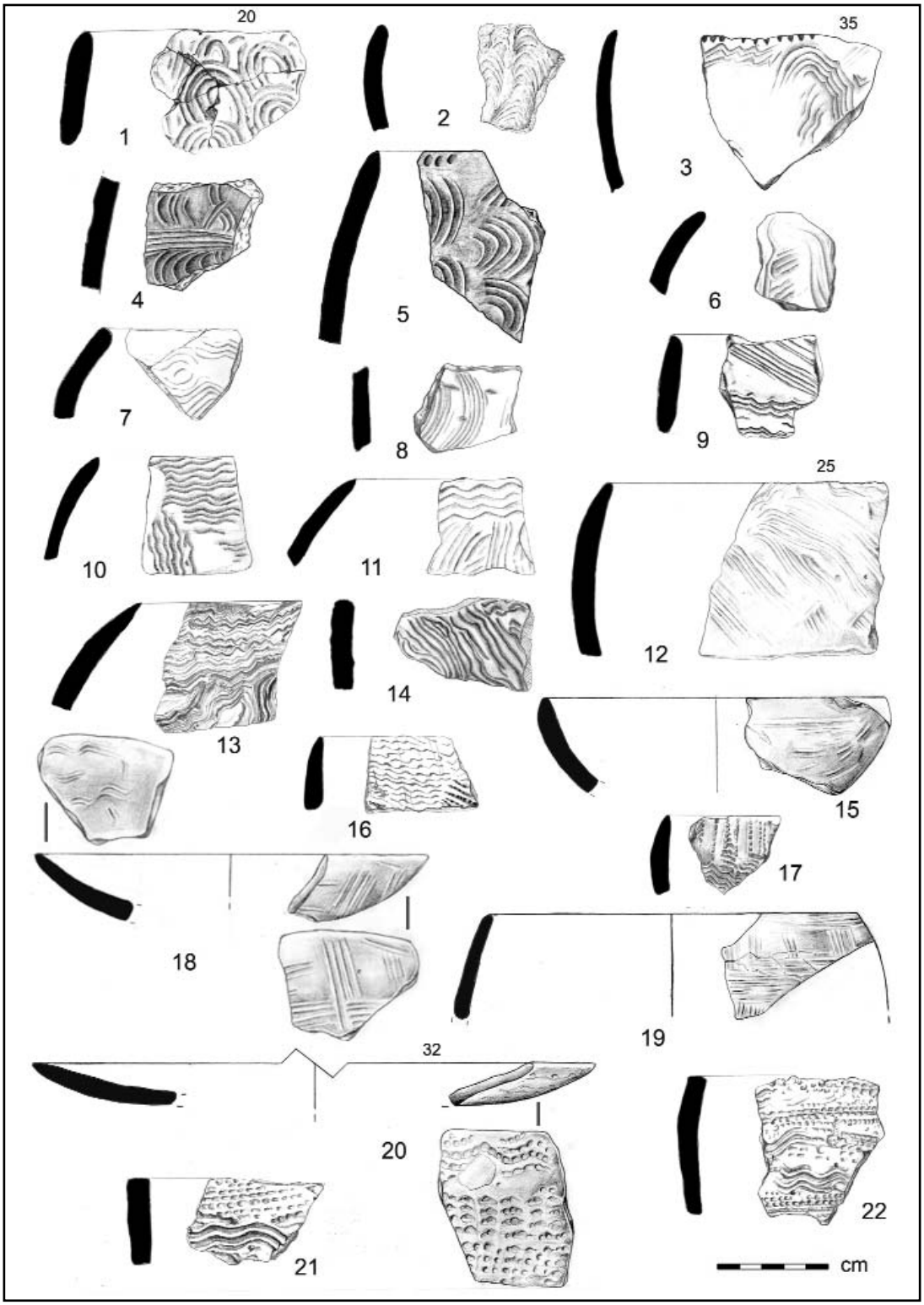

Figure 28.- Sheikh Mustafa: Pottery sherds with incised WL and impressed DWL decoration. 1-8, arched waves; 9-15, 18-19, composite waves and lines; 16-17, combination of WL and rocker decoration; 20-22, dotted wavy line decoration (sherd no. 17 comes from El Mahalab site). Numbers over some sherd drawings refer to the rim diameter in cm.

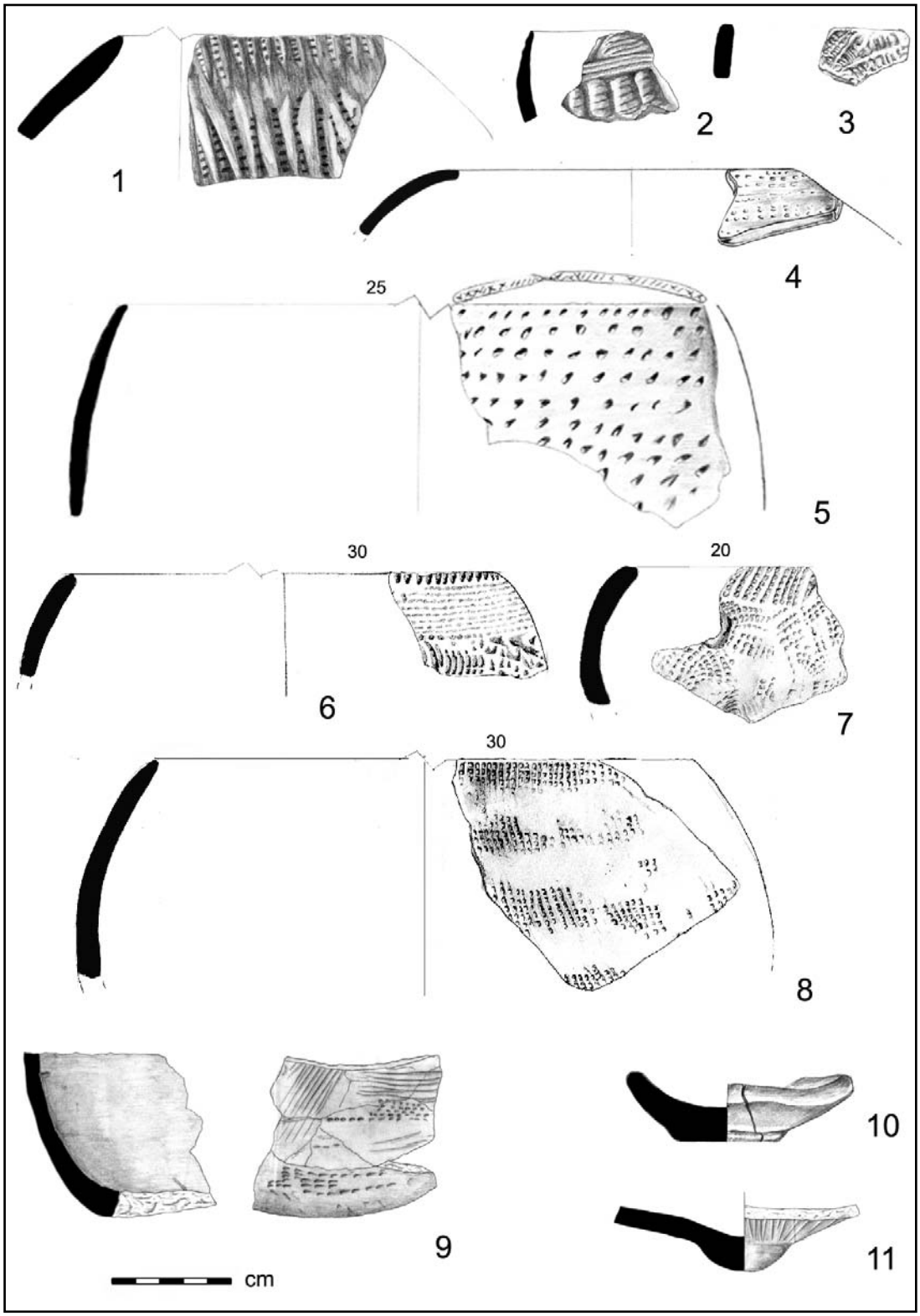

Figure 29.- Sheikh Mustafa: Pottery sheds with Rocker (nos. 1-3, 6-8), Alternatively Pivoting Stamp (4) and "smocking pattern" (5) decoration, and base sherds (9-11). Numbers over some sherd drawings refer to the rim diameter in cm.

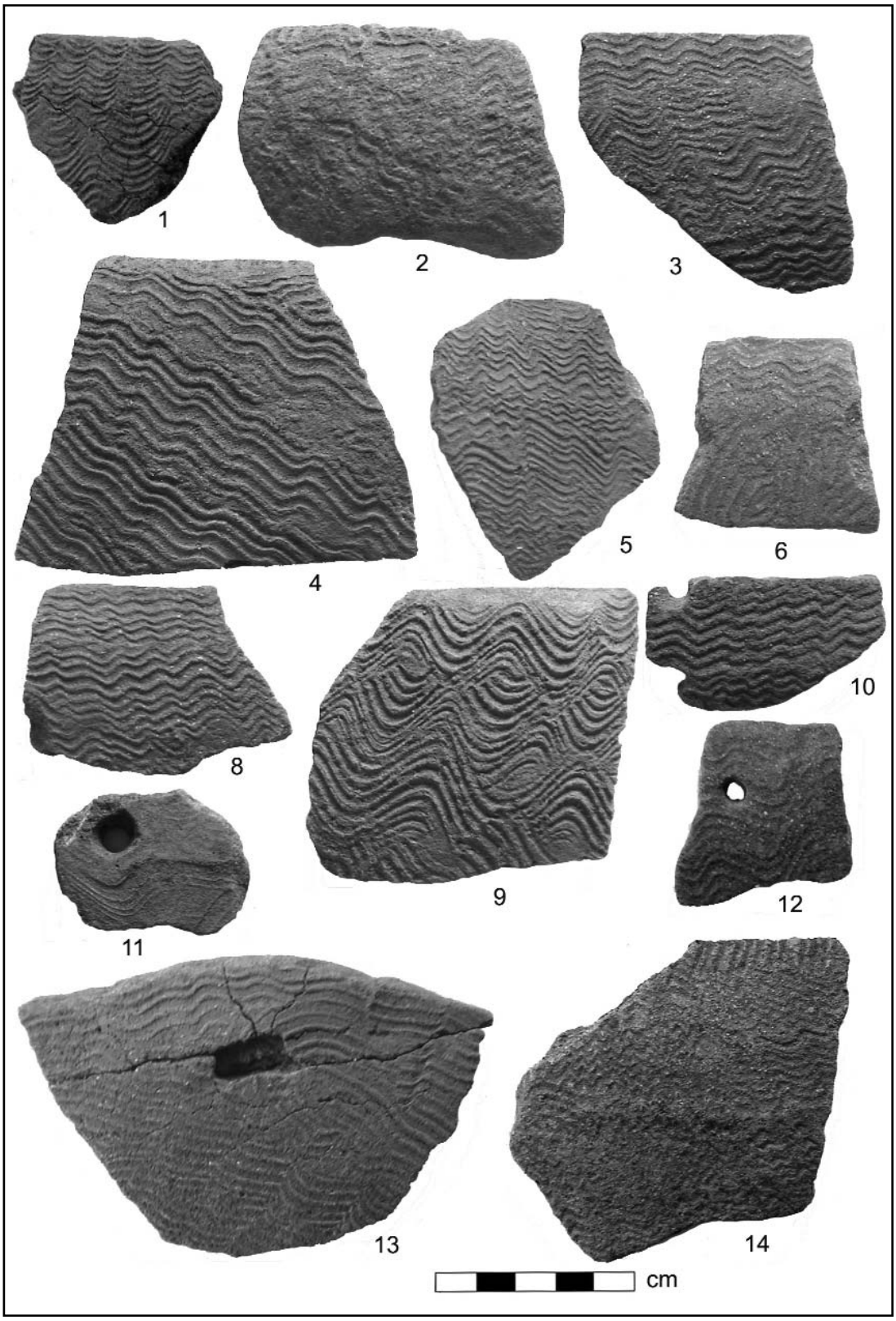

Figure 30.- Sheikh Mustafa: Wavy line sherds, classical waves.

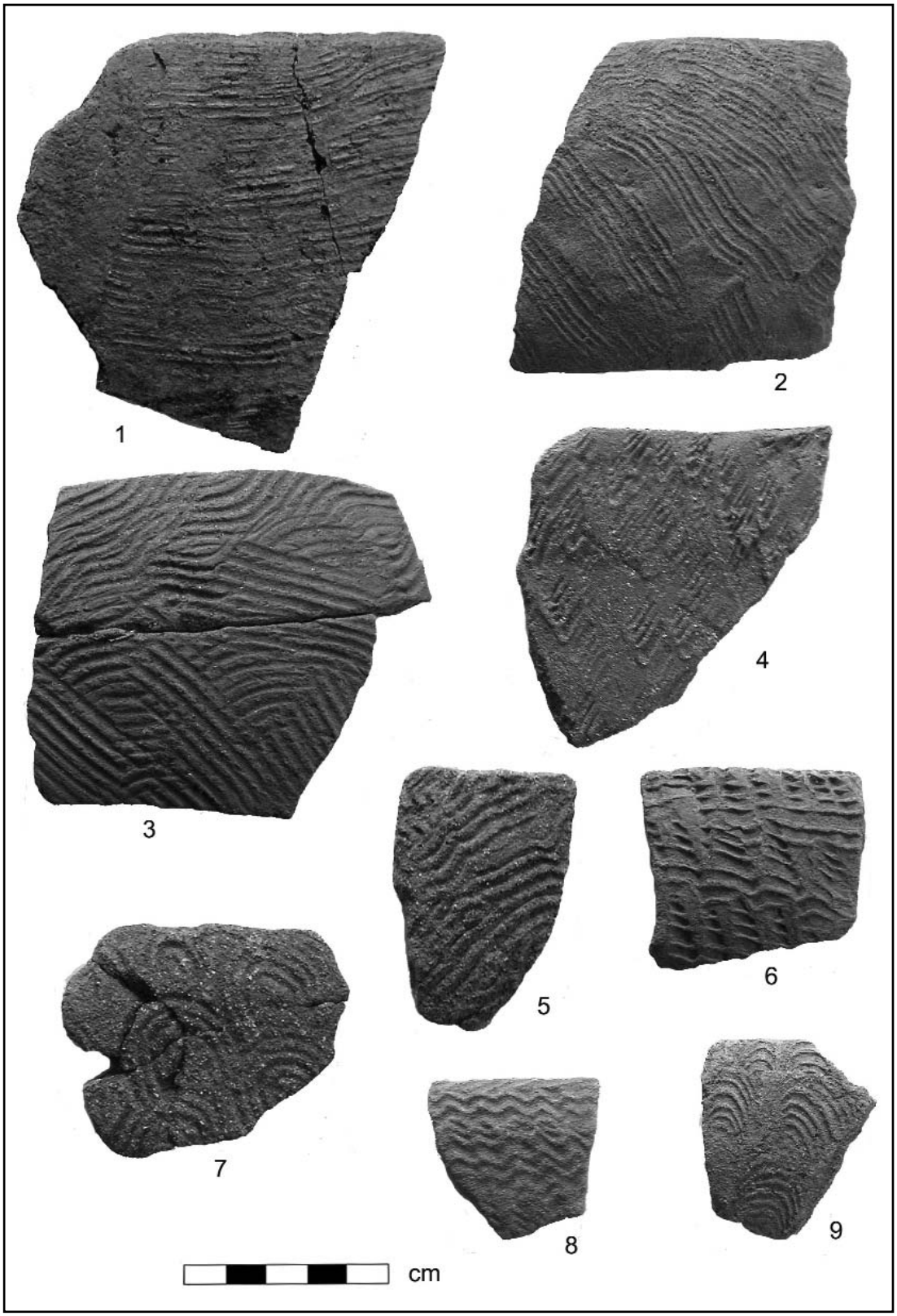

Figure 31.- Sheikh Mustafa: Wavy line sherds with linear, composite, angular and arched waves.

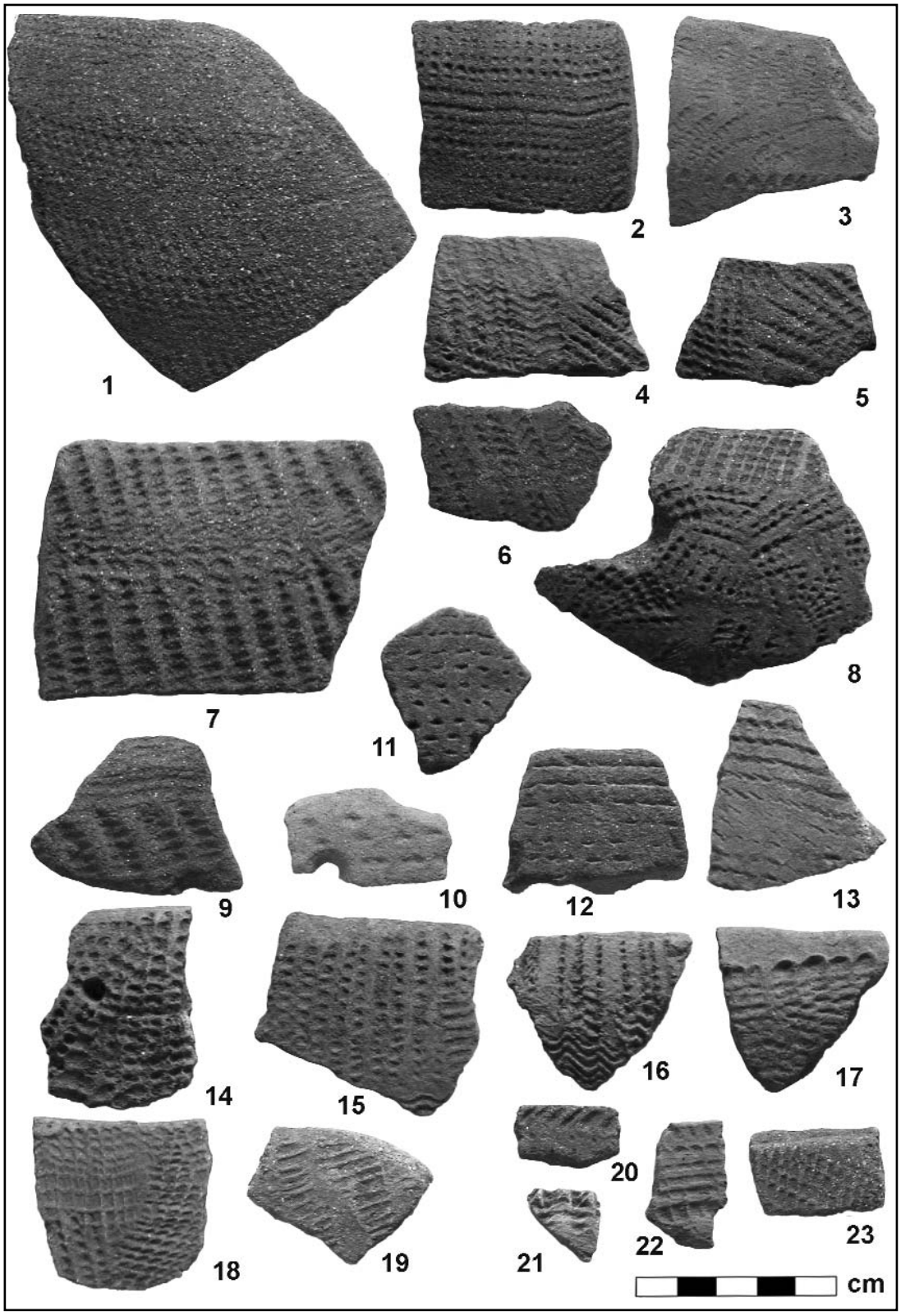

Figure 32.- Sheikh Mustafa: Rocker impressed sherds. Nos. 6, 11 and 16 have combinations of RK with DWL, APS and WL respectively.

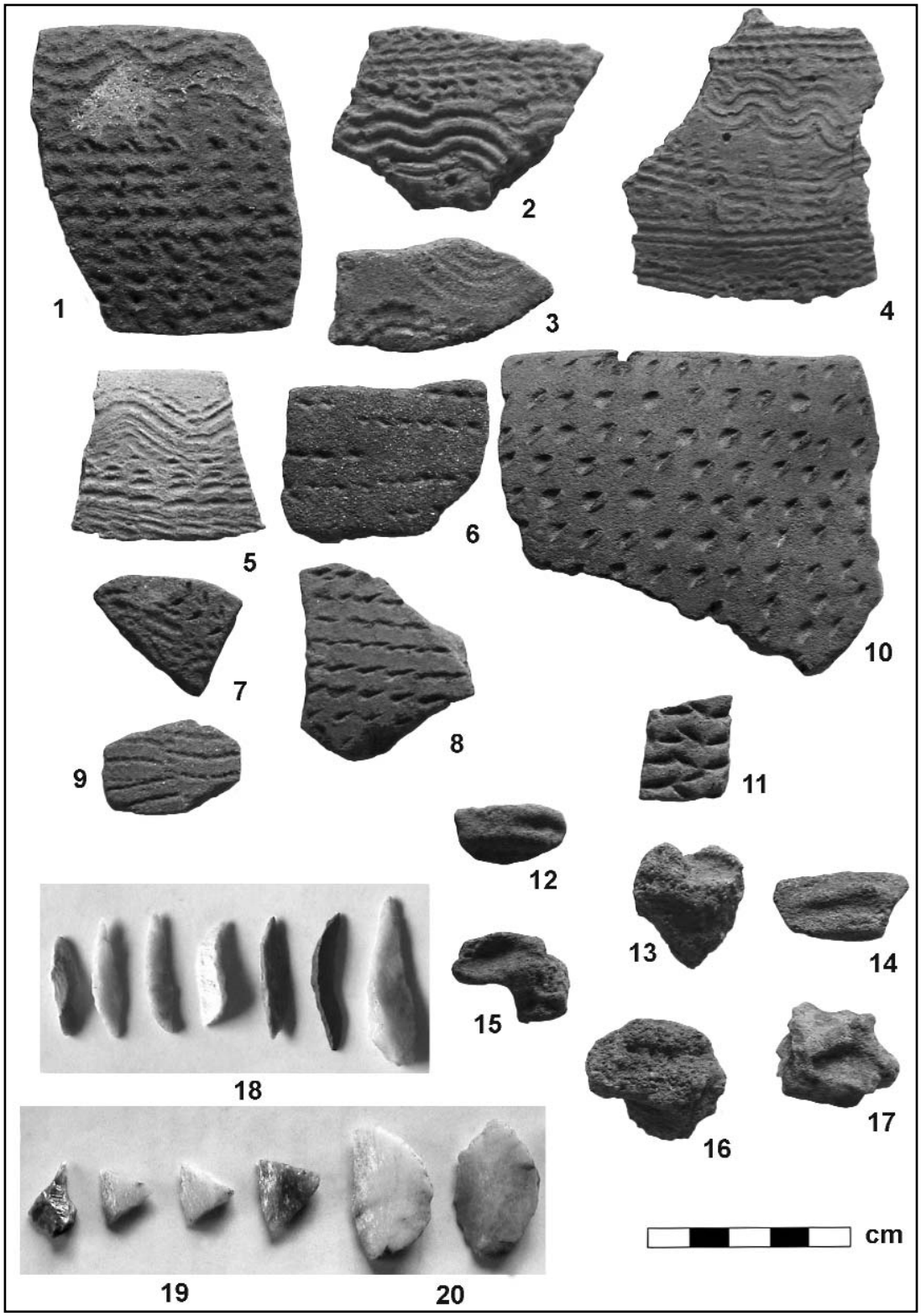

Figure 33.- Sheikh Mustafa: Dotted Wavy Line (1-5) and Alternately Pivoting Stamp decorated sherds (6-11); no. 10 has a "smocking pattern" decoration. Unburnt clay fragments with vegetal imprints (12-17; see section 1). Lithic tools: backed points (18), triangles (19) and lunates (20).

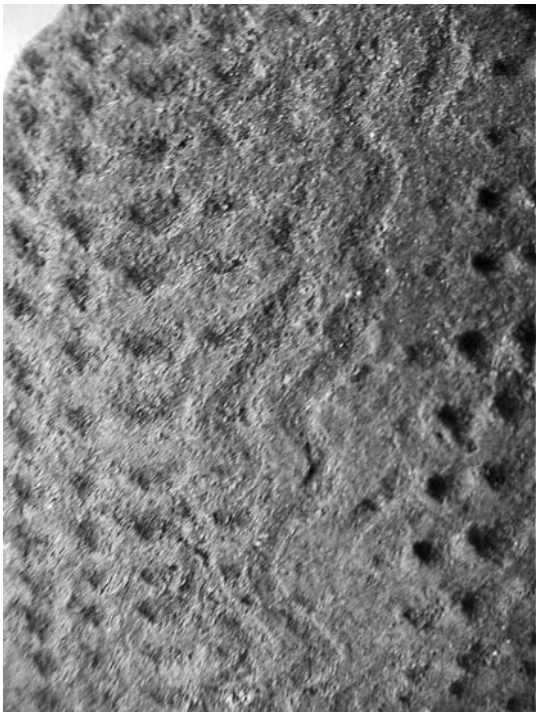

Figure 34.- Sheikh Mustafa: a sherd with rough incised wavy lines filling the empty space between wider rocker impressed areas.

A curious pottery find consists of an impressed sherd using the "smocking pattern" or "return technique" (Figures 29: 5; 33:10), a variant of the alternatively pivoting stamp system. If compared with the usual sherds from the site, it has a better-made fabric with finer mineral temper and very well smoothed surface. This decoration technique is characteristic of the Central Sahara and almost unknown in the Nile valley (Garcea 1998: 93), apart from a few sherds from Shaqadud (Caneva and Marks 1990: 19, pl. VIII) and El Ushara, near Shendi (Geus 1981: pl. XI: 2-3, 5, 9). It was found in the upper level of square G1 and can be interpreted as further evidence, together with the dotted wavy line sherds of Sheikh Mustafa and El Mahalab, of early contacts between the Sahara and the Middle Nile.

Table 4 shows the results of the analysis or a number of rim sherds from Sheikh Mustafa and El Mahalab. 176 sherds are large enough to allow for a general classification of their shape, and 85 out of them permit to infer approximately the vessel mouth diameter. Most if not all the vessels have a simple spherical or ellipsoidal shape, with round or, more frequently, small flat bases. Differences are found primarily in the relationship between mouth and maximum diameters of the pot. Those with smaller rim diameter are called "restricted", and those with bigger mouth "unrestricted" (Shepard 1956: 225-45). Following this system, four general shapes were recognised, ordered from left to right in the table: close restricted, restricted, unrestricted and open unrestricted (see drawings of actual instances of the four types in figures 29: 4, 28: 11, 28: 12, and 28: 18). The second and third types, i.e. closed and open bowls, are the most abundant in our two Mesolithic sites (54,5% and 35,2% respectively). Very closed forms and dishes are less frequent (6,2% and 4% respectively).

Even with a small inventory of shapes like this, the basic functions of pottery could be achieved: storage, cooking, food preparation, serving and transporting (Rice 1987: table 7.2). Feasible inferences about the possible functions of the vessels may be learnt from ethnoarchaeological data collected at other parts of Africa. According to the detailed and extensive research made by Alain Gallay and his team in Mali, our closed forms could have served to transport or preserve water, the restricted bowls for preserving water or any liquid or solid meal, the open bowls generally for cooking and eating, and the dishes for cooking cakes, moulding or eating (Gallay *et al*. 1996: 112-28). Comparing the mean diameters of mouth of the vessels used for

Decoration type		Diameter (cm)		Diameter (cm)		Diameter (cm)		Diameter (cm)
Wavy Line	9	28.7 ± 10.4 (n=6)	46	33.1 ± 8.8 (n=28)	35	34.9 ± 7.5 (n=17)	6	36.5 ± 2.1 (n=2)
Rocker	2	25 ± 7.1 (n=2)	39	36.1 ± 7.5 (n=17)	21	35.8 ± 4.9 (n=6)	-	-
D. W. Line	-	-	4	43 (n=1)	3	-	1	32
Plain	-	-	7	29.3 ± 9.0 (n=3)	3	40 (n=2)	-	-
Total	11		96		62		7	

Table 4.- Sheikh Mustafa and El Mahalab: different vessels rim shapes and mean values of rim diameters for the different decoration types. For each decoration and rim shape type the total sherds count, mean and standard deviation of rim diameter and measured sherds (n) are indicated.

Square	WL	RK	APS	PLA	DWL	Total
I-1	38	10	0	10	0	58
J-1	109	29	0	27	0	165
I-3	36	8	0	15	0	59
J-3	79	5	2	35	0	121
O-1	23	8	1	16	0	48
P-1	36	16	0	21	0	73
O-3	23	21	0	20	0	64
P-3	48	19	0	12	0	79
T-3	7	4	0	11	0	22
S-3	50	21	0	26	0	97
Q-3	29	2	0	27	0	58
R-3	37	3	0	5	0	45
G-13	52	6	0	32	0	90
H-13	96	14	0	26	0	136
G-15	94	14	1	54	0	163
H-15	57	83	1	28	0	169
G-10	84	83	1	49	0	217
H-10	68	84	3	58	0	213
H-12	71	88	0	58	1	218
O-13	35	34	0	16	0	85
P-13	38	28	0	13	0	79
O-15	29	39	0	10	0	78
P-15	27	15	0	12	0	54
e-1	26	9	0	32	0	67
e-3	70	20	0	46	0	136
f-3	6	8	0	4	0	18
E-1	42	27	2	26	3	100
F-1	76	31	0	39	0	146
E-3	38	21	0	14	0	73
F-3	39	15	0	17	0	71
G-1	124	33	2	83	0	242
H-1	110	46	3	73	0	232
G-3	25	26	0	20	0	71
H-3	26	10	0	28	0	64
G-5	39	12	0	24	0	75
H-5	54	38	0	44	0	136
G-7	24	13	0	20	0	57
H-7	32	18	0	33	0	83
G-9	36	16	0	33	0	85
H-9	65	48	0	82	1	196
G-11	31	14	0	24	1	70
H-11	44	22	0	43	0	109
G-17	68	26	1	63	0	158
H-17	63	28	0	52	1	144
G-19	80	40	3	90	0	213
H-19	94	48	1	121	1	265
I-13	49	10	0	54	0	113
J-13	60	8	0	69	0	137
I-15	58	44	1	55	2	160
J-15	47	24	1	57	2	131
E-13	46	11	1	54	0	112
F-13	44	6	0	38	0	88
E-15	43	13	0	77	0	133
F-15	44	8	0	32	0	84
A-13	20	10	0	20	1	51
B-13	27	11	1	26	0	65
A-15	44	12	0	33	0	89
B-15	11	0	0	9	0	20
G-21	66	16	3	74	4	163
H-21	76	25	0	70	1	172
G-23	66	10	0	92	0	168
H-23	37	21	1	64	0	123
Total	3116	1432	29	2416	18	7011

.../...

Table 5.- Pottery sherd counts by decoration types in the excavated squares of Sheikh Mustafa. Legend: WL, wavy line, RK, rocker impression, APS, alternately pivoting stamp, DWL, dotted wavy line, PLA, plain ware.

each task (Gallay 2002: 63) we find, however, that our pots show relatively constant values (between 25 and 36 cm), while those currently used by the Dogon are more varied (15 cm for water transport, 20 cm for cooking, 30 cm to preserve water, and 62 cm for storage; mean values). As regards the big storage vessels, the lack of big diameters in our sample can probably be attributed to the difficulty of measuring small sherds from large mouth fragments. In fact, the sherds whose diameters are not measurable are very small or either they have a rectilinear contour suggesting their origin in vessels with a very wide mouth. These big containers could have been used to store vegetal food (Magid 1989: Fig. 26), whose presence in the settlements is deduced from their imprints in some sherds (see Magid 2003). Another interesting outcome of the diameter calculations, as can be easily observed in table 4, is that the decoration types bear no relationship to the vessel form and function. Ratios of decoration types for each shape are very similar to those registered for the whole sites.

The sherd count numbers for each decoration type in the different grid squares excavated at Sheikh Mustafa are shown in table 5. Their percentages in the entire site are given in Figure 35. The count data were analysed applying a statistical multivariate analysis, namely principal component analysis. We used the computer program SPSS, *Statistical Package for the Social Sciences*, version 11.5.1. The results are shown in Figure 36.

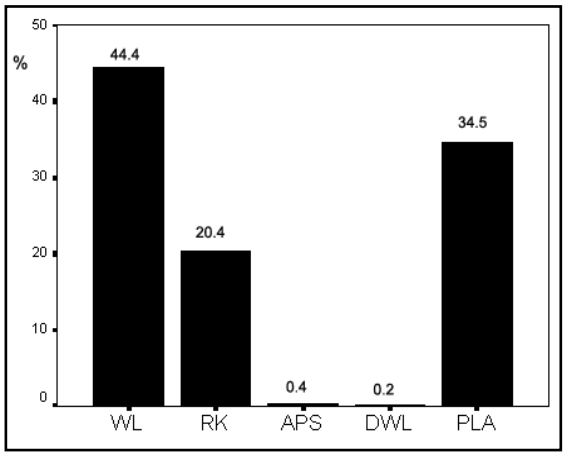

Figure 35.- Percentage values of pottery decoration types in Sheikh Mustafa. Legend as in table 5.

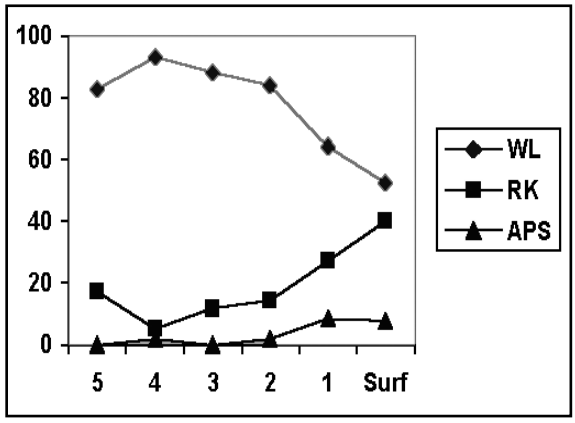

Figure 37.- Stratigraphic variation of pottery types after percentage data from table 6.

The representation of the excavated squares in Figure 36 does not permit inferring any model for the spatial distribution of pottery types at the site. Most of the them appear clustered together, as a result of the approximately regular distribution of the types in all the excavated areas. The only squares that are located outside the central cluster are those that have a few sherds of the rare DWL type (G21, E1, G15, I15). This class was found in some areas yet without any discernible model. Applying other options to the analysis (e.g. using variance instead of correlation to calculate the original matrix, or Varimax rotation instead of the original non-rotated solution of the analysis), the results hint at a weak tendency for some squares to have more rocker decoration than others, in comparison with the dominant wavy line decoration. In some cases those squares correspond to the outer areas of the site, for instance the squares in sectors F or G, and thus the tendency may be interpreted as an effect of the "dismantling" of the site by surface erosion (see section 1 and Figure 11). That is, recent materials (in this case, rocker-decorated sherds) tend to be found more abundantly in the peripheral areas because they have been washed down from their original stratigraphic position in the upper part of the central area. But even after this post-depositional change, there remain some clues of the original stratigraphical disposition of the site. Table 6 shows the percentage values of the three main pottery types in the five artificial levels of the squares K/L-1/3, excavated in 1994. In Figure 37 the diagram of stratigraphic variation is shown. This tendency of increasing rocker and decreasing wavy line pottery agrees with which is known from the survey seriation and other data sources (see Fernández *et al*. 2003: section 6).

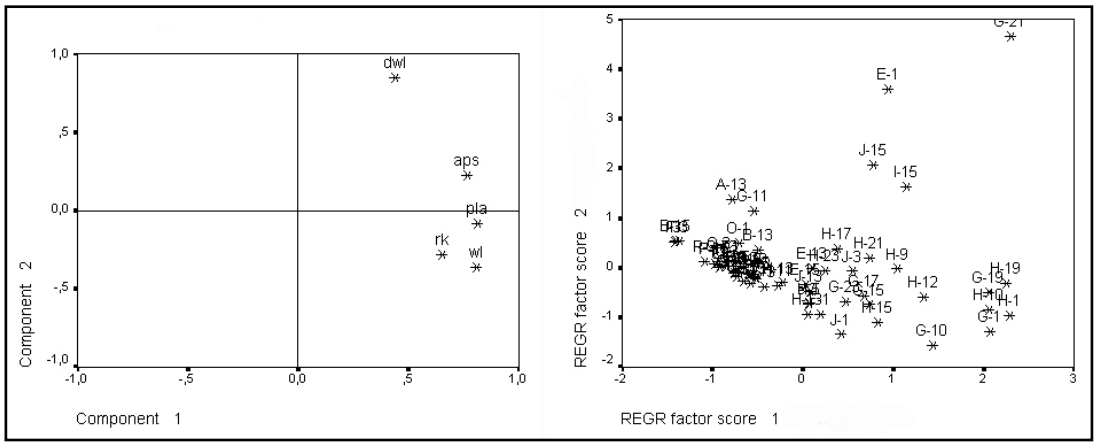

Figure 36.- Sheikh Mustafa: Principal Component Analysis of pottery types in the excavated squares (data from table 5). Diagram plots of the pottery types and squares in the first two components.

Level	WL	RK	APS
Surf.	21 (52.5)	16 (40)	3 (7.5)
1	105 (64.4)	44 (27)	14 (8.6)
2	147 (84)	25 (14.3)	3 (1.7)
3	106 (88.3)	14 (11.7)	0
4	110 (93.2)	6 (5.1)	2 (1.7)
5	29 (82.8)	6 (17.2)	0

Table 6.- Sherd counts and percentage values of different pottery types in the artificial excavation levels of squares I/J-1/3 at Sheikh Mustafa.

In the excavation of sectors A to G (1994) we measured the area of all the recovered pottery sherds (3494 in total) in order to check the breakage patterns and the relative abundance of each decoration type. Table 7 shows the percentage values of sherd counts for seven size categories at the seven sectors excavated during that season. At first sight, it is evident that the numbers are very similar for the different sizes, suggesting that all the sectors, and thus probably the whole site area, underwent the same amount of disturbance (Bradley and Fulford 1980: 92-3). A graphic representation has been made comparing the size curves for each sector, following a suggestion of Bradley and Fulford (Ibid.: 93). The method is similar to how particle sizes of soil sediments are matched in soil science to interpret the geophysical processes that took place and infer the past climates that caused it. Figure 38 shows similar curves for the seven sectors, this being further proof for the homogeneity of depositional and post-depositional processes at the Sheikh Mustafa site.

Using sherd size measurements from sectors A, B, E and F, where the biggest amount of pottery was produced, we compared the total area of sherds for each pottery decoration type. Table 8 displays the values in cm^2 and percentages for the different types. These values approximately coincide with the percentage values of sherd counts per decorative type in the same sectors, which are shown in the same table. This demonstrates that all the vessels, regardless of their decoration type, tend to break in a similar pattern. Sherd count is thus an accurate representation of the relative abundance of decoration types at the site. The slight tendency of plain sherds to have a bigger area than the decorated ones is probably due to the fact that the bottom parts of the vessels, usually undecorated, are regularly thicker and hence break in bigger size fragments.

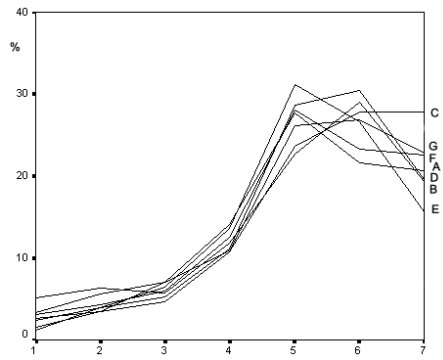

Figure 38.- Percentage values of the seven sherds size categories (1-7) in the excavated sectors (A-G) of Sheikh Mustafa, after data from table 7.

Decoration type	WL	RK	APS	PLAIN
Area in cm^2	9265	5240	109	5061
Area percentage	47.09 %	26.63 %	0.55 %	25.72 %
Sherd number	914	488	9	461
Sherd percentage	48.82 %	26.07%	0.48 %	24.63 %

Table 8.- Pottery sherd data (total sherd area and sherd number for each decoration type) in sectors A, B, E and F of Sheikh Mustafa.

The pottery of El Mahalab (Figures 39-40)

A total of 4680 pottery sherds were recovered from the excavation at the site. All of them show the same fabric that has been already described

Sector	>30 cm^2	30-20cm^2	20-15 cm^2	15-10 cm^2	10-5 cm^2	5-2.5 cm^2	< 2.5cm^2	Total
A	3.1	4.3	6.0	12.5	28.1	23.3	22.6	416
B	5.1	6.3	5.7	11.8	22.7	29.0	19.3	331
C	1.6	3.5	4.7	10.8	23.7	27.8	27.8	316
D	3.3	5.6	7.0	14.1	27.7	21.6	20.7	213
E	2.4	3.9	6.5	13.6	31.2	26.6	15.7	711
F	1.2	3.9	5.2	11.1	28.6	30.4	19.6	938
G	2.6	3.5	7.0	10.9	26.2	26.9	22.8	569

Table 7.- Percentage values of the different size categories of pottery sherds in the excavated sectors of Sheikh Mustafa (A-G).

in connection with the site of Sheikh Mustafa. The sherds have been classified according to the surface decoration type, following the same general principles as in the previous site (Caneva 1983, 1988; Caneva and Marks 1990). For the incised wavy line (WL) there are also examples of different motifs: classical waves (Figure 39: 2-5, 7, 9, 11), arched waves (Fig. 39: 1, 6), straight waves (Fig. 39: 10) and composite motifs (Fig. 39: 8). Here the rocker technique is more abundant than at Sheikh Mustafa, and some variation has been recognised namely the packed (Figure 39: 13-14, 17-18) and spaced zigzags (Fig. 39: 15-16, 19). Dotted wavy line, also more frequent in this site, presents several varieties: deep (Figure 40: 2, 4-8), shallow (Fig. 40: 1) and angular (Fig. 40: 3) dotted lines (Mohammed-Ali and Khabir 2003: Fig. 3). Also some examples of alternately pivoting stamp technique are shown in Figure 40: 10-15.

A few sherds (16 were noted) of Late Neolithic chronology were found during the excavation of the site, most of them in the A/B-13/15 squares. Five have rocker decoration (2 spaced, 2 packed, 1 plain edge, Figure 40: 19), one of them with red slip, and could belong to the Early Neolithic period. Two have incised decoration and five simple impression decoration (Fig. 40: 16-17, 20), a combination indicating their association with the Late Neolithic. Two thick impressed rims, culturally affiliated to Jebel Moya, were also recorded (Fig. 40: 21), as well as one sherd with the "smocking pattern" variety of APS decoration (Fig. 40: 18).

Both in the first test done in 1993 and in the 1994 excavation at squares A/B–13/15, the good stratigraphic conditions permitted an examination of the cultural variation during the time of occupation of the site. The following tables 9 and 10 show the number and percentage of sherds with different decoration types in the archaeological levels (1993) and metric excavation levels (1994).

In both sequences, a decrease in Wavy Line variety and an increase of Rocker variety is recorded. As to the other two types, Dotted Wavy Line pottery seems to decrease over time, while Alternately Pivoting Stamp has an approximately constant percentage along the stratigraphy. Data from the 1994 season have been put in a diagram showing the reverse position of WL and RK during the settlement occupation (Figure 41). The model is identical to that observed in other sites, such as Sheikh Mustafa (see preceding section), Saggai (Caneva 1983: 188), and in the surface data from our own survey (see Fernández *et al*. 2003, section 6, for a more extensive discussion of the pottery from these and other Sudanese sites).

Level	WL	DWL	RK	APS
e	17 (39.5)	4 (9.3)	14 (32.5)	8 (18.6)
c	10 (32.2)	0 (0)	14 (45.1)	7 (22.5)
b	13 (72.2)	5 (27.7)	0 (0)	0 (0)

Table 9.- Sherd counts and percentages in the archaeological levels of test-excavation at El Mahalab in the 1993 season.

Level	WL	DWL	RK	APS
1	2 (14.3)	0 (0)	10 (71.4)	2 (14.3)
2	30 (33.3)	0 (0)	45 (50.0)	15 (16.7)
3	24 (22.8)	3 (2.8)	66 (62.8)	12 (11.4)
4	20 (20.2)	2 (2.0)	60 (60.6)	17 (17.2)
5	60 (37.9)	6 (3.8)	74 (46.8)	18 (11.4)
6	53 (36.5)	5 (3.4)	65 (44.8)	22 (15.2)
7	47 (33.6)	7 (5.0)	63 (45.0)	23 (16.4)
8	25 (34.7)	3 (4.2)	36 (50.0)	8 (11.1)

Table 10.- Sherd counts and percentages in the artificial levels of excavation of squares A/B-13/15 at El Mahalab in the 1994 season.

As to the frequencies of the different types in the excavated squares, table 11 shows the raw data from the different seasons (see Figure 42 for the general percentages in the entire excavated site). In the 1994 excavation (A/B-13/15) no distinction was made of squares and all the remains were collected together in the four squares. The Principal Component Analysis of

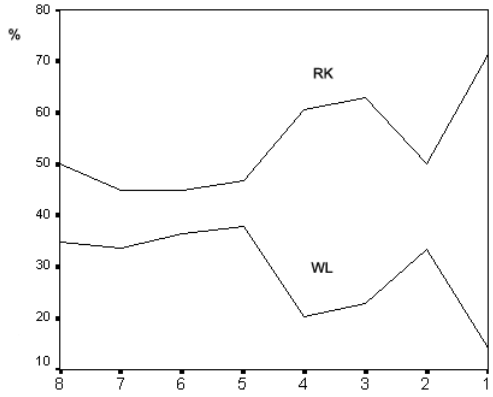

Figure 41.- Main pottery types variation in the excavation levels of the El Mahalab site (squares A/b-13/15). Regression tendency lines are indicated. Data from table 10.

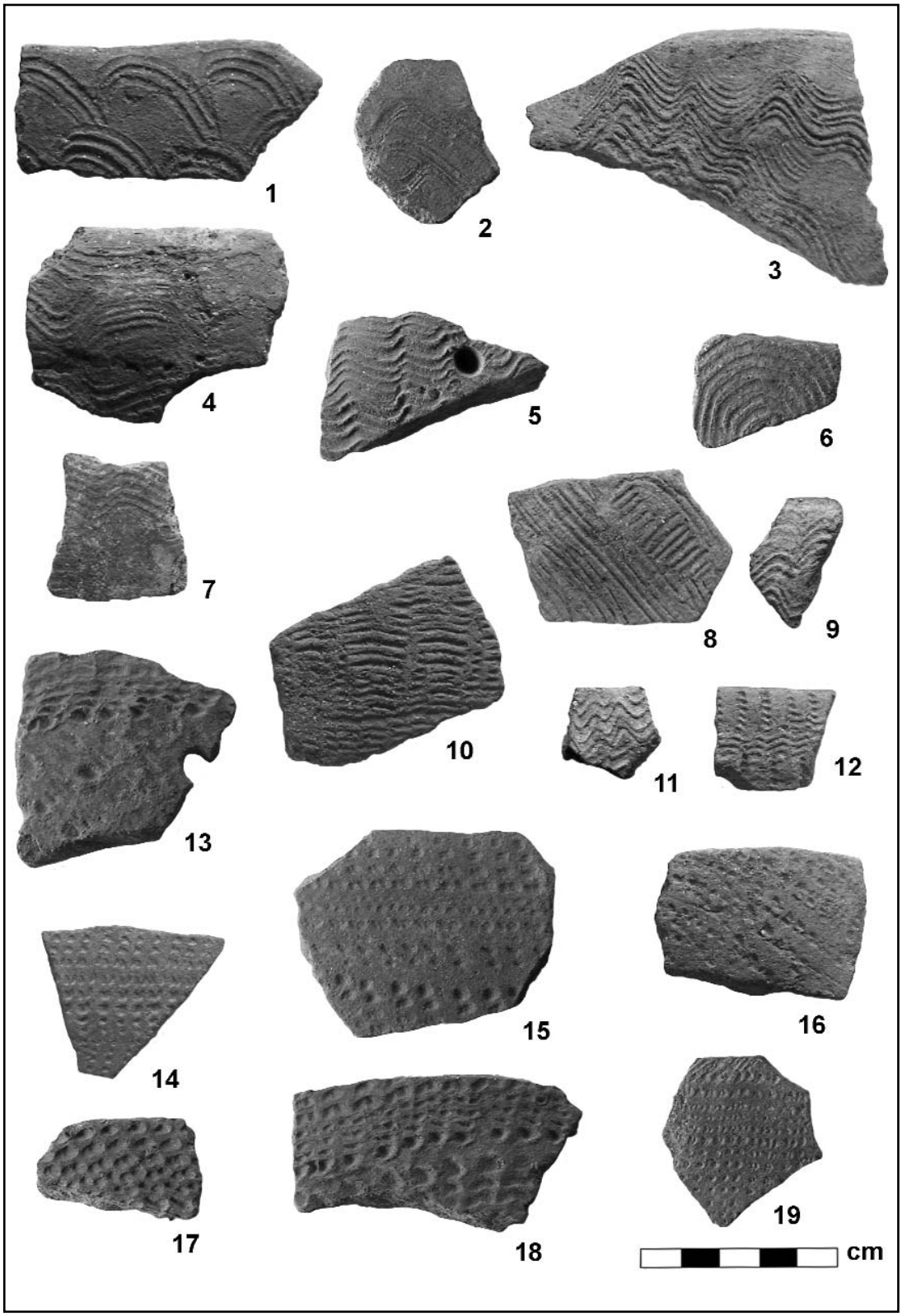

Figure 39.- El Mahalab: A selection of pottery sherds with Wavy Line (1-11) and Rocker decoration (13-19); no. 12 shows a combination of both techniques.

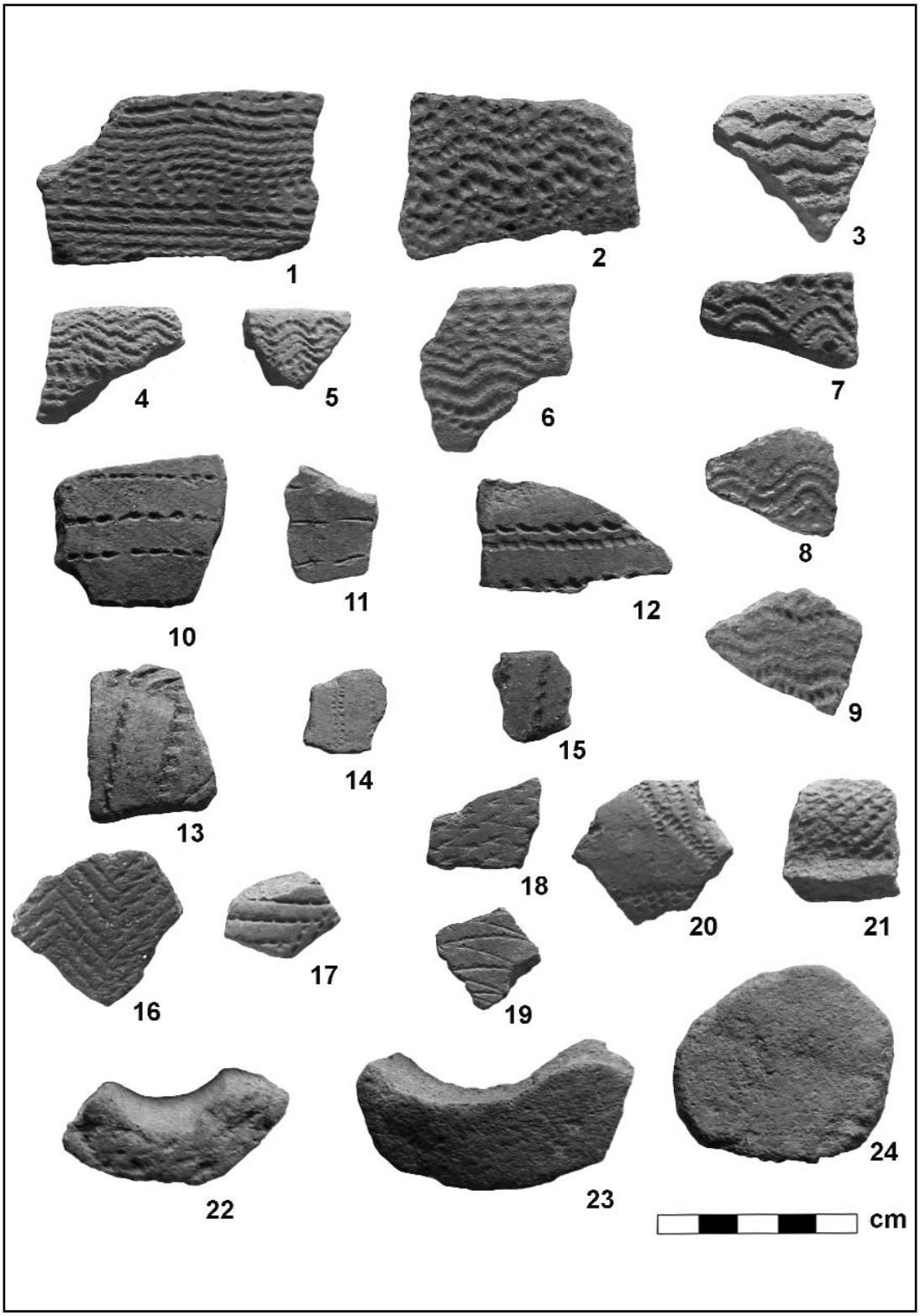

Figure 40.- El Mahalab: A selection of Mesolithic pottery sherds with Dotted Wavy Line (1-9) and Alternately Pivoting Stamp (10-15) decoration. Sherds nos. 16-21 are of Late Neolithic chronology. Nos. 22-24 are sherds from the bottom part of vessels that broke along the coiling joint lines.

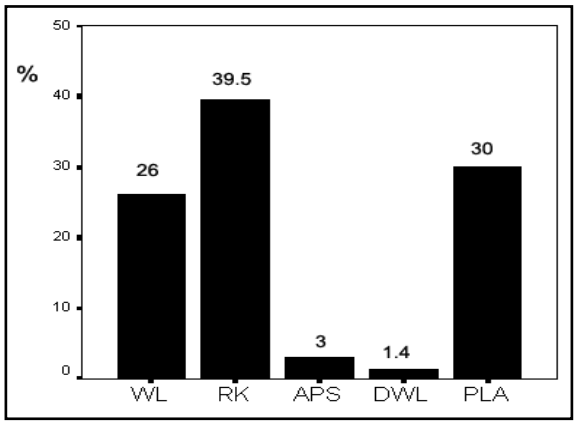

Figure 42.- Percentage values of pottery decoration types at El Mahalab site.

Square	WL	RK	APS	DWL	PLA	Total
TEST	40	28	15	9	16	108
AB1315	261	419	117	26	329	1152
A20	38	81	0	2	64	185
B20	26	94	1	3	83	207
A22	61	77	0	7	95	240
B22	83	93	0	1	74	251
A45	95	161	1	3	102	362
B45	89	127	1	3	126	346
A47	106	171	1	5	112	395
B47	100	158	2	3	79	342
N2	90	125	0	0	57	272
N4	55	98	0	1	77	231
O2	95	111	0	3	95	304
O4	80	107	2	1	95	285
Total	1219	1850	140	67	1404	4680

Table 11.- Raw frequencies of pottery sherds decoration types in the excavated squares of El Mahalab.

the data shows that all the types are almost equally distributed in the site and even the RK and WL numbers are so close that they are represented almost by the same point in the plot (Figure 43). The only difference is the slight separation of the DWL and APS types, that tend to appear more abundantly in the central part of the site (test and A/B-13/15), suggesting its earlier chronology with respect to the rest of the settlement (see discussion in preceding section). The outsider position in the plot of A/B-13/15 may be explained by having a quite bigger ceramic sample.

The pottery of Sheikh el Amin (Figures 44-50)

A total of 56.761 pottery sherds were recovered during the excavations, 36.739 in sectors A to I and the first excavation in sector J (J-1) (1997 field season), and 20.022 in the remainder of sector J (J-2) (1998). The fabric of most of the sherds is of better quality than in the Mesolithic pottery. Wall-thickness is between 5-8 mm for the bigger vessels with RK decoration and 4-6 mm for the smaller ones, usually plain, black topped or with incised decoration. The surface is treated more delicately than in the Mesolithic period and most of the sherds are carefully smoothed or even burnished (especially the black topped and incised varieties). Remains of red slip are conspicuous in many sherds, especially those of the black topped or incised category. The white paint that occasionally fills the impression or incision holes is most likely due to the precipitation of natural calcareous because it

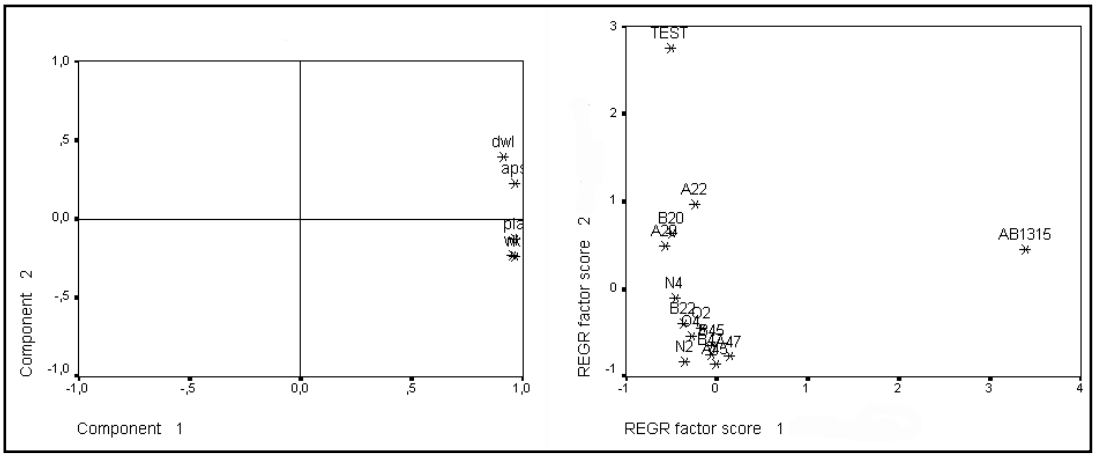

Figure 43.- El Mahalab: Principal Component Analysis of the pottery type frequencies of table 11. Diagram plots of types and excavates squares.

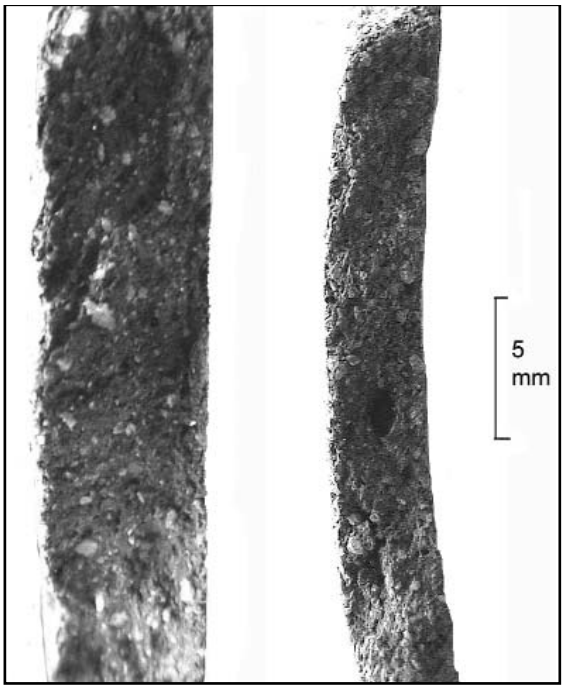

Figure 44.- The broken sections of a Mesolithic sherd from Sheikh Mustafa (left) and a Neolithic sherd from Sheikh el Amin (right).

also covers the broken section of many sherds. Clay and temper particles are of lower size and the fabric is also generally harder than in the Mesolithic examples. Most of the temper is of mineral origin, with the same characteristics that were observed in the Mesolithic pottery: white and coloured quartz, mica, black particles, etc. The particle size is of about 0.5-1 mm with occasional larger grains as it was usual in the Mesolithic sherds. Two actual examples of sherd fractured section can be seen in Figure 44, a Mesolithic Rocker sherd from Sheikh Mustafa (left) and a plain sherd from Sheikh el Amin (right). Apart from the wall and temper thickness being larger in the Mesolithic example, there are not other visible differences between both cases. In many sherds, however, particularly those of finer wares (incised, black topped) some signs of vegetal temper were recognised, small rectangular holes from chopped straw used as temper together with the more abundant mineral constituent.

Rim diameters are smaller in the Neolithic than in the Mesolithic vessels. Mean values at Sheikh el Amin are 19.5 cm for the incised, black topped and plain vessels, and 32.7 cm for the rocker impressed and APS decorated vessels. Comparing with similar shapes (open and closed bowls) from the preceding period (table 4), the difference is much clearer in the incised-plain than in the rocker vessels, whose values are only slightly smaller. This trend from big open hemispherical bowls to smaller and closer forms through time, is probably related to their use for milk during the Neolithic period (Caneva 1994: 216-7), a purpose maybe fulfilled by bowls with new decorative techniques namely the fine incision and black topping.

Following Caneva's system for Sudanese Neolithic pottery (Caneva 1988: 84-110), the sherds were classified according to their decoration system. The categories were simplified in the following types: rocker impression with evenly serrated edge (rocker regular: RKR), with unevenly serrated edge (rocker irregular: RKI) and with plain edge (rocker plain: RKP); regular rocker impression with spaced zigzags was classified separately (rocker spaced: RKS); alternately pivoting stamp (APS); dotted wavy line (DWL); incision (INC); Black Topped (BLT); simple zoned impression (IMP); fine incision, a rare technique typical of the Late Neolithic period (FIN); and the undecorated, plain wares or simply the plain sherds (PLA). Examples of RKR sherds can be seen in Figures 46: 1, 7; 11, 49: 2; RKI in Figures 46: 2-6 10, 12, 49: 3-5; RKP in Figure 45: 12-15, 48: 7; 49: 6, 8-9 "fish-net"); RKS in Figure 46: 8-9, 49: 1; APS in Figures 46: 13; 48: 5, 7, 10, 49: 7, 10-13; DWL in Figures 48: 1, 50: 15-18; INC in Figures 45: 1-9, 49: 14-16; BLT in Figures 47: 1, 4-5, 7, 49: 23-24; IMP in Figures 48: 4, 6, 12, 50: 7-11; FIN in Figures 45: 10-11; 48: 8, 9, 11, 49: 17-22; PLA in Figures 47: 2-3, 6, 8-9 (no. 6 has an incised rim). Some rare examples of rough incision are shown in Figures 48: 3, 50: 2-5; thick impressed rim in Figure 48: 12; scraped surface in Figure 50: 1; painted decoration in Figure 50: 6; and Mesolithic rocker technique on earlier, intrusive sherds in Figures 48: 2; 50: 12-14. Pottery sherds cut into circular or oval disks, whose maximum dimension or diameter varies between 17 and 40 mm, can be seen in Figures 48: 14, 50: 19-23. The complete pot of Figure 47: 10 comes from a disturbed grave in sector C-13. It has a polished surface without decoration and is probably of Meroitic date. For a more detailed contrast between pottery types in this site and other Neolithic sites investigated in

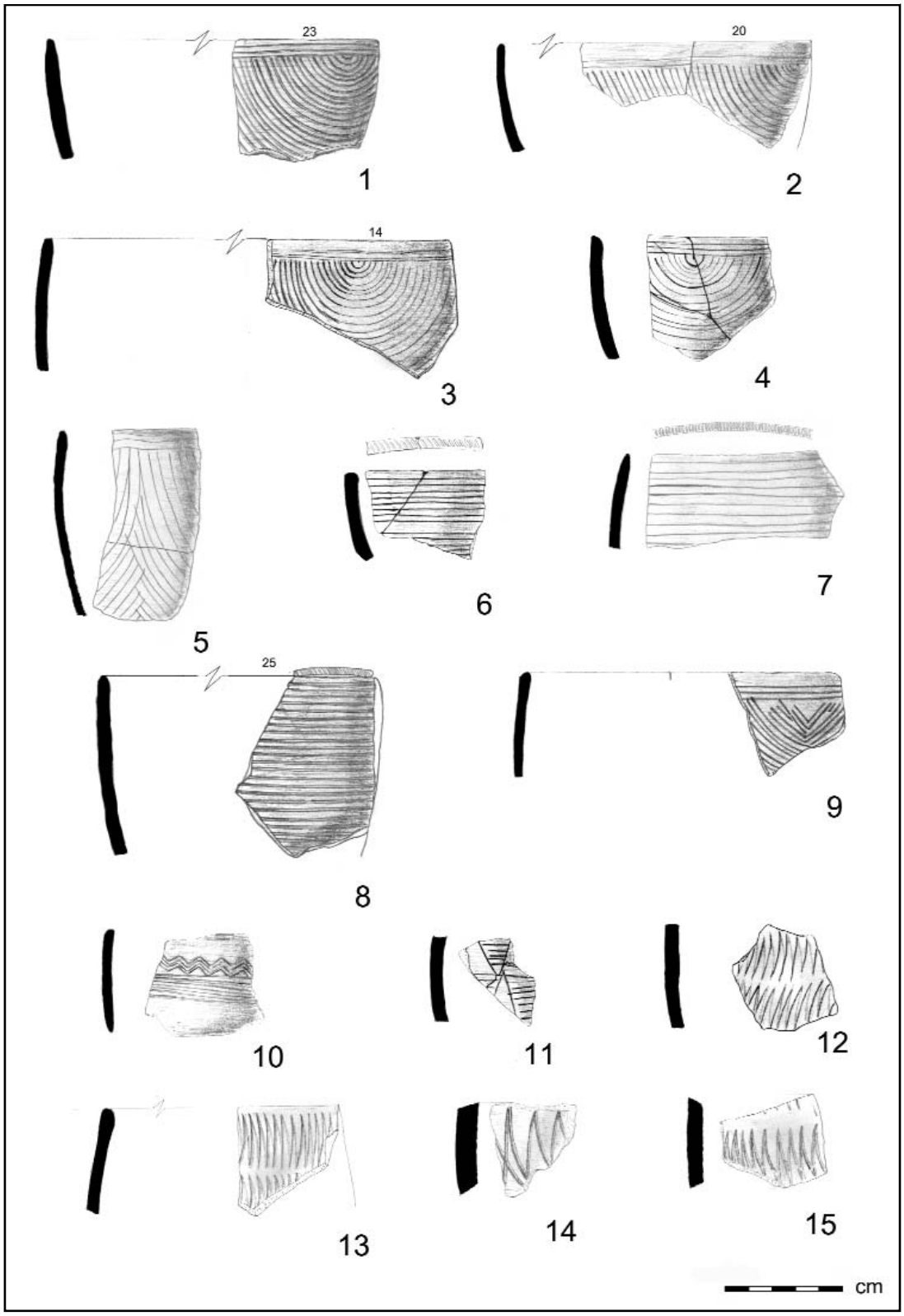

Figure 45.- Sheikh el Amin: pottery sherds with incised (1-9), fine incised (10-11) and plain edge rocker (12-15) decoration. Numbers over some sherd drawings refer to the rim diameter in cm.

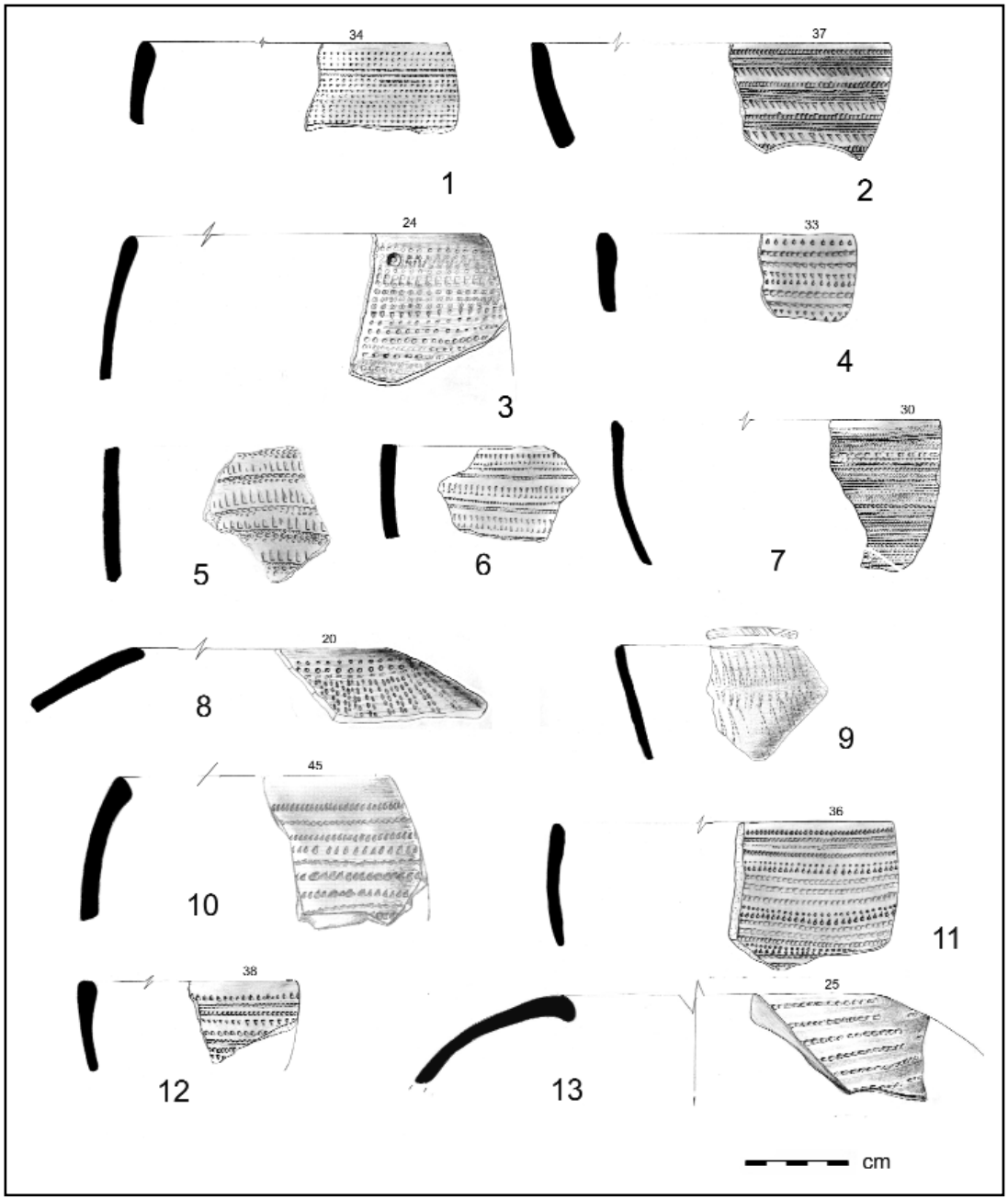

Figure 46.- Sheikh el Amin: pottery sherds with rocker (evenly spaced, 1, 7, 11; unevenly spaced, 2-6, 10, 12; spaced 8-9) and alternately pivoting stamp (13) decoration. Numbers over some sherd drawings refer to the rim diameter in cm.

the survey, see Fernández *et al*. 2003: section 7.

An interesting feature of the pottery collection from the site is the relatively large number of dotted wavy line sherds (Figures 48: 1; 50: 15-18). A total of 415 DWL sherds were recovered in the excavation, fairly well distributed along the site and in the artificial levels of the different sectors, with the exception of sector F where it is particularly abundant. These sherds show distinct fabric features when compared to the bulk of Neolithic pottery. They are thicker, harder and with copious mineral temper that sometimes protrudes from the surface giving it a characteristic shiny look when mica particles are frequent. The fabric is identical to that of the

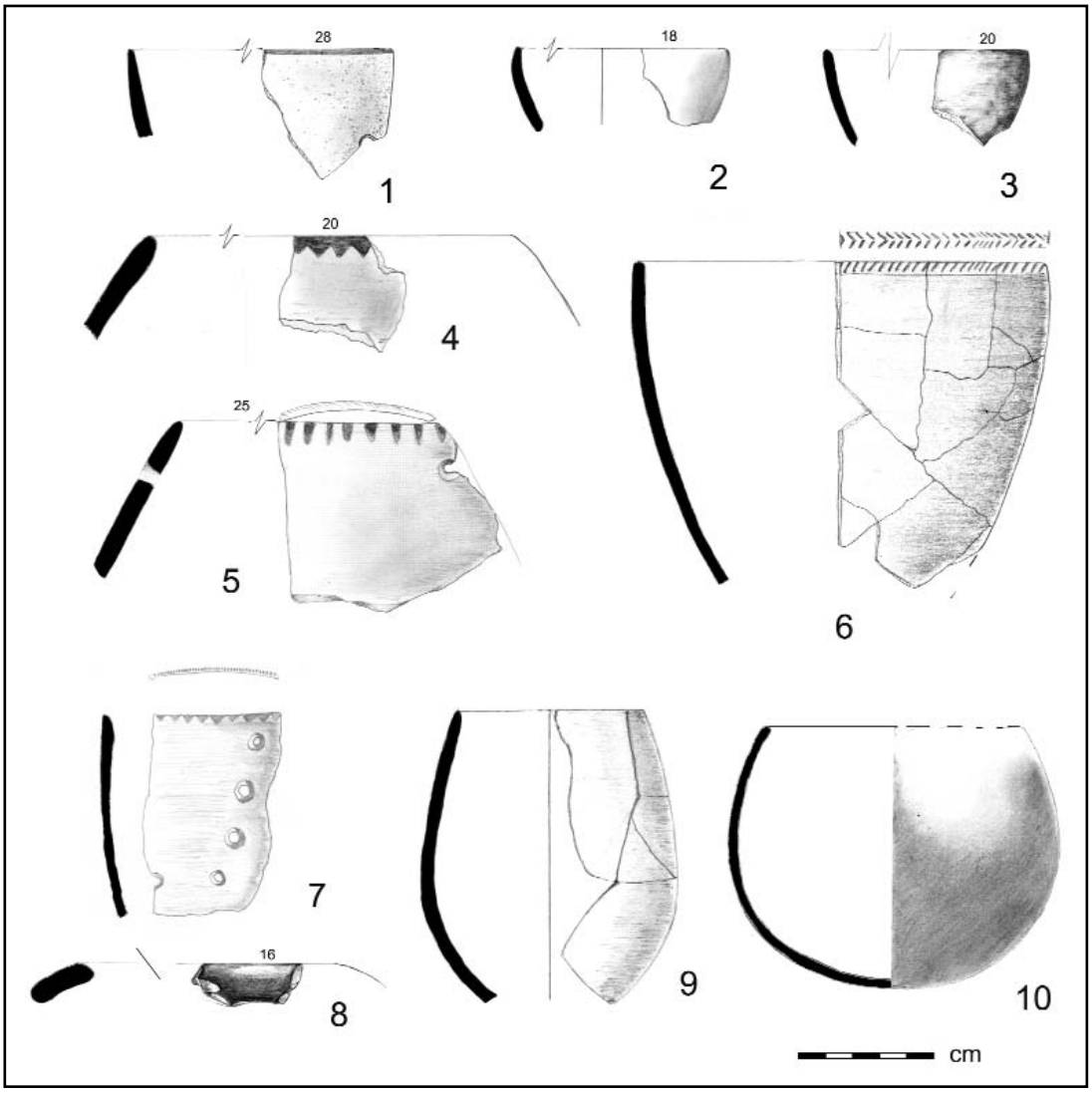

Figure 47.- Sheikh el Amin: pottery sherds with black topped decoration (1, 4, 5, 7) and plain surfaces (2, 3, 8, 9). No 10 is a complete Meroitic vessel. Numbers over some sherd drawings refer to the rim diameter in cm.

recorded Mesolithic sherds at SM and EM, and this can be taken as an indication of the sherds coming actually from a chronological earlier site on the same spot, and not from the Neolithic settlement. The same interpretation has been advanced for much of the DWL ware in other Neolithic sites, such as Kadero (Krzyzaniak 1978: 171) or Shaheinab (Arkell 1949: 68) where a hundred sherds were recorded, also scattered fairly uniformly about the site as in Sheikh el Amin. At this site, however, the DWL sherds probably came from a small Mesolithic camp located in its central area (Garcea in press). Other sherds of possible Mesolithic origin were found in the excavation, namely rocker impressed with big rough impressions all over the surface and the same fabric than the DWL (Figures 48: 2; 50: 12-14). No wavy line sherds were recorded, and this absence reminds of the "pure DWL" phase, without WL, suggested as typical of the end of the Mesolithic period in the Western Butana and northern Khartoum region (Caneva and Marks 1990: 21-2; Garcea 1993: 50-1; 1998: 92). The presence of a small surface concentration of DWL sherds and other Mesolithic items, such as microliths and stone circles, near the north-western corner of the site (location E 0481310 / N 1722568; see Fernández *et al*. 2003: section 2) suggests that the preceding Mesolithic settlement could have been a

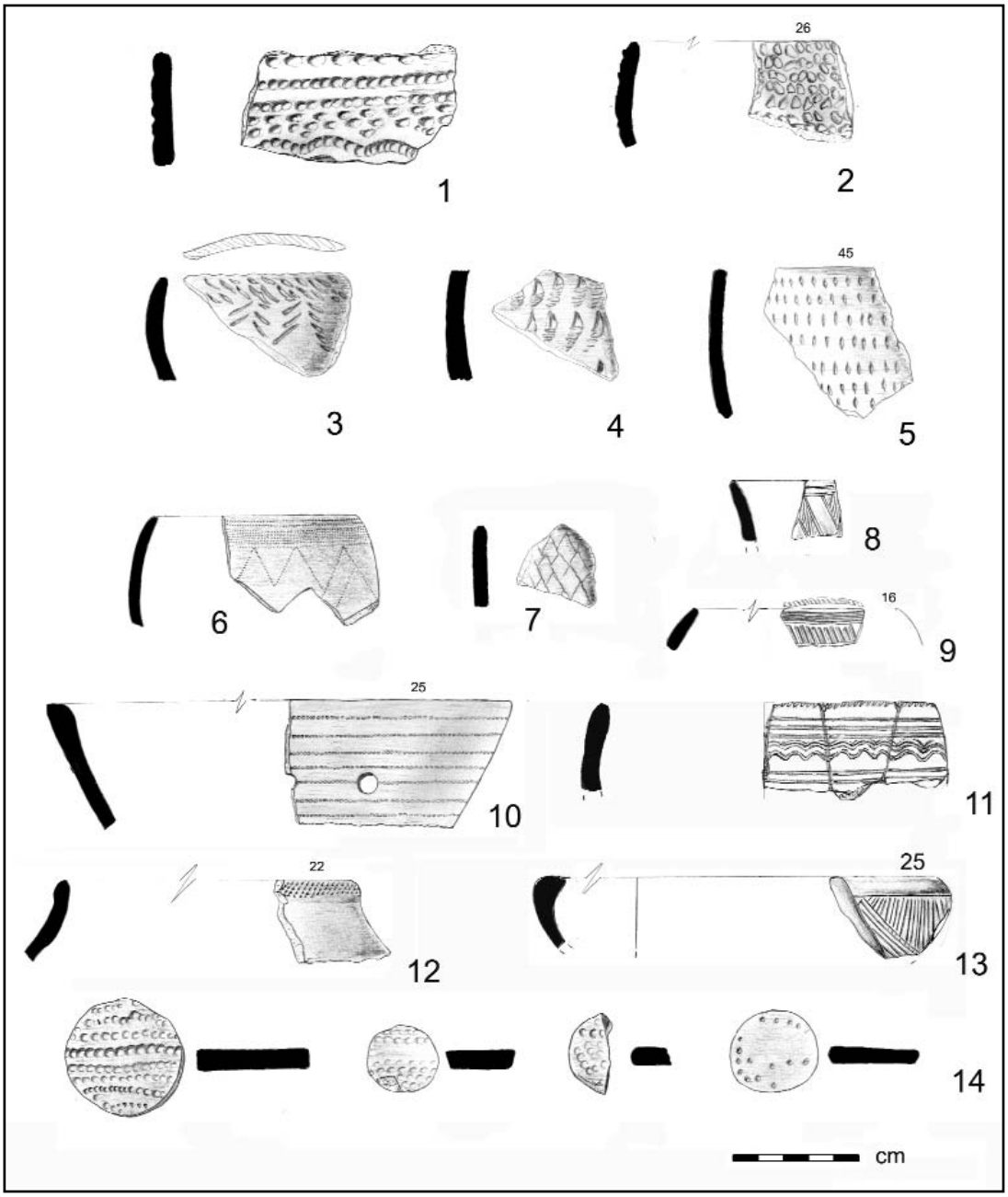

Figure 48.- Sheikh el Amin: pottery sherds with Mesolithic dotted wavy line (1), Mesolithic rocker (2), rough incision (3), simple impression (4, 6), fine incision (8, 9, 11, 13), plain edge rocker (7), alternately pivoting stamp ("smocking pattern", 5), thick impressed rim (12). Pieces of no. 14 are circular cut sherds (tokens). Figures over the sherd drawing refer to the rim diameter in cm.

small camp as in the case of Shaheinab. Nonetheless, the presence of DWL pottery all over the large Neolithic site rather hints at a substantial Mesolithic occupation. The spatial correspondence of the DWL finds and the Neolithic settlement area could also indicate some kind of cultural and demographic continuity between both periods, as it has been documented in a very small group of Sudanese sites, namely El Qoz (Arkell 1953: 97-101) and Shaqadud (Marks and Mohammed-Ali 1991).

In the excavated sectors of Sheikh el Amin there is not any indication of stratigraphic pattern and thus no evidence of chronological

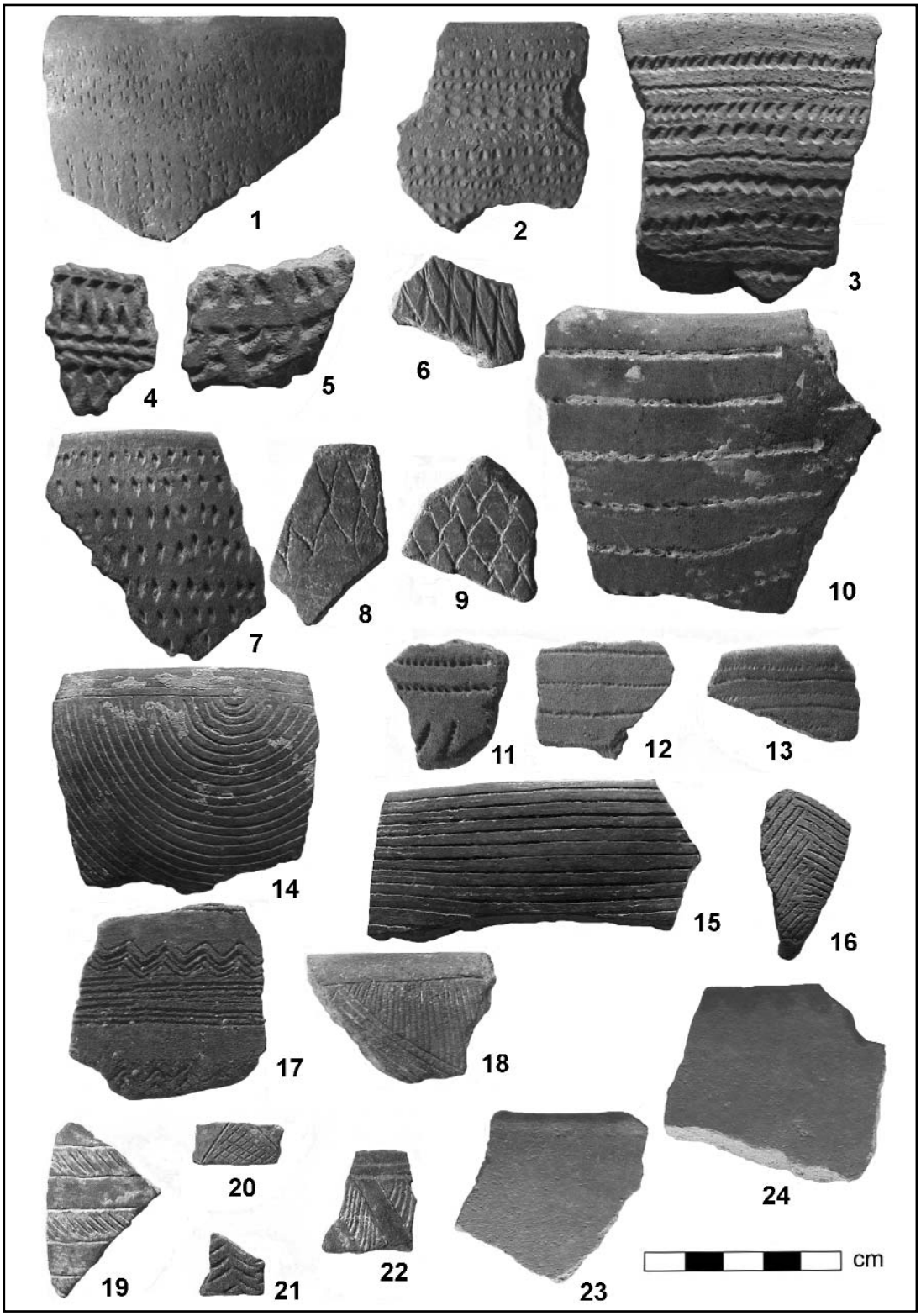

Figure 49.- Sheikh el Amin: pottery sherds with spaced zigzag rocker (1), evenly separated rocker (2), unevenly separated rocker (3-5), plain edge rocker (6, 8-9), alternately pivoting stamp (7 with "smocking pattern", 10, 11-13), incision (14-16), fine incision (17-22), and black toped (23-24) decoration.

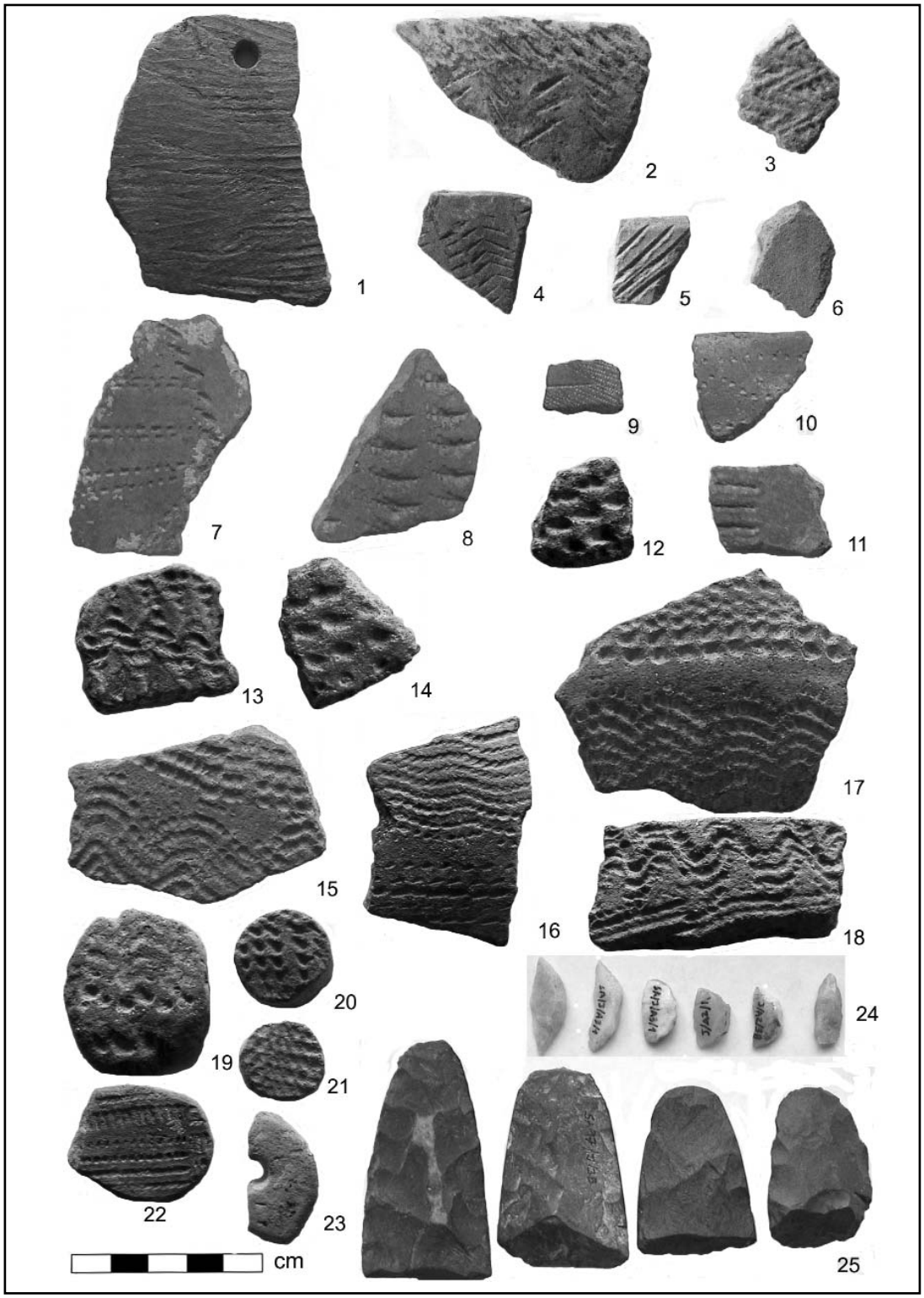

Figure 50.- Sheikh el Amin: pottery sherds with scraped surface (1), rough incision (2-5), painted? (6), simple impression (7-11), Mesolithic rocker (12-14), and Mesolithic dotted wavy line (15-18) decoration. Nos. 19-23 are sherds cut into circular shape. No. 24 is a sample of lithic lunates and a "mèche de foret" and no. 25 is a selection of rhyolite gouges, seen at the flaked side.

Level	RKR	RKI	RKS	RKP	APS	INC	PLA	Total
1	22 (14.6)	71 (47.0)	11 (7.3)	0 (0)	5 (3.3)	27 (17.9)	15 (9.9)	151
2	103 (18.3)	228 (40.5)	29 (5.1)	0 (0)	14 (2.5)	78 (13.8)	111 (19.7)	563
3	56 (17.7)	166 (52.5)	6 (1.9)	0 (0)	2 (0.6)	32 (10.1)	53 (16.8)	315
4	54 (14.2)	205 (53.8)	12 (3.1)	0 (0)	9 (2.4)	60 (15.7)	41 (10.8)	381
5	78 (16.6)	218 (46.4)	5 (1.1)	0 (0)	0 (0)	92 (19.6)	77 (16.4)	470
6	169 (25.6)	267 (40.4)	8 (1.2)	3 (0.4)	10 (1.5)	122 (18.5)	79 (12.0)	658
7	155 (17.9)	395 (43.6)	47 (5.2)	4 (0.4)	15 (1.7)	171 (18.9)	119 (13.1)	906
8	137 (15.2)	418 (46.3)	20 (2.2)	4 (0.4)	9 (1.0)	183 (20.3)	131 (14.5)	902
9	150 (15.9)	425 (45.1)	32 (3.4)	6 (0.6)	9 (0.9)	207 (21.9)	114 (12.1)	943

Table 12.- Pottery type distribution in the nine artificial levels excavated at sector A-1 of Sheikh el Amin. Data are expressed in sherd counts and percentage values. Legend for this and subsequent tables and diagrams: RKR: Rocker regular; RKI: Rocker irregular; RKP: Rocker plain; RKS: Rocker spaced; APS: Alternately pivoting stamp; DWL: Dotted wavy line; INC: Incision; BLT: Black Topped; IMP: Simple zoned impression; FIN: Fine incision: PLA: Plain.

change of the pottery or any other cultural types. For example, in table 12 the data are shown from sector A-1, excavated following nine artificial levels down to 130 cm deep. The pottery contents of each level, expressed both in sherd counts and percentages, are very similar -or seem to change in a random way- for each type along the stratigraphic sequence.

The raw frequencies of pottery types in the different excavated sectors of the site are shown in table 13. Total percentages at the site are presented in figure 51. The results of a multidimensional statistical analysis of data from table 13 (Principal Component Analysis using the program *Statistical Package for the Social Sciences*, SPSS version 11.5.1) can be seen in Figure 52. Sector J-2 was excluded to avoid the biasing effect of its large pottery sample on the analysis output. The spatial arrangement of pottery types on the diagram plot probably indicates chronological variation among the different areas of this vast site. Thus we have down at right a group of younger decoration types with BLT, PLA, FIN and RKS; the last type fitting less well in the group. The four types are plotted near the sector J-1, which is the only one that is widely separated from the other sectors in the second diagram plot. This is in accordance with the radiocarbon date from sector J mentioned earlier, almost 1000 years younger than that obtained from the sample in sector B (see section 1). The most frequent types of rocker decoration, regular and irregular, appear clustered with the incision in the right upper part, conceivably representing the "mainstream" of Shaheinab pottery decoration. The unexpected presence of simple

Sector	RKR	RKI	RKS	RKP	APS	INC	DWL	IMP	FIN	BLT	PLA	Total
A-1	922	2375	160	17	114	971	5	0	0	0	708	5270
A-2	461	1342	171	13	45	596	22	0	1	3	439	3091
B-1	425	529	66	6	41	346	4	1	1	0	398	1817
B-2	365	648	148	9	29	398	26	0	0	3	361	1987
C-1	770	995	234	160	49	702	15	2	1	0	689	3617
C-2	552	919	64	14	57	316	32	2	1	0	275	2232
D-1	324	515	345	5	32	552	14	0	4	6	675	2472
E	110	108	293	2	1	119	0	0	0	3	528	1164
F	42	118	17	48	16	47	52	0	0	0	115	455
G	240	472	159	1	34	259	14	0	6	2	377	1564
H	565	754	577	14	18	410	11	0	6	16	1257	3628
I	288	1043	115	12	12	302	10	0	2	4	394	2182
J-1	1131	2225	639	30	36	1443	42	0	8	13	1693	7260
J-2	3888	2470	4059	52	425	3607	172	7	20	23	5299	20022
Total	10083	14513	7047	383	909	10068	415	12	50	73	13208	56761

Table 13.- Raw frequencies of sherds with different decoration types in the sectors excavated at the site of Sheikh el Amin. Legend of pottery types as in table 12.

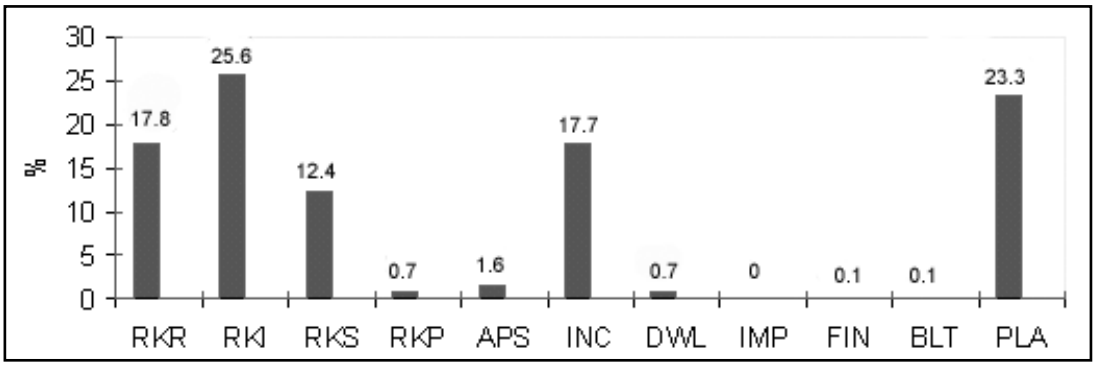

Figure 51.- Percentage values of pottery decoration types in Sheikh el Amin. Legend as in table 12.

impression (IMP) at left, with two presumably earlier types (APS and DWL), is probably an analysis artefact owing to its lower frequency. DWL type position in the middle point of the plot reflects its widespread presence all over the site. Its lack of association with any other pottery type, moreover, attests its non-Neolithic origin. As for the sectors, A-B-C could have been the earlier occupied areas of the site, situated in its central part. Later the settlement was enlarged peripherally through the areas of the other *kôms*, sectors H and J being used at a later phase of the occupation of the site.

The SPSS program run another set of statistical analysis with data obtained in the larger and more detailed excavation of sector J (Table 14; Figure 53). The frequencies of pottery types counted at each of the 60 excavated square meter in levels 3A, 3B, 3C and 3D (in level 3A the data were collected by smaller squares of 0.5x0.5 m) were analysed using Principal Component Analysis (PCA). The results in the four levels are similar. The first component, with the biggest concentration of variance, always represents what is called the "size" factor, meaning that all the types appear with a more or less similar concentration in all the squares. The second component usually represents an opposition of two or more or the types, but in every level this would happen with the less frequent types (APS, RKP, DWL), while the other, more abundant types are plotted together in the diagram. The same result was produced by the PCA of the total frequencies in each square adding together the four levels for the 60 excavated squares (Table 14). The plot diagram of the variables (pottery types) shows that the most abundant types (except RKS) are situated at the right end of the horizontal axis, thus denoting their important contribution to the frequency counts in all the squares (Figure 53). Only the less abundant types follow again a separate model of opposition in the vertical axis, which could have a chronological meaning: APS is opposed to FIN, IMP and BLT,

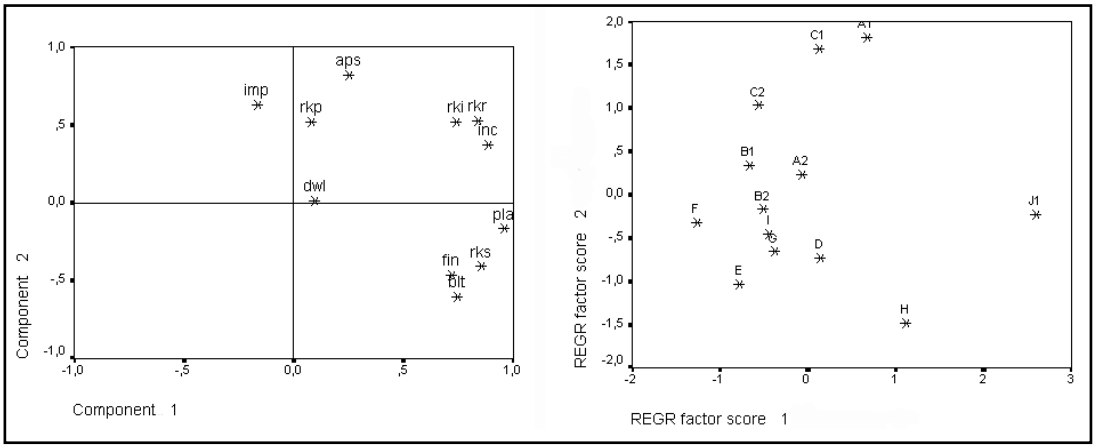

Figure 52.- Principal Component Analysis of pottery decoration types in the excavated sectors of Sheikh el Amin (save sector J-2). Diagram plots of types and sectors in the first two components. Legend as in table 12.

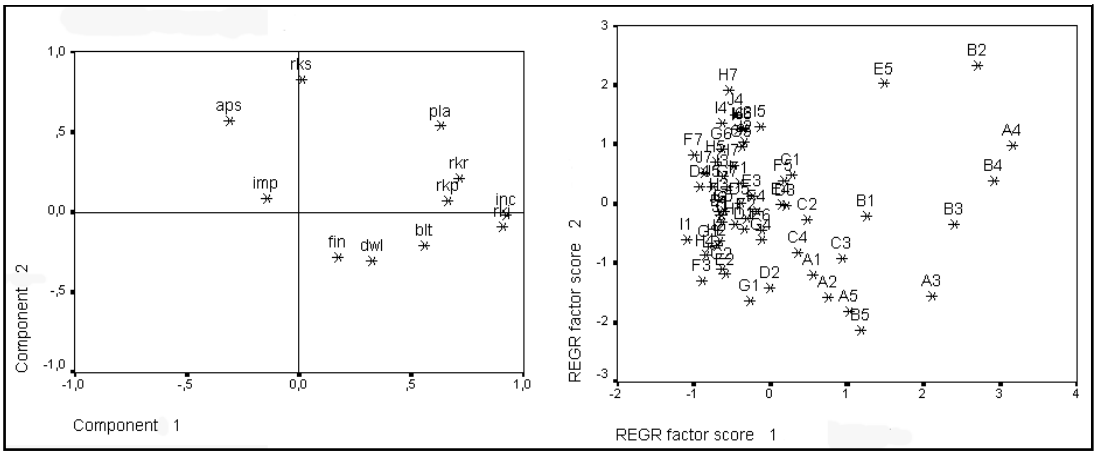

Figure 53.- Sheikh el Amin: principal Component Analysis of pottery types in the excavated squares of Sector J. Plot diagrams of types and squares in the two first principal components.

but also -and inconsistently- to DWL (but see above on this intrusive ware). Nonetheless, the origin of this unclear model lies probably in the lower frequencies of many of these types. As it is well known, small samples tend to destabilise statistical results. The plot diagram for the squares shows a big concentration at the left, with a few outsider squares (A3, A4, B2, B3, B4, and E5), which yielded more pottery sherds and thus show a bigger weight on the horizontal axis.

An analysis of the wireframe 3D graphs after applying the *Surfer* 8.01 program to the data in the excavated squares of sector J (Figure 54) shows certain patterns. Thus we have two areas of clustered RK, INC and PLA sherds, in the sector J-1 (A/B-1/2) and the opposite corner at south-east (H/J-6/7). Less abundant varieties (APS, RKP) behave in a more random way, as it is also the case with DWL, showing again a separate model from the rest of the types.

Another outcome of the analysis is the higher frequency of sherds in the squares at NW and W (squares A/F – 1/3) than in the other corner of the excavation of sector J, a fact that was already apparent during the excavation (Figures 24-25). From F5 to J1 there seems to be a kind of an "empty border" band between the two different density concentrations. Inside the area with higher pottery frequency, a line of denser patches was detected roughly parallel to the boundary. Also the natural level underlying the artefacts horizon was different in the two areas, hardened clay in the denser part and a more sandy one that resembles the natural terrace formation in the other area. During the fieldwork a singular feature was recorded between squares G1 and H1, an area with small patches of burnt red clay and sparse and very small charcoal fragments, which could be the remains of an ancient hearth. It was also observed that the snail shells (*Limicolaria*), very abundant in the entire sector J, tended to appear clustered in small concentrations. (Because of their abundance these shells were taken out from the J-1 sample during the bone cleaning and preparation for transport, which explains their low number in the final counts, see Chaix 2003.) This abundance can probably be explained by the preference of these snails for habitats with tall grass, which rapidly grows in the fertile soils of settlement sites after being abandoned (Gautier 1983: 95).

Vegetation growth would have been more intense in rubbish areas, and that is how one may interpret this area in the site, perhaps only apparently more intact than other sectors. It could be a rubbish midden heap that was not completed up to become a mound as in other areas of the site, but the results of analysing the grinders distribution (see later) rather suggest that the area was a living space. Yet the great diversity of cultural items (especially pottery decoration types) in the other excavated sectors strongly suggests that we are dealing with the actual discard areas of the Neolithic settlement. It is an ascertained archaeological fact that secondary refuse deposits are characterised by bigger size of the artefacts, because the smaller have a stronger probability of being left as primary refuse –i.e. in its original context of daily use–

Square	rkr	rki	rks	rkp	aps	inc	dwl	imp	fin	blt	pla	Total
A1	108	168	40	1	0	102	2	0	0	0	113	534
A2	65	169	35	1	5	107	6	0	2	1	159	550
A3	123	152	58	1	3	164	4	0	3	5	161	674
A4	143	354	71	8	9	221	3	0	0	0	199	1008
A5	87	234	24	2	3	144	7	0	0	0	100	601
B1	111	173	75	0	1	101	4	0	1	2	208	676
B2	175	224	162	2	5	154	10	0	1	2	250	985
B3	72	258	58	8	3	186	6	0	0	1	196	788
B4	120	302	77	7	7	162	3	0	0	4	198	880
B5	97	176	46	0	1	152	2	0	1	4	72	551
C1	139	54	105	2	5	72	4	0	1	0	106	488
C2	86	94	75	3	3	114	5	0	0	0	123	503
C3	99	89	72	1	9	130	12	1	2	3	120	538
C4	97	73	81	1	8	102	17	0	1	0	95	475
C5	62	53	54	1	14	80	4	0	0	0	96	364
D1	76	57	88	0	5	81	5	0	0	1	73	386
D2	86	56	45	4	4	83	7	0	0	0	57	342
D3	107	71	68	4	10	77	3	0	0	1	85	426
D4	69	49	71	0	18	76	4	0	0	0	60	347
D5	69	57	71	1	9	109	0	0	0	0	87	403
E1	58	43	88	1	6	60	2	1	0	2	71	332
E2	63	43	65	2	2	54	2	0	0	1	49	281
E3	113	48	84	0	9	86	2	0	1	0	88	431
E4	124	61	83	0	8	73	13	0	0	0	118	480
E5	154	86	130	4	11	164	5	0	0	1	152	707
F1	73	50	99	1	8	67	3	1	0	2	88	392
F2	107	37	56	3	9	68	1	0	0	0	70	351
F3	66	44	35	1	5	47	0	0	0	0	62	260
F4	107	65	75	0	6	74	5	0	0	0	104	436
F5	131	52	79	0	8	89	3	0	1	0	141	504
F6	86	49	73	4	8	46	4	0	2	0	101	373
F7	86	54	78	0	26	63	4	0	1	0	48	360
G1	81	42	49	0	3	71	6	0	1	1	82	336
G2	51	36	74	1	4	66	6	0	0	1	53	292
G3	67	44	84	0	6	43	10	0	0	0	57	311
G4	73	37	68	3	6	56	12	0	0	0	117	372
G5	93	35	104	0	7	68	2	0	0	0	137	446
G6	78	39	85	0	12	70	0	0	0	0	130	414
G7	66	47	70	1	11	58	0	0	0	1	119	373
H1	76	44	77	1	3	69	2	0	0	0	94	366
H2	57	47	67	0	6	52	4	0	1	0	104	338
H3	54	38	106	0	4	51	4	0	1	0	117	375
H4	56	42	62	0	10	45	4	0	2	0	88	309
H5	48	48	80	0	13	64	0	1	1	1	149	405
H6	79	48	99	1	10	70	0	0	0	0	152	459
H7	82	62	111	0	14	50	0	0	0	0	163	482
I1	45	39	62	0	6	49	0	0	0	0	80	281
I2	55	44	72	0	3	65	0	0	1	0	107	347

.../...

I3	58	33	101	0	6	68	0	0	1	0	132	399
I4	65	48	121	0	9	66	1	0	0	0	130	440
I5	56	44	118	1	8	74	0	0	0	2	166	469
I6	82	46	82	2	10	51	0	1	0	0	172	446
I7	58	53	84	1	15	59	2	0	2	0	153	427
J1	70	42	79	1	6	62	0	0	1	0	84	345
J2	69	39	99	2	12	85	3	0	0	0	125	434
J3	66	50	108	1	10	95	0	0	0	0	137	467
J4	75	36	87	2	16	70	0	0	0	0	152	438
J5	67	21	68	1	9	51	0	0	0	0	128	345
J6	72	56	76	1	6	51	5	1	0	0	95	363
J7	61	40	84	0	8	63	1	1	0	0	119	377
Total	5019	4695	4698	82	461	5050	214	7	28	36	6992	27282

Table 14.- Pottery types frequencies in the excavated squares at sector J of Sheikh el Amin.

during cleaning activities (Schiffer 1972, 1987: 62-3). The refuse disposal places usually show a greater cultural diversity, the bigger the more permanent is the rubbish dump (Boone 1987). Diversity in its turn always increases following the "waste stream" from the original systemic context to the definitive archaeological context (Schiffer 1988: 472-3). This model also agrees with the aforementioned procedure proposed by Karim Sadr (1991: 20-3) to distinguish between long, medium and short-term (seasonal) occupations in the steppe of Eastern Sudan. Beside the surface artefact density, which ordinarily reflects the duration of occupation, the spatial differential distribution can be used as a measure of sedentariness. Thus, sites with cluster midden mounds surrounded by empty spaces –cleared habitation zones– could correspond to a permanent or at least a "medium" term occupation where people lived for a long time in the same structures. On the contrary, those sites with a "sheet midden", i.e. a relatively thin, even spread of artefacts over a flatter surface could have come from seasonally reoccupied settlements where every year, as today the Sudanese Kababish still do, people erect their tents or temporary huts and choose the waste zones in different places. Sheikh el Amin meets the first conditions while Rabob (no. 50, see Fernández *et al*. 2003: section 2), a bigger and mostly flat site in the Butana plain away from the Nile, meets the second. Even though radiocarbon dates are not very different between these two sites (Ibid.: section 4), Rabob cultural features seem to be of younger date than those of Sheikh el Amin (Ibid.: section 7). The change from one occupation model to the other is in close agreement with the suggested shift from sedentary to more mobile conditions and the installing of a pastoralist economy in Central Sudan during Later Neolithic times (Krzyzaniak 1978; Haaland 1987; Caneva 1988).

3. The lithic material

The lithic material of Sheikh Mustafa and El Mahalab

The two excavated Mesolithic sites have yielded quite a large quantity of lithic artefacts, including retouched tools, cores, flakes, blades, bladelets, lithic debitage and stone rings and grinders, amounting to more than 85.000 pieces. More than 5000 retouched tools were discovered and later classified into some 30 technological types. In table 15 a summary is shown of the lithic count data at both sites. Grinders were very abundant, but their extreme breakage pattern (see section 1) makes their analysis unfeasible, beyond the simple fragments count as it is presented in tables 15, 20 and 21. Stone rings were found in fewer numbers. Most of them were also broken to small pieces, what made difficult to differentiate them from the grinder fragments.

Raw material was mainly whitish compact quartz (98%) coming in small globular nodules (3-6 cm is the usual dimension) from the layers of the Nubian Sandstone Formation. Small nodules of vitreous transparent quartz were much less abundant. A few flakes and points were made on small fossil wood cores, and Nubian sandstone was used to make big flakes that were found on the surface of the site but rarely in the

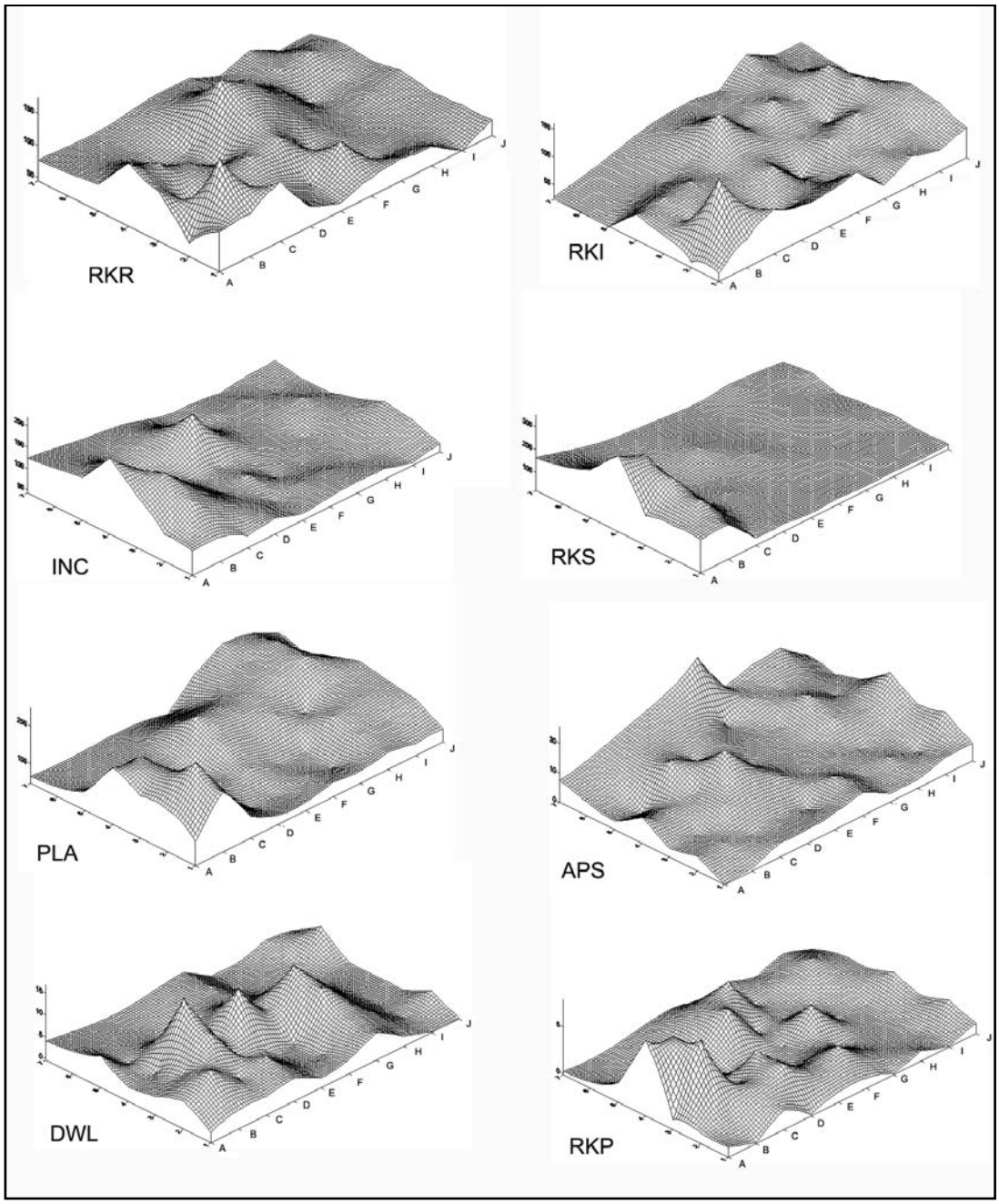

Figure 54.- Sheikh el Amin: 3D ('wireframe') plot for the raw frequencies of pottery decoration types in sector J.

Type	Type	F1	F2	F3	BL	CO	TO	GR	Total
SM	N	5907	13139	17369	1342	1034	1609	442	40842
"	%	14.47	32.17	42.53	3.28	2.53	3.94	1.08	100
EM	N	8901	18634	9902	918	4817	811	362	44345
"	%	20.07	42.02	22.33	2.07	10.86	1.83	0.82	100

Table 15.- Sheikh Mustafa and El Mahalab: total frequencies and percentages of technological lithic types at Sheikh Mustafa and El Mahalab. Legend: F1, F2, F3, primary, secondary and tertiary flakes, BL, blades and bladelets, TO, retouched tools, CO, cores, GR, grinders.

stratigraphic levels. Some rhyolite nodules were found over the sites surface, but apparently not flakes neither tools were struck from them.

The cores (Figures 55-56)

Eight core types have been distinguished in the lithic industry of SM and EM. *Type 1*: superficially struck cores with only a few primary flakes removed; no preparation of striking platform; this type could merely represent the initial core preparation or simply a test of its raw material quality (Figure 55: 1). *Type 2*: irregular subspherical cores on small quartz pebbles, from where tertiary flakes were very frequently struck. This is the prevalent type at both sites, particularly in the bigger sample analysed from El Mahalab. The rare sandstone cores found are of this type, always of bigger size than the abundant quartz ones (Figure 55: 2). *Type 3*: cores on elongated pebbles with two striking surfaces converging on a vertical flaking ridge in the middle. Rarely used for tertiary flakes. Most secondary flakes and the retouched lunates come from these cores. The striking platforms are of non-prepared cortex (Figure 55: 3). This is the most representative core in the Sudanese industries, and the more frequently described (Caneva and Zarattini 1983: fig. 1; "slicing technique" in Kobusiewicz 1994: fig. 2, 1998: fig. 1, e). *Type 4*: the same as the previous type yet with a prepared striking platform done by prior transverse flaking. The resulting faceted platforms are perceptible in the struck flakes, of secondary and especially tertiary types (Figure 55: 4). Since the frequency of prepared platforms increases in the resulting flakes as the core reduction progresses, for instance in biface flaking, probably this type is but an advanced stage of type 3 (Andrefsky 1998: 88-9). *Type 5*: cores with double striking platform and peripheral flaking directions that result in cylindrical or elongated shape. They are used to obtain tertiary flakes and small blades and bladelets (Figure 56: 5). *Type 6*: bladelet cores, differing from types 4 and 5 in the striking direction, following small peripheral and parallel blows. Bipolar cases have normally one of the platforms of smaller dimension resulting in the conical aspect of the core (Figure 56: 6).

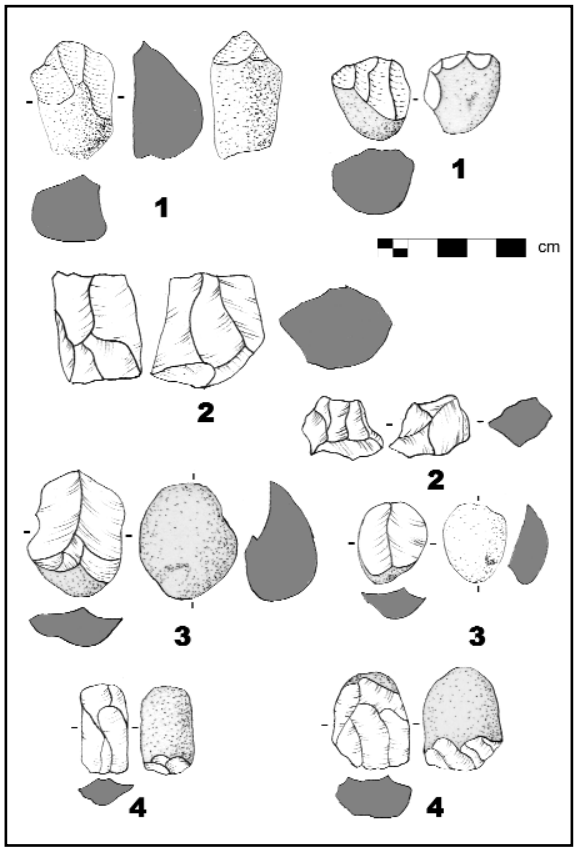

Figure 55.- Sheikh Mustafa and El Mahalab: Core types 1 to 4.

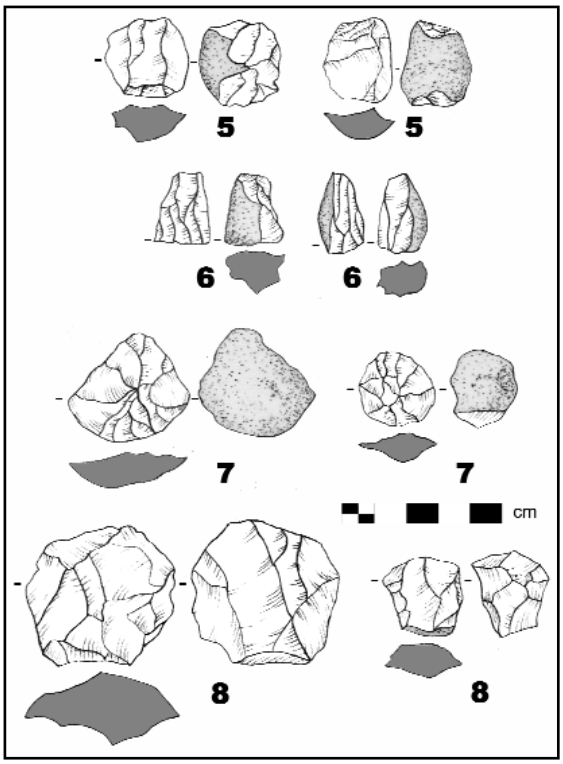

Figure 56.- Sheikh Mustafa and El Mahalab: Core types 5 to 8.

	S. Mustafa		El Mahalab	
Type	**N**	**%**	**N**	**%**
1	13	3.5	468	13.6
2	147	39.7	1933	56.1
3	70	18.9	431	12.5
4	51	13.8	383	11.1
5	14	3.8	69	2.0
6	16	4.3	68	2.0
7	53	14.3	79	2.3
8	6	1.6	12	0.3
Total	370	99.9	3443	99.9

Table 16.- Core type frequencies in a selected sample from 1994 excavations at Sheikh Mustafa and the complete sample from the excavations at El Mahalab.

Type 7: circular unifacial cores ("discoidal"), where only one horizontal plane is exploited following a radial peripheral way to get broad tertiary flakes, usually with cortical platforms. They are thicker in the central area, just as a microlithic variant of the well-known "tortoise shell" cores (Figure 56: 7). *Type 8*: miscellaneous or composite examples that combine some of the features of previous types. The most abundant are those associating a circular exploitation surface (type 7) with globular flaking (2) or double platform (5), etc. (Figure 56: 8). The cores sample from El Mahalab and a selected sample from 1994 excavation at Sheikh Mustafa were classified according to this typology and the frequencies and percentages are shown in table 16.

The flakes

Three general flake types have been distinguished in SM and EM, namely primary, secondary and tertiary flakes. The threefold classification is largely coincidental and with that proposed for the Saggai site by Caneva and Zarattini (1983: 215-7, Fig. 1) and for Kadero by Kobusiewicz (1994: 349-50). Primary flakes are those which are first struck from the cores, and thus their dorsal side retains whole or most of the cortex surface. They amount to 20.05 % of the whole group of flakes recovered at both sites. Secondary flakes bear a substantial portion of cortex on their dorsal face forming a naturally backed side, being usually slightly elongated with segment shape (43.02 %). Tertiary flakes do not bear any cortex on the dorsal side and are very varied in shape and size (36.93 *%). Secondary flakes are more frequent at El Mahalab, which agrees with the larger presence of lunates in this site. Blades are very rare since the cores are generally rather small, and most often fall into the bladelet category (length < 3 cm). They represent 2.97 % of the total flaked products, many of them being retouched (see later).

The retouched tools (Figures 57-58)

A total of 5.312 retouched tools were recovered in the excavation of both Mesolithic sites. They were classified into 30 types, which in their turn are assembled in four general categories: Upper Palaeolithic substratum (no. 1-9), microblades (10-17), geometrics (18-29) and varia (30). General typologies by Tixier (1963) for Northwest Africa and Fortea (1973) for the Western Mediterranean, and more specific by Caneva and Zarattini (1983) for Central Sudan have proved useful when classifying our pieces. The general tool list is presented in table 17 bellow.

End scrapers (Es) tend to be thick, and are usually retouched on thick cortical primary flakes or flaked cores (pebble); less frequently on tertiary flakes or bladelets. Side scrapers (Ss) are small flakes with simple continuous retouch over one of their sides; only straight and convex types occur. Burins (Bu) are varied and not standardised; usually lateral and never dihedral; frequently uncertain. Denticulates (De) have few and little marked teeth along only one side, generally curve; notches are always of the simple kind with only one indentation, laterally or distally placed. Perforators (Pe) have straight or curved points created by retouch on both sides, usually on small tertiary flakes. Retouched flakes (Fr) can be of any of the three types and have simple continuous retouch on one side without indentations. Raclettes (Rc) are small tertiary flakes, their contour edge more or less continuously backed by steep retouch. Truncations (Tt) are flakes or bladelets with a distal break, perpendicular or inclined, made or regularised by means of steep or semi-steep retouch; some double examples with both ends retouched may be classified as geometrics. Backed blades (BB) have generally only one steep-retouched (backed) side, and are frequently broken.

Tools of the microblade and geometric groups (fig. 33: 18-20) are smaller in size and usually more standardised than the aforementioned

No	TYPE	DESCRIPTION
1	Es	End scraper
2	Ss	Side scraper
3	Bu	Burin
4	De	Denticulate-notch
5	Pe	Perforator
6	Fr	Retouched flake
7	Rc	Raclette
8	Tt	Truncation
9	BB	Backed blade
10	Bb1	Backed bladelet, straight
11	Bb2	Backed bladelet, curved
12	Bbp1	Backed bladelet, pointed straight
13	Bbp2	Backed bladelet, bipointed curved
14	Bt	Truncated bladelet
15	Bbt	Bi-truncated bladelet
16	Mf	Mèche de Foret
17	Po	Point
18	Te	Triangle, equilateral
19	Ti	Triangle, isosceles
20	Ts1	Triangle, scalene
21	Ts2	Triangle, scalene atypical
22	Tr1	Trapeze
23	Tr2	Trapeze, atypical
24	Lu1	Lunate, narrow
25	Lu2	Lunate, broad
26	Lu2cb	Lunate, broad completely backed
27	Lu2pb	Lunate, broad incompletely backed
28	Lu2nb	Lunate, broad naturally backed
29	Lu3	Lunate, varia
30	Va	Varia

Table 17.- General list of retouched tools in the Mesolithic and Neolithic sites.

"Upper Palaeolithic" group. Backed bladelets (Bb) present steep retouch on one of the sides, which can be rectilinear (Bb1) or curved (Bb2); they are not intentionally sharpened by trimming, and were frequently broken. Pointed backed bladelets have straight lateral margins and usually only one pointed end (Bbp1) or curved sides and two pointed ends (Bbp2); the steep retouch on the backed side is usually bipolar (alternating or *sur enclume*). Width is always less than 1/3 of the piece length; the curved side may be regular or sinuous. Type Bbp2 is the most standardised in both sites and the most frequent tool type in Sheikh Mustafa. Truncated on one end (Bt) or on both ends (Bbt) bladelets are not very abudant; truncation can be perpendicular or oblique. *Mèches de foret* (Mf) are small thick blades or bladelets with both ends pointed and elongated oval-shaped, with steep of semi-steep retouch on all the contour. Points (Po) exhibit one or two backed sides, with straight blanks and flat retouch to sharpen the distal end or either with convergent double curved sides.

Geometric microliths from both sites exhibit quite standardised shapes, especially triangles and lunates. Equilateral triangles (Te) have two of their three sides formed by backing, the third one being always a naturally cutting edge and never the platform side; they cannot be mistaken with convergent double points that have a much narrower third side. Isosceles triangles (Ti) have generally backing retouch along one of the long sides and at the base; bipolar retouch is frequent on the long side. Scalene triangles were retouched along the two shorter sides and the longest was left with its natural edge; typical scalenes have the short side approximately half the length of the longest (Ts1) and when it is less we have the elongated, atypical scalene (Ts2). Trapezes are small flakes, retouched on the proximal and distal ends and rarely on the sides; retouched ends can have concave or convex shape; typical present symmetrical retouched sides (Tr1), atypical have them asymmetrical (Tr2).

Lunates are very abundant at both sites, especially in El Mahalab that is chronologically younger. These pieces are very standardised, retouched on the curved side of secondary flakes; this retouch has eliminated more or less the natural edge with cortex. The width of the narrow examples (Lu1) is equal or less than half the length; they are usually completely backed. The broader variety (Lu2) may have retouch along all the curved side (Lu2cb) or only on part of it (Lu 2pb). Some examples were left with the entire natural cortex on the curved side (Lu2nb), differing from usual secondary flakes in that they have some retouch or preparation on the ends. The type Lu3 includes several variants on the normal lunate shape: humped with a central protuberance in the curved side, truncated with retouched truncation in one end, notched, etc. Finally, the varia category (Va) includes a small sample with those artefacts not included in the previous list.

Table 18 shows the complete list of retouched lithic tools found in the excavated areas of Sheikh Mustafa and El Mahalab. In Figure 59 a comparison is made between the curves of accu-

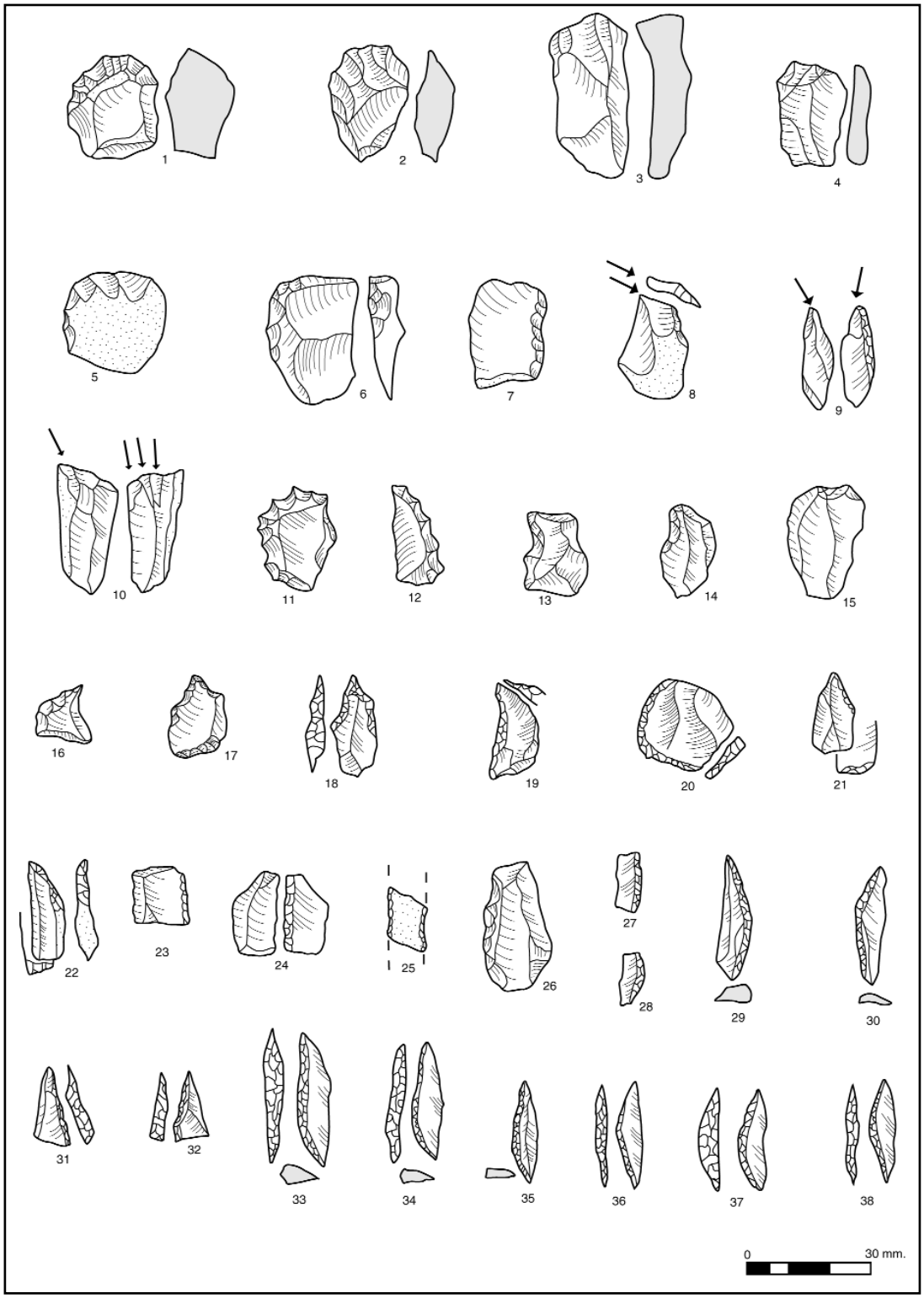

Figure 57.- Sheikh Mustafa and El Mahalab retouched tool-types: end scrapers: 1-5; side scrapers: 6-7; burins: 8-10; denticulates, notches: 11-15; perforatores: 16-19; raclette: 20; truncations: 21-22; backed blades: 23-26; straight backed bladeletes: 27; curved backed bladeletes: 28; pointed backed bladelets, straight: 31-32, curved: 29-30, 33-38.

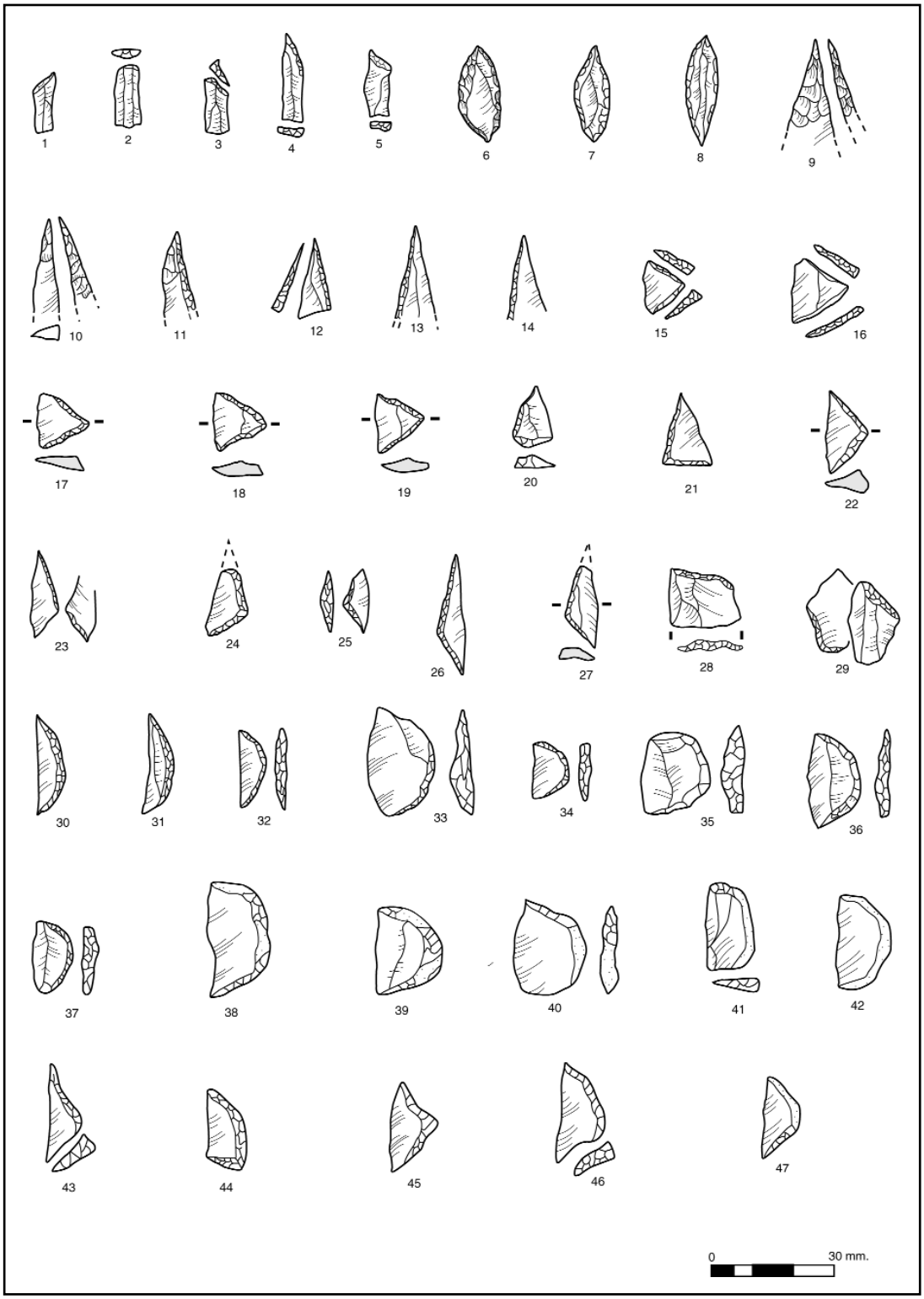

Figure 58.- Sheikh Mustafa and El Mahalab retouched tool types: truncated bladeletes: 1-3; bi-truncated bladeletes: 4-5; Méches de Foret: 6-8; points: 9-14; equilateral triangles: 15-19; isosceles triangles: 20-22; scalene triangles: 23-27; trapezes: 28-29; narrow lunates: 30-32; broad lunates, completely backed: 33-37, partially backed: 38-42; humped lunate: 43, 45, with truncation: 44, 46-47.

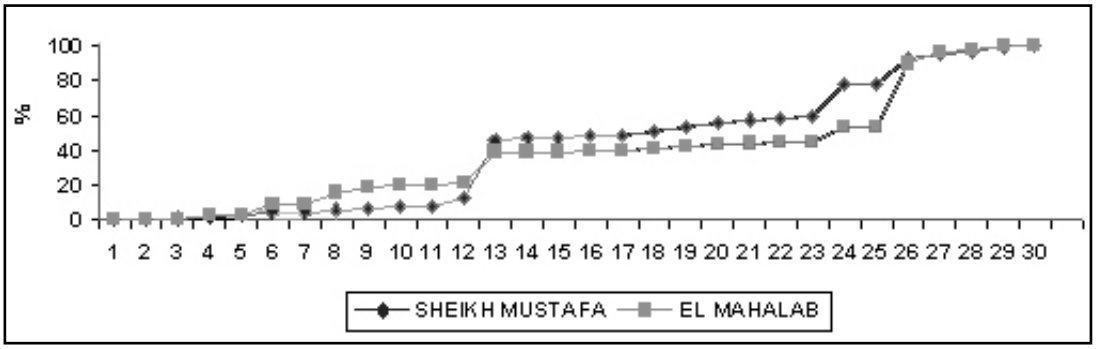

Figure 59.- Sheikh Mustafa and El Mahalab: accumulated percentages curves of the typological list of table 18.

		S. Mustafa		El Mahalab	
No	**Type**	**N**	**%**	**N**	**%**
1	Es	31	0,67	3	0,67
2	Ss	4	0,09	0	0
3	Bu	13	0,28	1	0,22
4	De	41	0,88	9	2,02
5	Pe	32	0,69	2	0,45
6	Fr	89	1,92	27	6,08
7	Rc	3	0,06	0	0
8	Tt	65	1,40	29	6,53
9	BB	60	1,29	11	2,47
10	Bb1	35	0,75	8	1,80
11	Bb2	21	0,45	2	0,45
12	Bbp1	227	4,89	6	1,35
13	Bbp2	1513	32,62	76	17,11
14	Bt	38	0,82	0	0
15	Bbt	2	0,04	0	0
16	Mf	65	1,40	3	0,67
17	Po	32	0,69	2	0,45
18	Te	107	2,31	6	1,35
19	Ti	114	2,46	3	0,67
20	Ts1	95	2,05	6	1,35
21	Ts2	91	1,96	2	0,45
22	Tr1	28	0,60	2	0,45
23	Tr2	41	0,88	1	0,22
24	Lu1	878	18,93	37	8,33
25	Lu2	7	0,15	0	0
26	Lu2cb	685	14,77	164	36,9
27	Lu2pb	125	2,69	27	6,08
28	Lu2nb	30	0,65	7	1,57
29	Lu3	152	3,28	10	2,52
30	Va	14	0,30	0	0
TOTAL		4638	99,97	444	100,1

Table 18.- Sheikh Mustafa and El Mahalab: retouched tools types frequencies and percentages.

mulated percentages of the 30 types for the two sites. Both curves are very similar but for two specific tool-types: backed pointed bladelets (type no. 12-13) and narrow lunates (no. 24), which are more abundant in SM, and broad lunates (no. 26-27) that are more frequent in EM. This reversal of the respective frequency of backed pointed bladelets and lunates has surely a chronological meaning, since SM has a series of radiocarbon dates (7900-7600 bp) that are earlier than those from El Mahalab (7700-6900). The stratigraphy of A-B/13-15 squares of El Mahalab also shows a variation of percentages following the same model, with backed points decreasing and lunates increasing through time (Figure 60). This suggests that the process was a continuous one and it was still proceeding during this site's period. Also an increase in truncations and a decrease in geometric triangles from SM to EM is observed in the data (table 18).

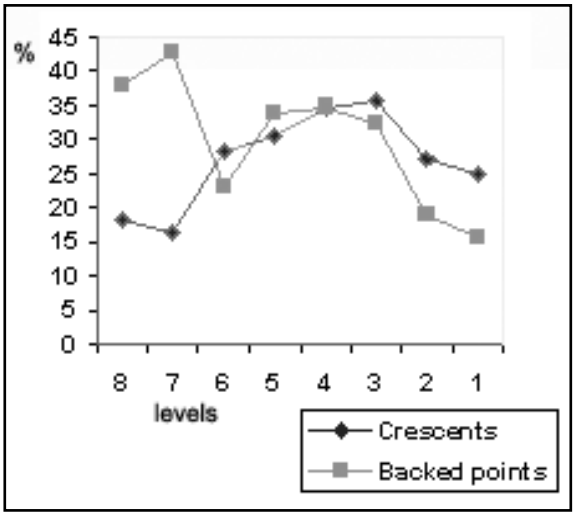

Figure 60.- El Mahalab: variation in the percentages of lunates and backed points in the 8 artificial levels of the excavation of A-B/13-15 squares.

Sampling		
Lithic type	S. Mustafa	Al Mahalab
Lunates	34.0 %	46.3 %
Backed bladelets	39.9 %	18.9 %
Triangles	14.8 %	10.1 %
Truncations	1.5 %	12.2 %
Other	9.8 %	12.5 %
Excavation		
Lithic type	S. Mustafa	Al Mahalab
Lunates	38.6 %	55.4 %
Backed bladelets	39.8 %	22.1 %
Triangles	9.8 %	4.5 %
Truncations	1.3 %	6.5 %
Other	10.5 %	11.5 %

Table 19.- A comparison between percentages of the most abundant lithic tool types in the first excavations at Sheikh Mustafa and El Mahalab (data from squares K/L-1/3 at SM and A/B-13/15 at EM), and in the total excavated area.

From a methodological point of view, it is interesting to compare the typological quantitative results derived from the extensive excavation at both sites and the preliminary results obtained from the initial test-pits and excavations. We have already seen that the results from initial surface sampling in our sites generally presented fairly similar results to those from further and systematic sampling (Fernández *et al.* 2003: section 6). In table 19 we have contrasted the results from the whole excavation (table 18) with those from 1994 first testing of the sites, observing no significant differences between both approaches.

Tables 20 and 21 shows the lithic types raw frequencies, including debitage, at the excavated sectors of SM during the second 1994 field season and in El Mahalab. Following the usual procedure, we statistically analysed these data using

Square	**F1**	**F2**	**F3**	**BL**	**CO**	**LU**	**BP**	**ET**	**ST**	**TT**	**GR**	**Total**
I1	191	386	525	50	7	16	37	3	3	5	22	1245
J1	326	829	1.045	102	18	18	61	5	1	8	57	2470
I3	394	639	922	95	21	24	53	3	1	9	30	2191
J3	409	844	1.043	121	42	40	52	4	9	8	47	2619
O1	171	376	615	51	12	8	28	2	5	1	6	1275
P1	168	381	525	49	23	9	30	2	1	4	9	1201
O3	101	264	210	38	22	12	8	1	3	4	3	666
P3	133	268	340	18	20	18	10	1	3	3	5	819
S3	98	203	317	10	17	3	6	2	0	1	9	666
Q3	147	333	523	18	43	19	16	0	1	0	10	1110
R3	158	365	554	16	43	6	24	0	5	2	8	1181
G13	181	583	599	63	16	13	56	1	2	5	5	1524
H13	332	765	1.025	80	29	14	87	7	3	7	9	2358
G15	527	1.199	1.579	133	65	26	110	15	7	3	17	3681
H15	734	1.659	2.314	206	56	36	176	8	6	11	22	5228
G10	130	352	402	21	24	8	10	1	1	1	14	964
H10	172	485	497	42	42	18	11	4	1	7	14	1293
G12	198	460	570	39	64	19	17	6	5	4	19	1401
H12	168	411	426	23	78	14	22	5	4	4	15	1170
O13	196	459	625	40	58	9	34	3	3	5	32	1464
P13	374	693	981	40	113	27	41	3	0	6	13	2291
O15	219	375	620	27	74	14	27	3	6	3	16	1384
P15	184	343	503	32	56	7	22	3	3	1	19	1173
e1	121	286	353	6	59	4	9	2	0	1	21	862
e3	75	181	256	22	32	4	12	1	0	3	20	606
Total	5907	13139	17369	1342	1034	386	959	85	73	106	442	40842

Table 20.- Sheikh Mustafa: raw frequencies of lithic categories in the squares excavated during the 1994 field season. Legend: F1, F2, F3, primary, secondary and tertiary flakes, BL, bladelets, CO, cores, LU, lunates, BP, backed points and bladelets, ET, equilateral triangles, ST, scalene triangles, TT, other retouched tools, GR, grinders.

Square	F1	F2	F3	BL	CO	LU	BP	TR	TT	GR	Total
A/B13/15	3672	7615	4583	206	1294	130	107	26	110	58	17801
A45	338	667	485	50	233	32	21	0	24	16	1866
A47	336	947	533	73	220	15	4	4	8	23	2163
B45	649	1155	661	102	382	33	15	4	22	45	3068
B47	450	1261	616	113	400	30	18	3	16	38	2945
A20	355	672	417	22	109	19	5	0	1	10	1610
A22	366	662	279	16	331	8	2	1	2	15	1682
B20	342	627	252	56	249	9	3	1	7	9	1555
B22	192	481	269	31	116	8	3	0	4	14	1118
N2	447	891	335	47	297	12	1	2	5	25	2062
N4	655	1422	674	66	560	27	3	0	7	56	3470
O2	502	1032	464	62	333	18	10	1	9	23	2454
O4	597	1202	334	74	293	15	2	1	3	30	2551
Total	8901	18634	9902	918	4817	393	157	43	218	362	44345

Table 21.- El Mahalab: raw frequencies of lithic categories in the excavated squares. Legend as in table 20, except TR for all triangle types.

Principal Component Analysis (*SPSS* program). At El Mahalab, to avoid the biasing effect of its big sample numbers, data from squares A/B13/15 were divided by four. The results are shown in Figures 61 and 62. As it is common in our data, the greater part of the variance (51 % and 60 % in these cases) is concentrated in the first component, which is characterised by high scores in all the initial variables (the so-called "size" component). This means that all the lithic types are more or less equally represented in all the site areas. The following two components, however, with about 25-19 % of the total variance, show a model of opposition between grinders and cores, and backed points at both sites. Lunates are associated with points but also spatially tending towards the core-grinder group. The squares plot shows that those in the upper part, thus being affiliated with grinder-cores and a bit with lunates, are those located in the outer parts of the site (belonging to sectors D, G and F in SM, B and C in EM) while those in the negative part of the diagram are situated in the central areas (sectors A and B in SM, A and 1994 pit in EM). This could be interpreted as a functional separation of the site into different activity areas (backed points in the centre, lunates, grinders and cores in the periphery), but a simpler chronological explanation seems again more likely. As aforementioned, the remains in the peripheral parts of the settlements are at least partially composed by materials washed down from the central parts, so younger materials would tend to appear over-represented in the outer areas of

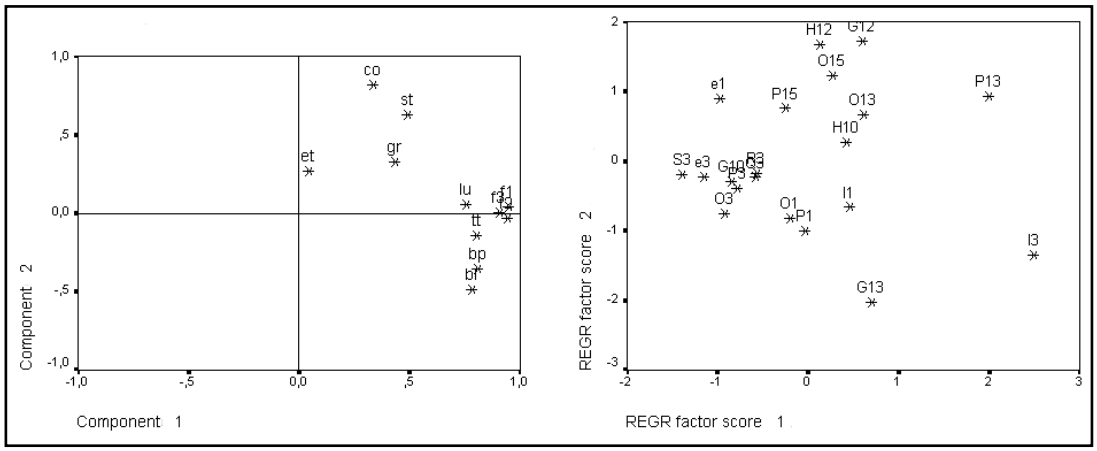

Figure 61.- Sheikh Mustafa: principal component analysis of lithic types in the excavated squares during the 1994 season. Diagram plots of types and squares in the first two components.

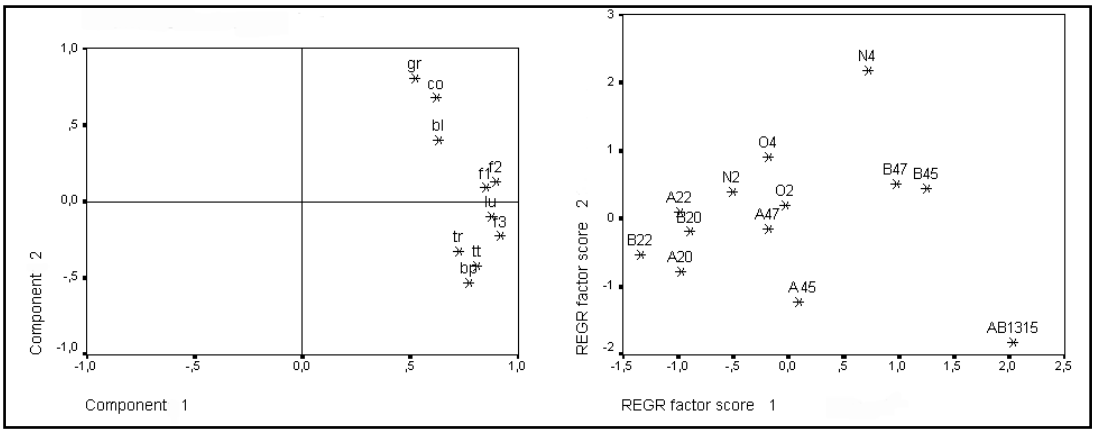

Figure 62.- El Mahalab: principal component analysis of lithic types in the excavated squares. Diagram plots of types and squares in the first two components.

the site (see Figure 11). This model also agrees with the already described chronological evolution of lithic strategies during the Mesolithic, with a gradual decrease of the bladelet component (backed points) and a parallel increase of geometrics (especially lunates). So the greater presence of the latter in the outer parts could be explained by the effect of deflation over the upper parts of the central site into the periphery. The abundance of grinders in the peripheral areas could also indicate an increasing importance of this tool type during the temporal duration of both sites.

Comparison of frequencies of tool types from the Blue Nile sites with other Mesolithic sites in the Khartoum province and neighbouring areas bears interesting conclusions. Even though different classification systems are usually adopted, which hinder clear contrasting, some differences are quite peculiar. The abundance in our sites of backed blades and especially bladelets (tool types no. 9-16), more than 42 % of the retouched tools in Sheikh Mustafa and nearly 24 % at El Mahalab, greatly contrasts with published data from other sites in Central Sudan. Backed pieces are about 7.5 % of the "geometrics" group at Saggai, while crescents and triangles amount to 80 % of the group (Caneva and Zarattini 1983: 225). They are even less abundant in other sites surveyed in the same area (Caneva *et al*. 1993: tables 6.1 to 6.4). Counts are of 4.8 % at Sorurab and of 9.4 % at Khartoum Hospital (Mohammed-Ali 1982: 70). The excavation of the later site yielded backed pieces amounting to 7.9 % of the total "crescents" group that included lunates, triangles and trapezes (145 out of 808 pieces; Arkell 19849: 42-3). Outside the Khartoum area, backed pieces are 2.6 % and 8.9 % of the Early and Late Mesolithic lithic assemblages at Shaqadud (Marks 1991: 121, table 6.11). Also in the sites of the Atbara area (Aneibis, Abu Darbein and El Damer), the frequency of this tool type is low, always less than 6 % (Magid 1995: 58-9). Curiously, we must look at more northern sites, in the Western Desert of Sudan and Egypt, to find comparable amounts of backed pieces, for example at the Selima Sandsheet in Sudan or the Early-Middle "Neolithic" of Bir Kiseiba in southern Egypt (Schuck 1993; Idris 1994; Wendorf, Schild and Close 1984). The great variability of Khartoum Mesolithic cultural assemblages, however, has been already emphasised (Clark 1984; Marks and Mohammed-Ali 1991: 246-7; Caneva *et al*. 1993: 246), and accounted for by the diffusion of a distinct pottery technology to many independent local groups (Hays 1971: 136).

The change from the microblade to the geometric component, as deduced from our data seems to be part of a general trend all through the Holocene. During the following Neolithic period lunates are predominant and backed bladelets are very scarce (see later). In order to investigate the actual utilisation of some of these tools, microwear use analysis was attempted on some Mesolithic microliths from our excavations, using Scanning Electronic Microscopy (by J.J. Ibañez from the University of Cantabria), yet without any results. Also not results were attained in an essay with a bigger sample of sixty backed pieces on chert from the sites in the Atbara region (Magid 1995: 61). Anyhow, backed points, luna-

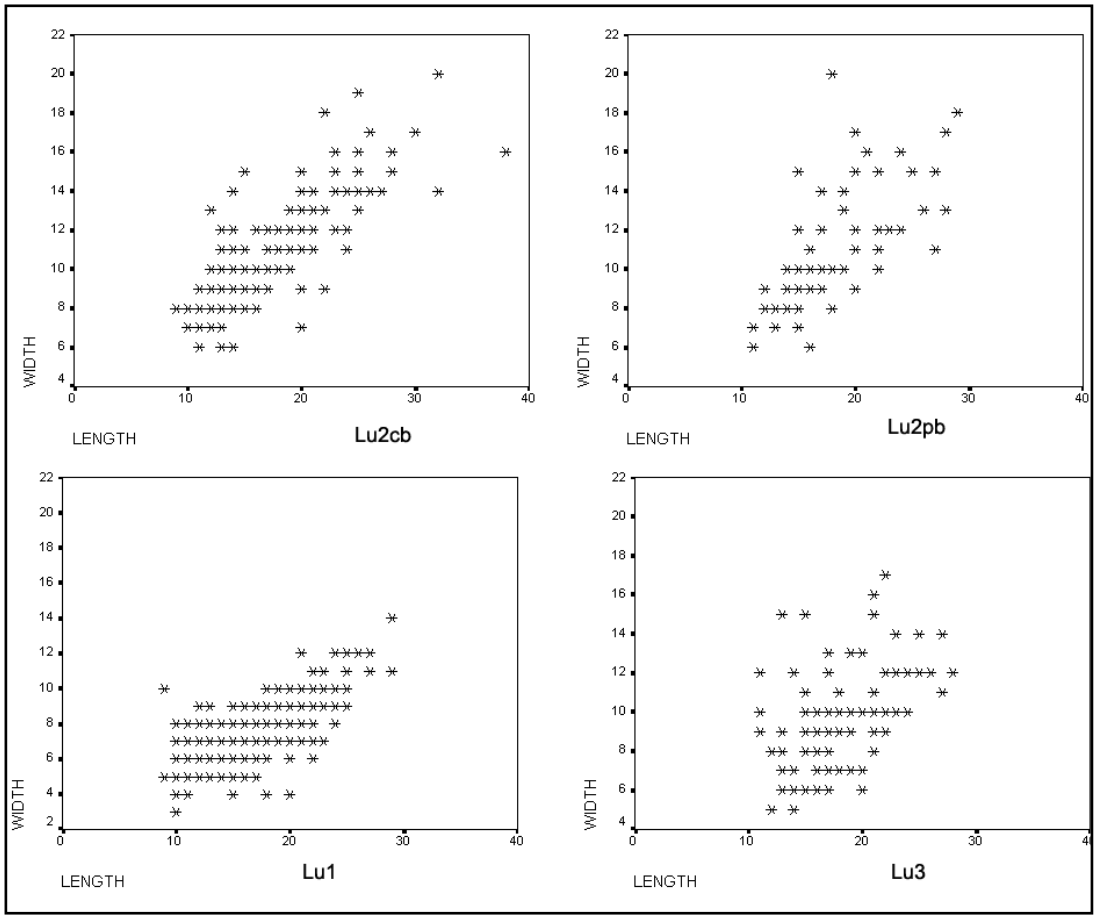

Figure 63.- Sheikh Mustafa: scatter plots of length and width of lunate types. Lu2cb, Lu2pb: broad lunates, completely or partially backed; Lu1: narrow lunates; Lu3, other lunates. Dimensions in mm.

tes and other geometrics are known from a wide ethnographic and archaeological background to have been generally used as components of projectile weapons (e.g. Clark *et al*. 1974; Nuzhnyj 1989). The copiousness of these tool types at the Early Khartoum excavation led Arkell to call the Sudanese Mesolithic population as the "people of the bow" (Arkell 1949: 107).

Comparison of dimensions of tool types from both sites may give us some clues to understand the technological change. Figures 63-65 display the scatter plots for lunate types in SM (Fig. 63) and EM (Fig. 64), and backed points from both sites (Fig. 65). Broad lunates are fairly similar at both sites, irrespective of being of the partial or complete backing varieties; mean dimensions are but somewhat larger in the second site (table 22). Narrow lunates are also larger at El Mahalab (table 22). Pointed backed bladelets are not very different in dimension from narrow lunates (Fig. 65, table 22). ¿Could this indicate that narrow lunates were used indistinctly for the func-

Site	Tool type	N	Length (mm)	Width (mm)
S. Mustafa	Narrow lunate	403	16.39 ± 3.71	6.93 ± 1.73
"	Broad lunate	224	17.76 ± 5.11	10.89 ± 2.99
"	Pointed backed bladelet	843	17.09 ± 3.96	5.17 ± 1.12
El Mahalab	Narrow lunate	37	17.62 ± 3.96	7.73 ± 2.43
"	Broad lunate	198	18.90 ± 4.24	11.12 ± 3.24
"	Pointed backed bladelet	82	19.29 ± 3.85	5.87 ± 1.43

Table 22.- Sheikh Mustafa and El Mahalab: mean dimension and standard deviation for the main microlithic types at both sites.

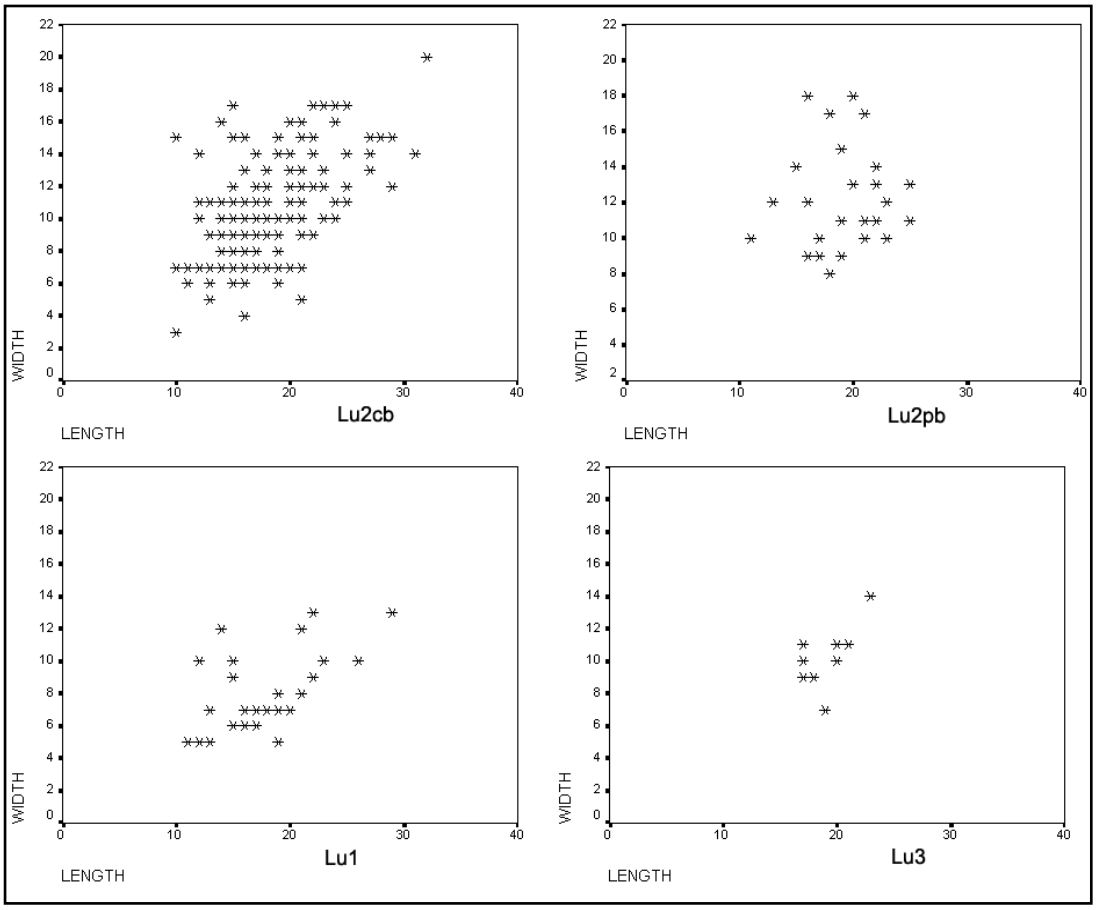

Figure 64.- El Mahalab: scatter plots of length and width of lunate types. Lu2cb, Lu2pb: broad lunates, completely or partially backed; Lu1: narrow lunates; Lu3, other lunates. Dimensions in mm.

tions of large lunates and backed points? Some of the curved backed points, particularly those with slightly bent ends (Figure 57: 33) could have served as fishhooks. Bipointed microliths, especially narrow crescents, have been suggested as fulfilling this function in the European Mesolithic (Octobon 1924; Brezillon 1977: 252) and the "Saharan-Sudanese Neolithic" (Camps 1974: 232). They resemble bone tools with similar shape, the "fish-gorges" that have been recorded in many Northern African Late Palaeolithic industries (Camps-Fabrer 1966: nº 39-41; Vermeersch, Paulissen and Van Peer 1990: 454). Some similar examples made in bone have been recorded at several Sudanese Mesolithic sites (Arkell 1949: 78, pl. 54: 7; Haaland 1995c: fig. 2: c, e). The high frequency of fish remains in the lower levels of Sheikh Mustafa (Chaix 2003), exactly where more bipointed bladelets have been recorded, represents further support for this hypothesis.

The reversion of lunates and points frecuencies from SM to EM, and the increase in dimension of backed points from one to another site (Fig. 65, table 22) probably hints at the same process: from small thin points to big wide points; from piercing to chisel-like projectile ends. Interestingly, the same tendency has been recorded in the European transition from Palaeolithic to Mesolithic and Neolithic times (Nuzhnyj 1989: 95). Sharpened points are characteristic tools at the end of the Palaeolithic and beginning of Mesolithic, when arrows were used to hunt big and slow game, easier to hit at sensible body parts (Ibid.: Fig. 1: 1-3). Transversal, chisel-ended points, i.e. lunates or triangles, were more frequently used during the end of Mesolithic and in the Neolithic period, when game was smaller and faster, but less resistant to arrow wounds. Lunate tips were shot at any part of the animal body, its wide cutting edge producing bigger and bloodier wounds (Ibid.: Fig. 1: 12-5; 3: 11-3; 4:

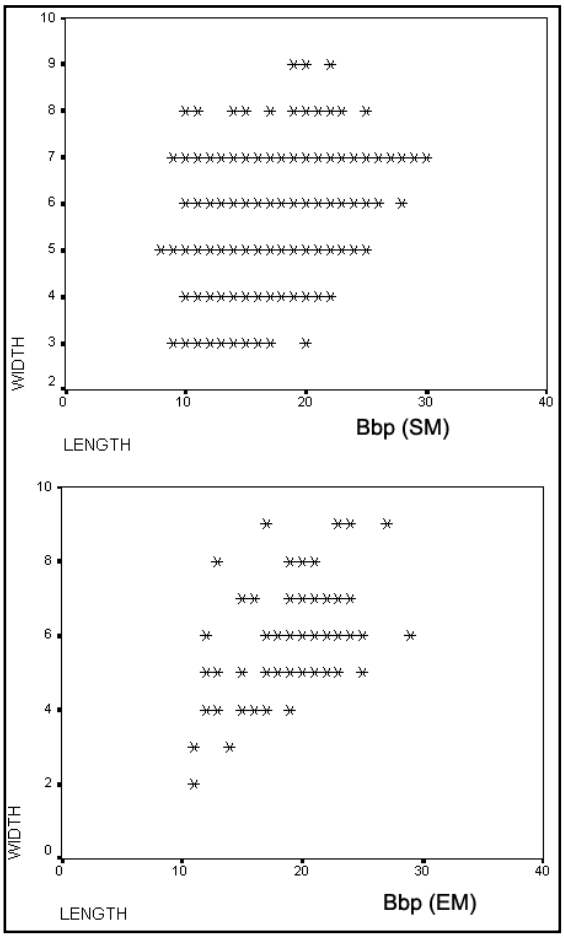

Figure 65.- Sheikh Mustafa and El Mahalab: scatter plots of pointed backed bladelets dimensions (Bbp).

42, 46). Significantly, the percentage of small ruminants (small antelopes and gazelles) in the excavated faunal samples is 9.4 % at Sheikh Mustafa (level 2) and 23.1 % at El Mahalab (level 1) (Chaix 2003: tables 2 and 6). In the Neolithic site of Sheikh el Amin (SA) this percentage increases to 34.2 % (Ibid.: table 12) (Figure 66). The chisel ended arrows made up of mastic with broad and narrow lunates are the only type made with microliths that has been registered in Egyptian Predynastic and Early Dynastic contexts (Clark *et al*. 1974).

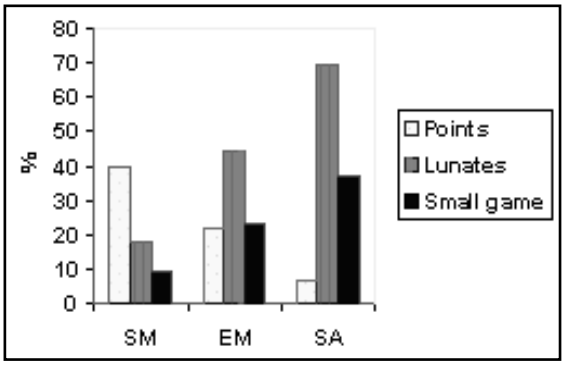

Figure 66.- A model for the economic change during the Holocene in the Wadi Soba area: percentage variations of lunates and backed points in the three sites are probably related to the shift from big to small game hunting.

The lithic material of Sheikh el Amin

A total of 14530 lithic artefacts were recovered in the excavation, including debitage, retouched tools, flaked-polished gouges and sandstone grinders, mostly broken. Flaked debitage and tools were made almost exclusively on white quartz of the same type already described for the Mesolithic sites, but a few big flakes in sandstone have been also found. Rhyolite was used only for making gouges (see later). Only 121 retouched tools were recognised, a fairly small proportion (0.8 %) if compared with the preceding Mesolithic sites (for instance, 3.94 % in Sheikh Mustafa, 1.83 % in El Mahalab). A similar fact was documented at Geili area (Caneva 1988: 116). The types follow approximately the proposed typology for the Mesolithic period (table 17; Figures 57-58), but they are noticeably less varied. The frequencies and percentages of each type are presented in table 23. Most representative examples of each type are drawn in Figure 67. As a major change with respect to the Mesolithic period, at this period there is a clear predominance of lunates (Fig. 50: 24), amounting to more than 70 %. This high frequency contrasts with published data from Kadero (6.9 %) and Geili (5.2 %) (Nowakowski 1984: Fig. 5; Caneva 1988: 119), but it corresponds with the results obtained from Shaheinab where they are the most frequent type (Arkell 1953: 25-6). In size, lunates are not very different in length but their width is smaller than in the Mesolithic pieces. The mean dimensions of a sample of 13 complete lunates in the sector J is of 18.15 $\pm$ 3.98 mm for the length, and 8.15 $\pm$ 1.14 mm for the width (compare with table 22 above). As aforementioned, its relatively high frequency could be attributed to the economic importance of small game hunting among Butana Neolithic groups.

The quartz cores found may also be classified according to the Mesolithic typology (Table 16; Figures 55-56). Table 24 shows the frequencies

Type	N	%
Denticulate	4	3.3
Retouched flake	13	10.7
Retouched blade	1	0.8
Backed bladelet	1	0.8
Mèche de foret	7	5.8
Point	4	3.3
Triangle	2	1.7
Triangle, isosceles	2	1.7
Trapeze	1	0.8
Lunate, narrow	1	0.8
Lunate, broad	79	65.3
Lunate, natural side	5	4.1
Lunate, humped	1	0.8
Total	121	99.9

Table 23.- Sheikh el Amin: retouched tool types frequencies at the site.

and percentages of core types from the 1997 excavation (sectors A to J-1). Here the most frequent type is no. 3, the pebble core struck following the "slicing technique" to make lunate-like secondary flakes. This abundance conforms to the higher frequency of lunates in the site lithic sample.

The grindstones are very abundant in the site. As a mean value, about 10 fragments were found per each excavated square meter, but in the central parts the frequency could reach near 20 pieces. These values are not so high as in the deeper part excavated at Kadero, where up to a few hundred grinders were found per square meter (Krzyzaniak 1978: 166). In Sheikh el Amin they are more abundant, however, than at Shaheinab where only a few were found (Arkell 1953: 54). As in Kadero, this fact was most probably related to the gathering and consumption of wild cereals, whose

Type	N	%
1	67	10.4
2	38	5.9
3	399	62.2
4	90	14.0
5	7	1.1
6	0	0
7	40	6.2
8	0	0
Total	641	99.8

Table 24.- Sheikh el Amin: core type frequencies (see Figures 55-6).

impressions have been detected in a number of sherds from the site (see Magid 2003).

A total of 26 gouges, complete and fragmented, were found in the excavation, all but one were made of rhyolite stone. Celts were not recognised after the broken examples, and the seven complete pieces were catalogued as gouges (Figures 50: 25; 68). If added to the total lithic sample of table 23, they would represent 17.7 %, which is not far from the values at Kadero (14.6 %; Nowakowski 1984: fig. 5) being more frequent than in Geili (1.4 %; Caneva 1988: 119) but much less than at Shaheinab, where near 500 pieces were found (Arkell 1953: 31). As it was clearly stated by Magid (1989: 157-77), the end of these artefacts was not tilling the soil but most probably wood-working activities as suggested by Arkell (1953: 31) and confirmed by Scanning Electron Microscopic microwear analysis of some of them (Magid 1989: pl. 11). Almost all our examples belong to Magid's type IV -flaked on the upper face and partly flaked, partly polished on the lower face-, which is the most frequent in the region (Ibid.: 159), the only exception being one from sector C made in fine sandstone and polished on both faces (Figure 68: 6). Mean dimensions for the seven complete examples are 4.75 $\pm$ 1 cm for the length and 3.38 $\pm$ 0.22 cm for the maximum width at the base respectively, falling into the lower range of size variation for the gouges in the Khartoum region (Ibid.: 167). The length variation is remarkable in our sample (3.7 - 6.6 cm) and probably due to the repetitive sharpening whenever the working edges became blunt (Ibid.: 159). In fact, four of our examples had their distal end freshly flaked, and only one had it completely blunt (Figure 69). The originality of these pieces, which were made up with an exotic raw material, brought from Shabaloka gorge 80 km north of Sheikh el Amin, also points at their possible social function (Haaland 1987: 221). That this material gave something of a prestigious position to its owner is suggested by the presence of a rhyolite axe in one of the richest graves of adult men at the Kadero cemetery (Krzyzaniak 1991: 523).

The frequencies of the main lithic types at the excavated sectors of the site are shown on table 25. A principal component analysis was made on the data, excluding sectors J1 and J2 for their bigger sample tends to distort the results by clustering all the other squares together in the plot.

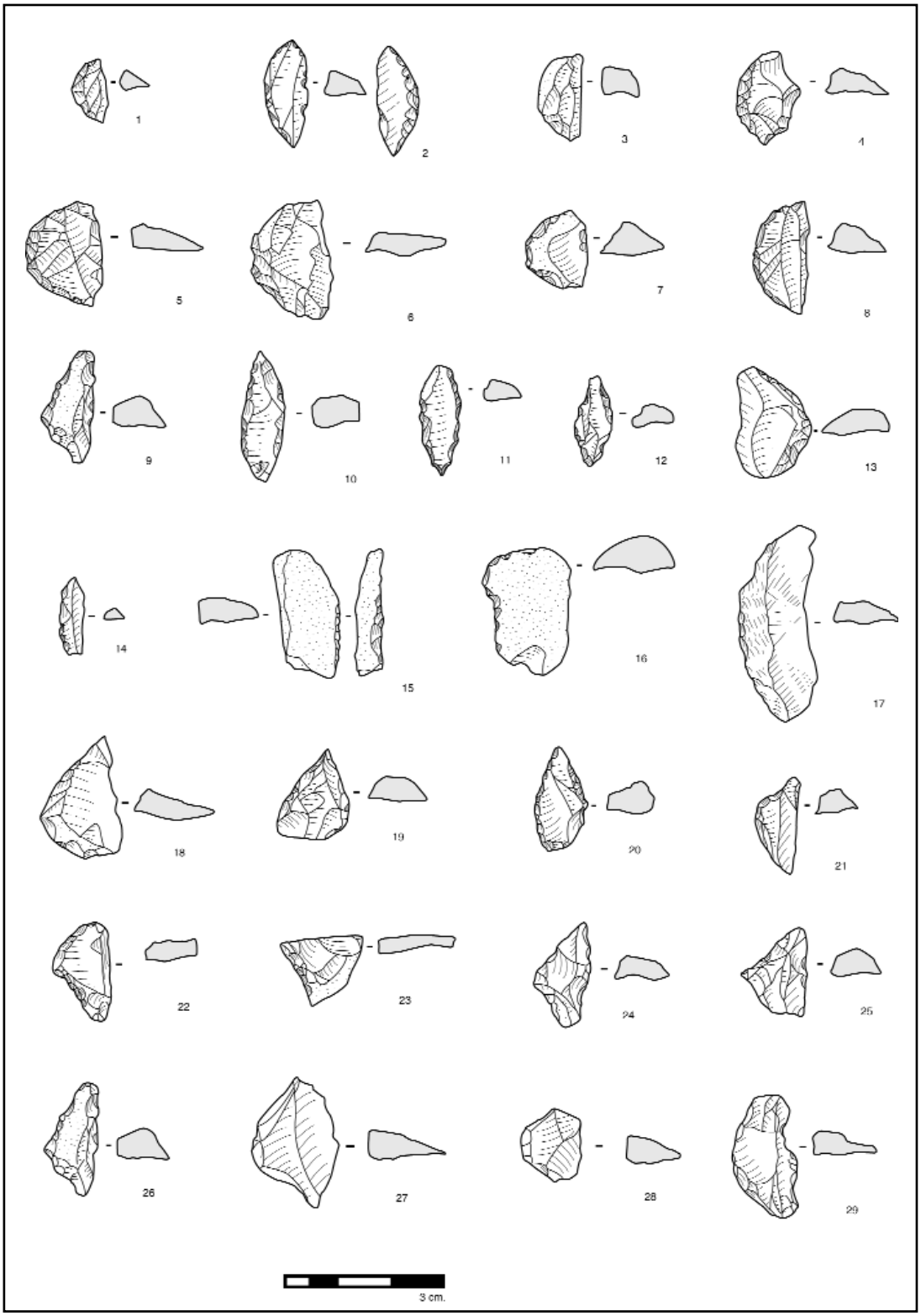

Figure 67.- Sheikh el Amin: retouched tools types in white quartz. 1-3, narrow lunates; 4-8, broad lunates; 9-12, mèches de foret; 13, curved backed blade; 14, backed bladelet; 15-16, retouched flakes; 17, retouched blade; 18-20, points; 21, perforator; 22-24, triangles; 25-28, trapezes; 29, denticulate.

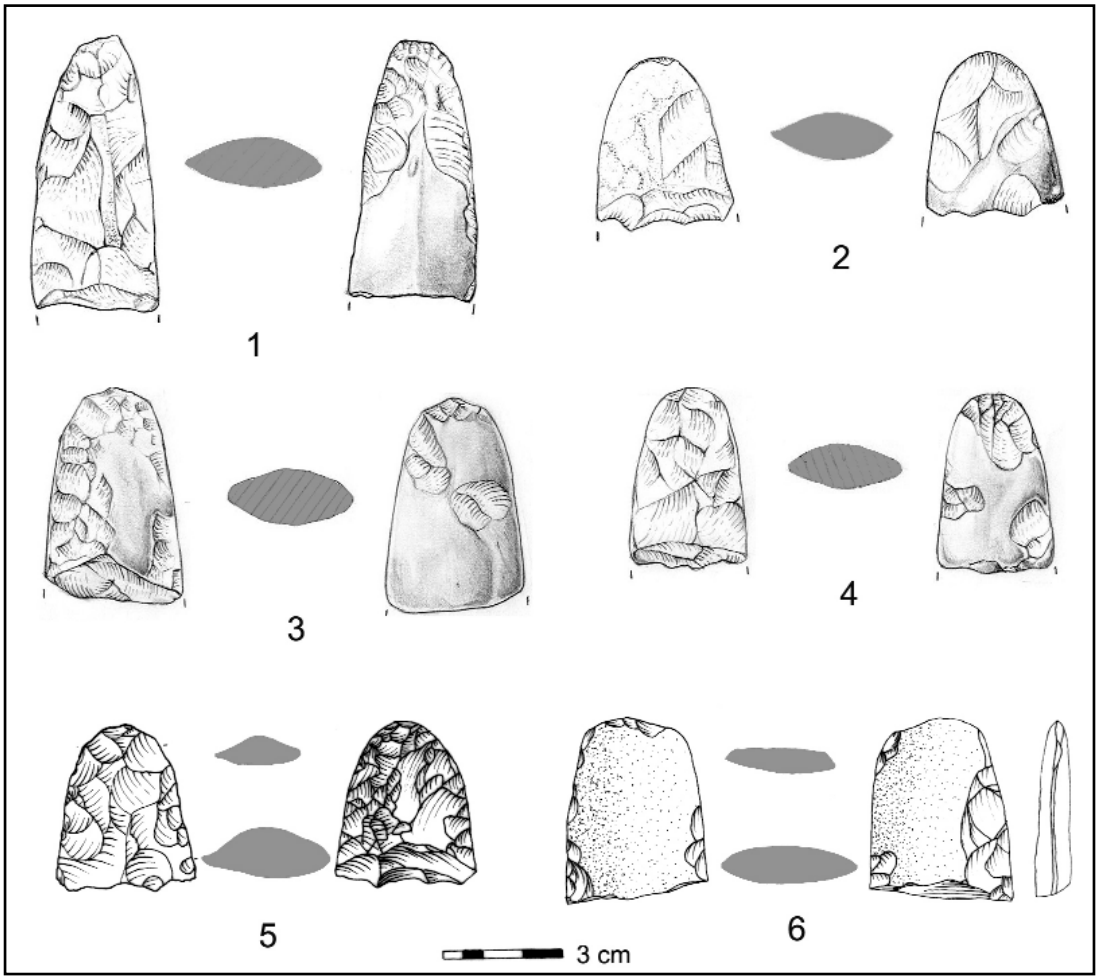

Figure 68.- Sheikh el Amin: part-polished and flaked gouges. No. 1 (sector A), 2 (C), 3(J), 4(B), 5(surface), 6(C). All in rhyolithe except no. 6 in fine quartzite. No. 6 is polished on both sides.

Figure 69.- Sheikh el Amin: freshly flaked (below) and blunted (above) edges of two gouges.

Though the model is not very clear (Figure 70), there is some indication that the grinders and the backed points are opposite in the diagram plot to other tools (lunates and especially triangles and gouges). The former are associated with the squares at the central part of the site, probably of earlier chronology as it was previously suggested (see pottery analysis), and the later with the peripheral parts (sectors D, E, G, I).

A total of 6264 lithic artefacts were excavated in Sector J. Table 26 shows the distribution of types in the excavated square meters of the sector. Principal component analysis was applied to the total data, and separately to data from the upper (3a-b) and lower (3b-c) levels. Apart from the "size effect" in the first component, the results of all these analyses show a tendency in the second component to a difference between, on the one hand, grinders and gouges, and on the other

Sector	F1	F2	F3	BL	CO	LU	BP	TR	TT	GO	GR	Total
A1	57	247	156	4	149	2	0	0	0	0	114	728
A2	111	435	175	2	217	4	0	0	1	1	82	1028
B1	147	449	275	4	179	6	0	0	1	0	121	1182
B2	111	408	156	0	151	4	3	0	1	0	106	940
C1	103	583	256	2	94	11	1	0	0	1	111	1162
C2	102	442	179	0	67	7	0	0	0	0	64	858
D	140	413	228	4	156	3	0	1	1	1	50	1000
E	19	56	25	0	18	1	0	0	0	0	53	171
F	15	40	35	0	27	2	0	1	0	0	22	142
G	56	174	87	1	47	6	0	1	0	0	39	411
H	33	122	41	0	83	1	1	0	0	0	73	354
I	30	97	49	2	68	0	0	0	1	1	43	291
J1	291	1035	494	16	523	19	3	0	0	3	33	2417
J2	972	1405	265	9	702	13	4	1	1	9	477	3846
Total	2187	5906	2421	44	2481	79	12	4	6	26	1388	14530

Table 25.- Sheikh el Amin: frequencies of lithic tools and debitage in the excavated sectors. Lithic types are as follows: F1, F2 and F3: primary, secondary and tertiary flakes; BL: blades and bladelets; CO: cores; LU: lunates; BP: backed points and bladelets, including mèche de foret; TR: triangles; TT: other tools; GO: gouges; GR: grinders, including upper and lower parts, rubbers, hammerstones and the few perforated discs, most of them in a very fragmentary condition.

hand most of the tools (Figure 72). The same pattern is also produced by the 3D representation of spatial arrangement of tools in the sixty squares, applying the Surfer program to the frequency data (Figure 71). Lithic flakes and cores appear to follow a concentration line diagonally distributed from NW to SE, almost perpendicular to the "border" that was distinguished in the general find distribution analysis (see section 1, figs. 24-25). Inside that line there are areas of more dense concentration of lithics (squares D-E/3-5). On the contrary, grinders and gouges tend to cluster in two opposite concentrations at the NW and SE corners. Grinders follow the same clustering model both in level 3B and 3C (Figure 73), probably because they were less affected by post-depositional processes owing to their bigger weight. They give us an image of several activity areas related to food probably vegetal-processing such as CD-4/5, GH-1/2 where remains of a hearth were detected, and HJ-6/7. These areas are more clearly seen in figure 74, with grinders highlighted with a dashed circle around. The analysis of soil chemical composition also shows a bigger concentration in the south-eastern area (Figure 75).

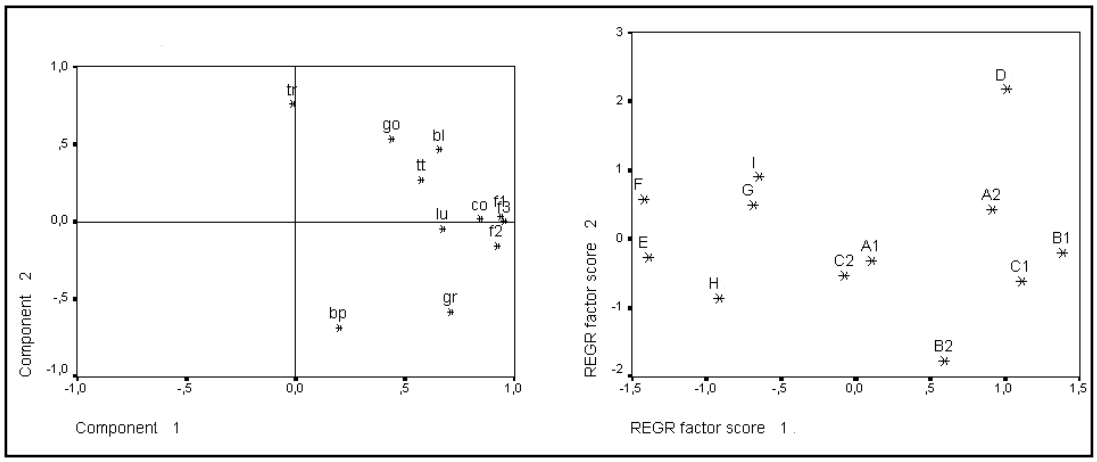

Figure 70.- Sheikh el Amin: principal Component Analysis of lithic types in the excavated sectors. Diagram plots of types and sectors (except sector J) in the two first principal components.

Square	F1	F2	F3	BL	CO	LU	BP	TR	TT	GO	GR	Total
A1	26	51	31	2	31	1	0	0	4	0	3	149
A2	16	52	23	1	26	4	1	0	0	0	4	127
A3	27	54	33	1	18	6	1	0	1	0	3	144
A4	23	93	51	2	25	0	0	0	1	0	2	197
B1	14	37	24	0	23	5	0	0	1	0	1	105
B2	17	61	17	0	23	0	0	0	1	0	2	121
B3	21	76	38	0	29	0	0	0	0	2	8	174
B4	17	77	37	3	39	3	0	0	1	0	9	186
B5	11	53	13	0	20	0	0	0	0	0	2	99
C1	19	62	23	0	17	0	0	0	0	0	6	127
C2	16	65	13	0	16	1	1	0	0	0	30	142
C3	29	48	13	0	16	2	0	0	0	0	13	121
C4	20	50	31	0	42	0	0	0	0	2	21	166
C5	20	29	10	0	11	0	0	0	0	0	16	86
D1	39	33	13	0	28	0	0	0	0	3	6	122
D2	20	44	11	0	20	0	0	0	0	0	6	101
D3	28	81	17	0	30	1	0	0	0	0	11	168
D4	37	53	16	0	36	0	0	0	0	0	10	152
D5	23	28	11	0	18	0	0	0	0	0	9	89
E1	33	56	15	0	22	0	0	0	0	0	15	141
E2	20	33	7	0	10	0	0	0	0	0	12	82
E3	37	55	15	0	27	1	0	0	0	0	18	153
E4	42	71	22	0	31	1	0	0	0	1	16	184
E5	52	73	20	0	40	3	0	0	0	1	8	197
F1	26	33	7	0	15	0	0	0	0	0	11	92
F2	21	41	8	0	7	0	0	0	0	0	8	85
F3	18	36	17	0	9	0	0	0	0	0	6	86
F4	25	60	10	0	25	1	0	0	0	0	5	126
F5	41	63	15	0	27	0	0	0	0	0	8	154
F6	41	49	17	0	33	1	0	0	0	0	7	148
F7	24	43	12	0	16	0	0	1	0	0	7	103
G1	14	33	10	0	18	0	0	0	0	0	15	90
G2	19	22	6	0	13	0	0	0	0	0	5	65
G3	9	21	2	0	10	0	0	0	0	0	3	45
G4	10	29	5	0	13	0	0	0	0	0	6	63
G5	18	39	9	0	13	0	0	0	0	0	9	88
G6	11	23	4	0	18	0	0	0	0	0	8	64
G7	22	36	4	0	22	0	0	0	0	1	6	91
H1	23	37	11	0	20	0	0	0	0	0	11	102
H2	25	44	16	0	18	0	0	0	0	0	5	108
H3	17	19	4	0	12	0	0	0	0	0	8	60
H4	5	5	1	0	6	0	0	0	0	0	4	21
H5	10	16	6	0	14	0	0	0	0	0	11	57
H6	14	12	3	0	16	0	0	0	0	0	17	62
H7	11	16	8	0	12	0	0	0	0	0	16	63
I1	20	21	1	0	3	0	0	0	0	0	2	47
I2	15	22	5	0	16	0	0	0	0	0	5	63
I3	16	18	2	0	10	0	0	0	0	0	8	54
I4	11	17	2	0	19	0	0	0	0	0	6	55
I5	12	26	11	0	28	0	0	0	0	0	11	88

.../...

Square	F1	F2	F3	BL	CO	LU	BP	TR	TT	GO	GR	Total
I6	19	44	8	0	28	0	0	0	0	0	9	108
I7	12	30	5	0	14	0	0	0	0	2	9	72
J1	25	58	4	0	25	0	1	0	0	0	8	121
J2	28	38	4	0	18	2	0	0	0	0	6	96
J3	38	48	11	0	35	0	0	0	0	0	2	134
J4	19	20	4	0	23	0	0	0	0	0	13	79
J5	15	30	5	0	29	0	0	0	0	0	8	87
J6	9	35	12	0	28	0	0	0	0	0	8	92
J7	13	21	6	0	14	0	0	0	0	0	8	62
Total	1263	2440	759	9	1225	32	4	1	9	12	510	6264

Table 26.- Raw frequencies of lithic tools in the excavated squares of sector J of Sheikh el Amin. Legend as in table 25.

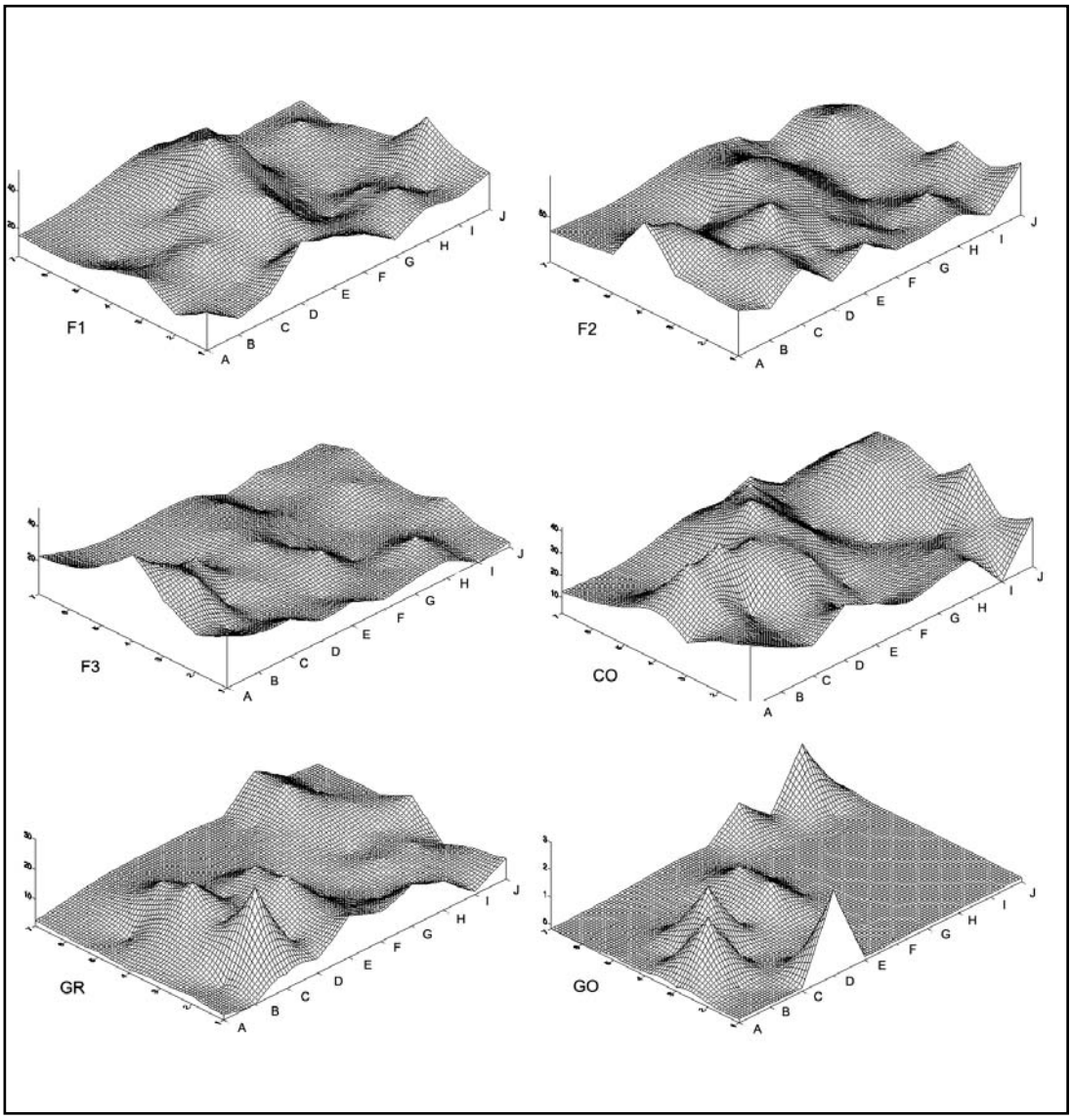

Figure 71.- 3D plot ('wireframe') for the raw frequencies of lithic types in the squares of sector J.

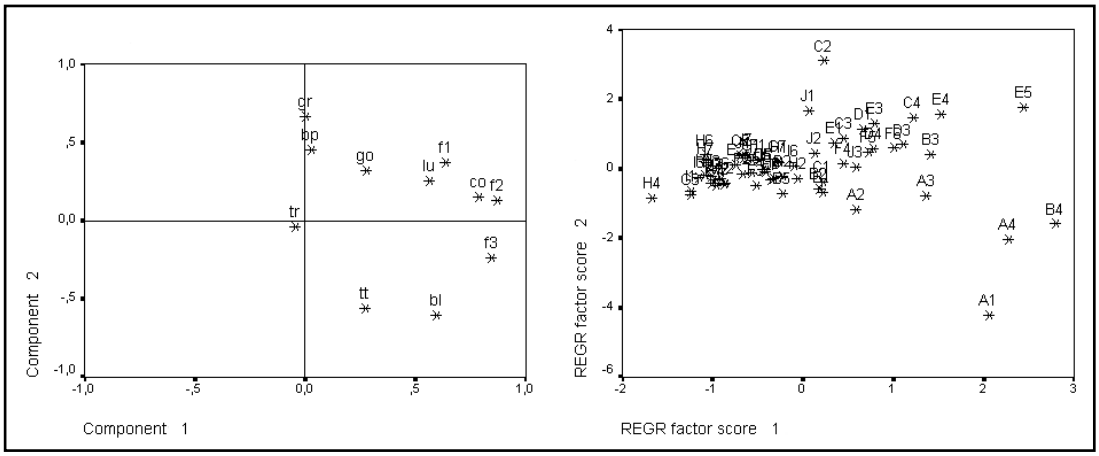

Figure 72.-Principal component analysis of lithic tool types in the excavated squares of sector J. Diagram plot of the types and the squares in the first two principal components.

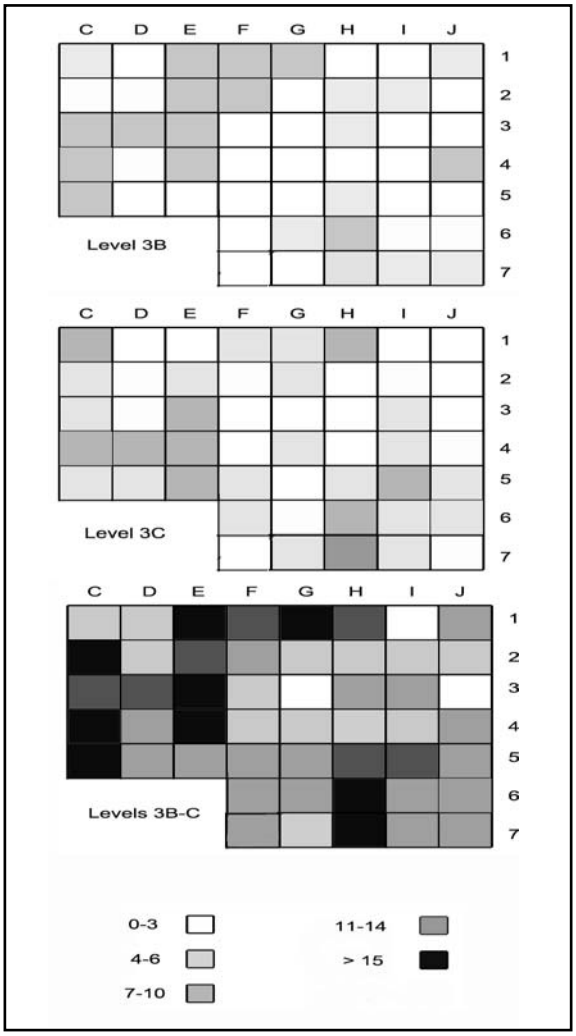

Figure 73.- Grinder frequencies per square meter in levels 3B, 3C and both levels combined from sector J-2 of Sheikh el Amin.

4. Other finds

A set of decorated bone pieces was recovered during the excavation of the Sheikh Mustafa and El Mahalab sites. Five of them are fragments of small bone tubes of rib parts (Figures 76: 1-5; 77: 3-7) and other two are small parts of metapodial bones (Fig. 76: 6-7; 77: 1-2), all from gazelles or other small ruminant (Louis Chaix, pers. comm.). They were found in sectors B, G, L and P of SM. Crossing parallel lines made by fine incision invariably forms the decoration. These artefacts are relatively frequent at the Mesolithic sites, for instance at Early Khartoum, where the bone tubes were interpreted as hairpins on the grounds of their similarity with Predynastic pieces from Egypt (Arkell 1949: 76-7, pl. 52: 4). They were also recorded at Saggai (Zarattini 1983: 243-6, fig. 1:7) and Aneibis (Haaland 1995c: 129-30, fig. 5: d-f). Their probable symbolic meaning, however, should not be overlooked. Another similar piece is a small fragment of ostrich eggshell from sector A, decorated with two areas of crossing incised lines, separated by an empty area (Figures 76: 8, 77: 8), which also closely resembles two fragments from Aneibis (Ibid.: fig. 5: b-c). In our Figure 76, nos. 10-11, two examples are shown of possible cut-marks on bone, one of them (no.10) with a rare undulating shape (cf. Haaland 1995c: fig. 1: a). Two fragments of sharpened bone awls (from sectors B and G at SM) and a bone polished point on a ruminant ulna from sector E are displayed in Figure 76: 16-17 and 12. Four flat circular beads (three from sectors A, B and G of

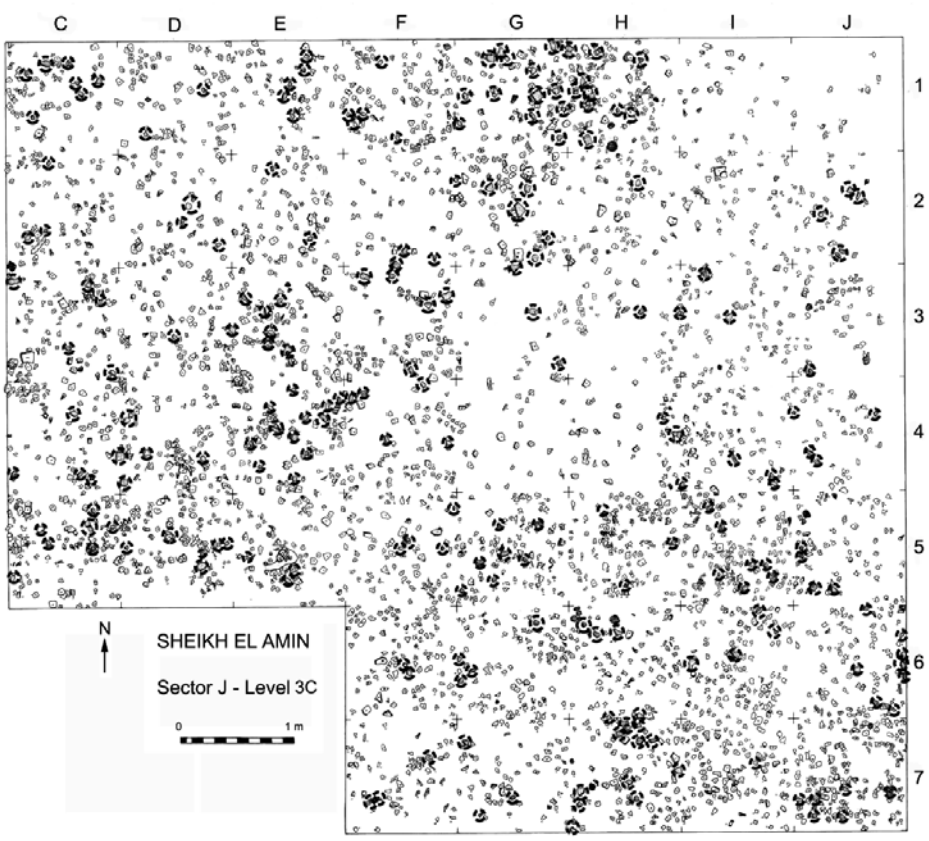

Figure 74.- Sheikh el Amin: Plan of level 3C of sector J-2 with grinders emphasized with dashed circles around.

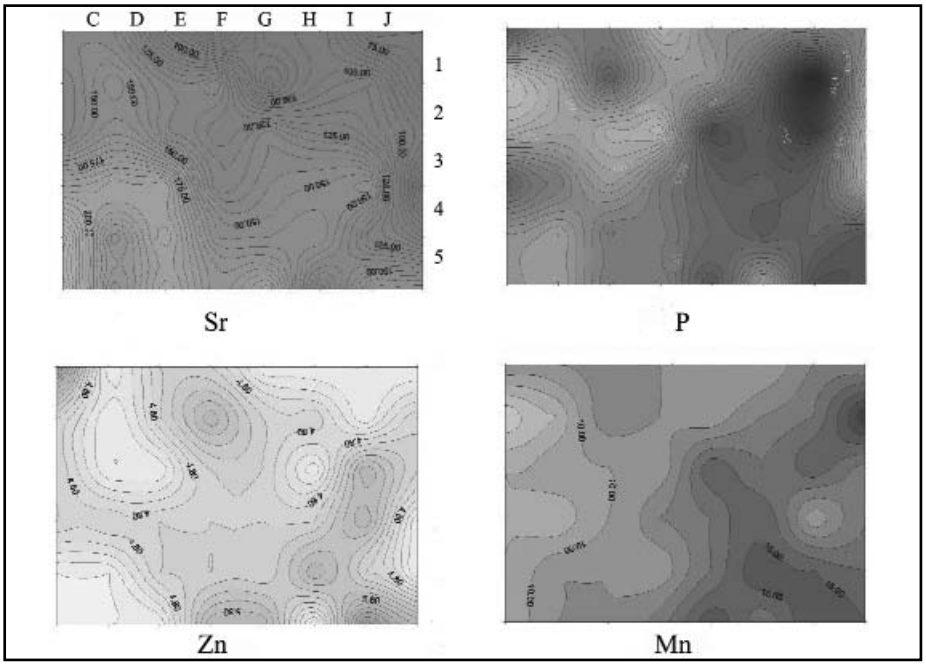

Figure 75.- Contour maps of chemical elements distribution in the excavated deposit of Sheikh el Amin-Sector J-2, level 3C, squares C-J/1-5. Sr, Strontium, P, Phosphorus, Zn, Zinc, Mn, Manganese. Analysis by Víctor Manuel-Valdés.

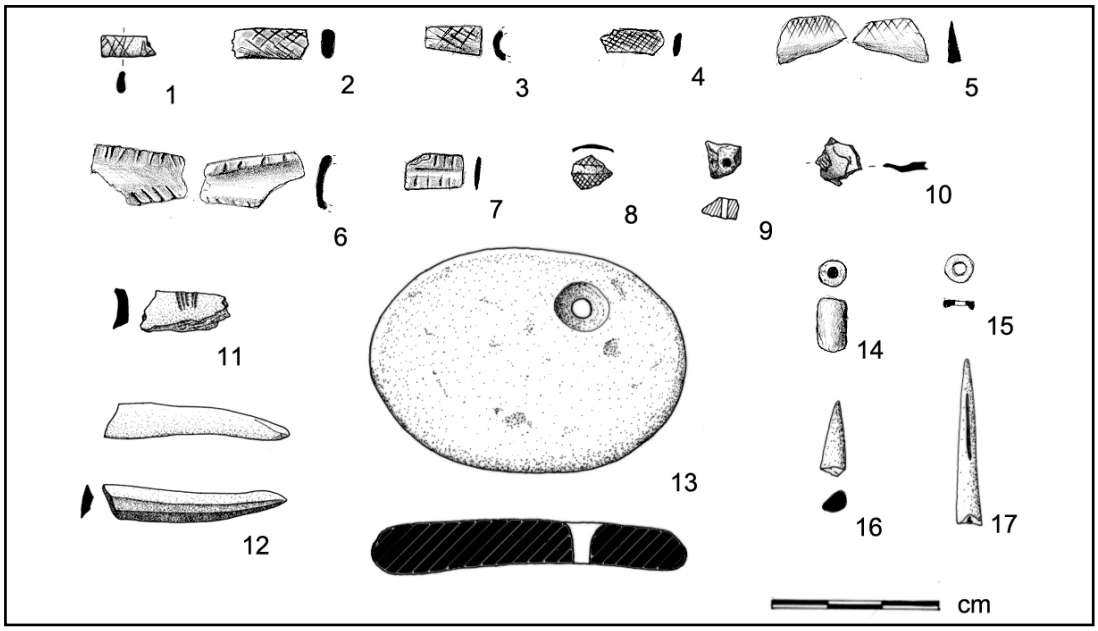

Figure 76.- Decorated bone and other finds from Sheikh Mustafa and Sheikh el Amin (14). Geometric incised patterns on small fragments of ruminant ribs and other bones (1-7). Incised pattern on a fragment of ostrich eggshell (8). Perforated bone (9). Cut marks on bone fragments (10-11). Polished bone point and awls (12, 16-17). Stone beads (14-15). Pottery pendant or net-sinker? (13).

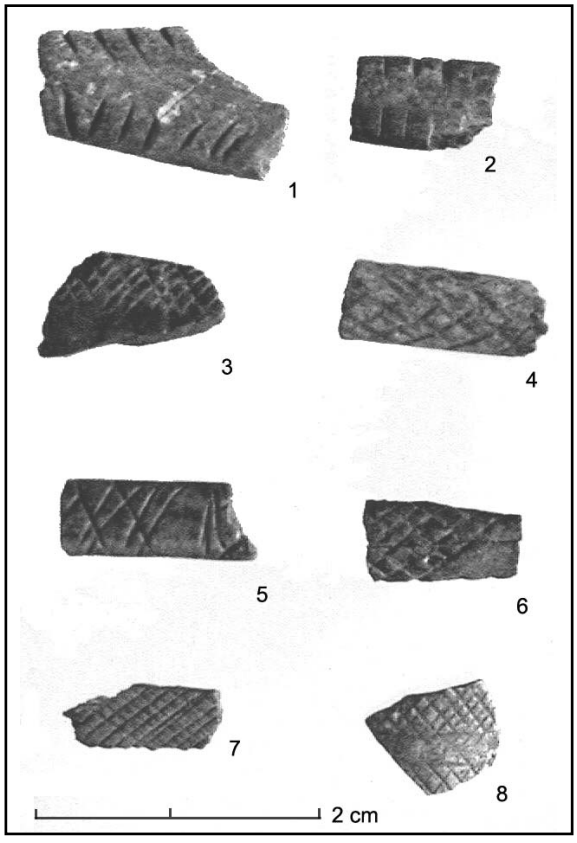

Figure 77.- Sheikh Mustafa: incised bone (1-7) and ostrich eggshell (8) fragments.

SM, one from sector A of EM), all made on stone, were also found (Figure 76: 15).

The artefact shown in Figure 76, no. 13 is a unique oval pottery disk from sector F of SM, carefully rounded and perforated on a broken potsherd. These disks are known at Early Khartoum (Arkell 1949: 92, pl. 86: 2) and the Atbara sites (Haaland 1992: fig. 3, 1995a: figs. 10, 13), where they are interpreted as fish net-sinkers. Our case is, however, fairly small and light to have served this purpose (stone examples would be more helpful, see Arkell 1949: pl. 36:17-20, 40:1-3). The higher frequency of this type at the Sheikh el Amin site (see figures 48: 14; 50: 19-23), where fish remains are very scanty (Chaix 2003), also suggests that they were used for another function, most likely as adornments or game-playing items.

At Sheikh el Amin seven polished bone awls or points were found in sectors A, B and J (Figure 78: 1-3, 6-9). Two wider bone points from sectors A and B (Fig. 78: 4-5) are probably lance points (Zarattini 1983: 246), no. 4 has one of the sides serrated with short parallel incisions (cf. Haaland 1995c: fig. 1, b). One bone epiphyseal end from sector B was rounded by polishing its spongeous part, maybe to be used as a handle (Figure 78: 10). Perforated pieces of shell (Fig.

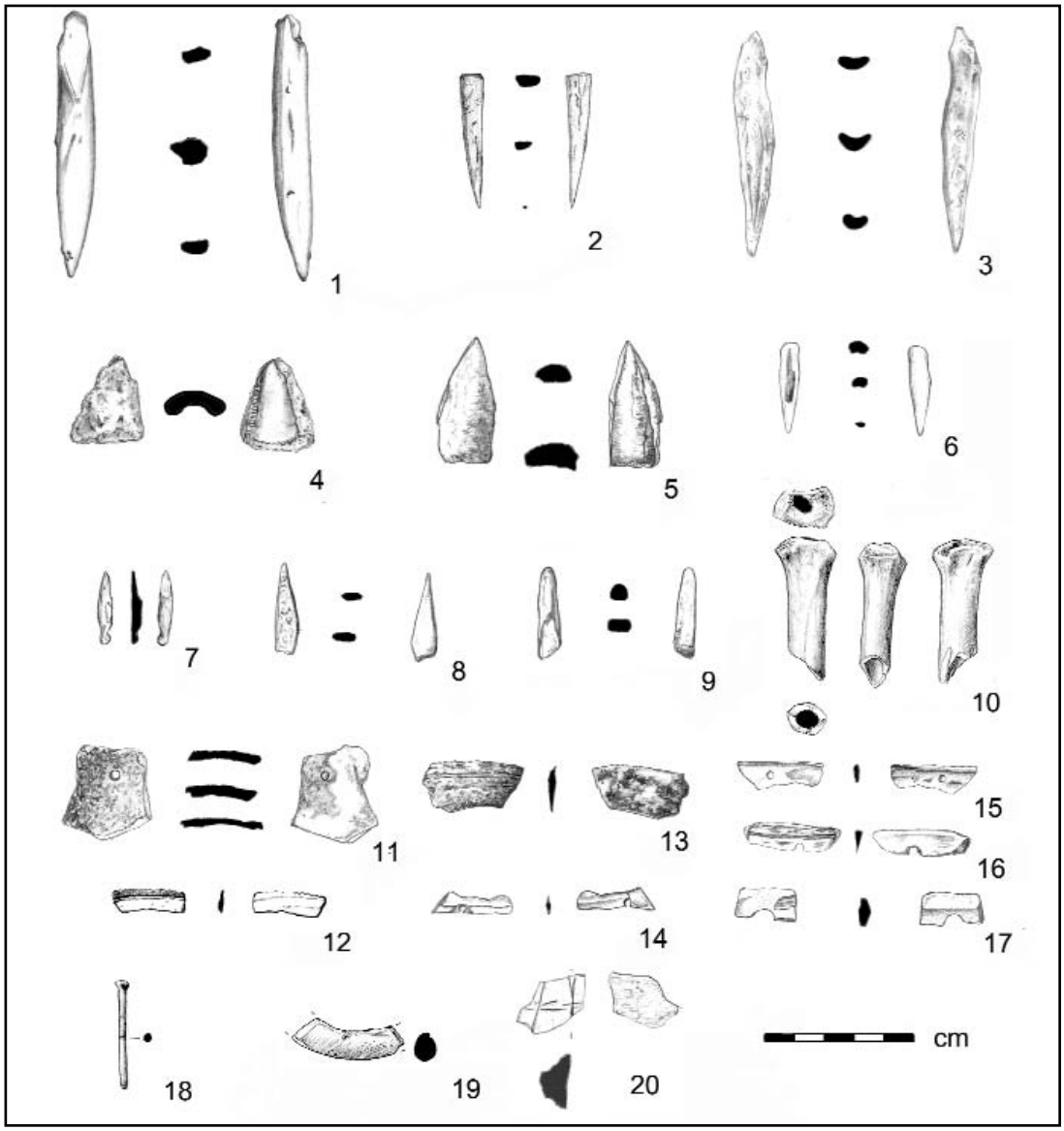

Figure 78.- Sheikh el Amin: bone tools and other finds. Bone awls and fragments (1-3, 6-9). Bone points, no. 4 has a serrated left edge (4-5). Worked bone handle? (10). Perforated shell (11, 14-16) and stone (17). Shell serrated pottery combs (12-13). Zeolite lip plug (18). Ivory bracelet fragment (19). Incised bone fragment (20).

78: 11, 14-16) and stone (17) from sectors B, C and J are most probably unfinished beads, broken during its manufacture. One cylindrical bead made on porous stone was found in sector C (Fig. 76: 14). Two shell fragments with serrated edges from sector J (Fig. 78: 12-13) were probably employed in rocker decoration of pottery (Haaland 1995c: fig. 6). One fragment of bone, roughly incised (decorated?) with perpendicular lines, was found in sector A (Figure 78: 20). A broken circular bracelet on hippo ivory canine was uncovered at sector A (Fig. 78: 19). Apart from the zeolite labret found in sector B (Fig. 78: 18), another lip plug was found in sector J, with biconical shape similar to other known pieces (Arkell 1953: pl. 5, 11-right), yet it was lost in the Soba house during the field season. One shell fish-hook from sector I, like the Shaheinab examples illustrated by Arkell (1953: 27), 21 mm in length, and three flat stone beads from sectors A and I were misplaced in the Khartoum Museum and could not be adequately documented.

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