CHAPTER 14

A SEDIMENTS ANALYSIS OF MUD BRICK AND NATURAL FEATURES AT EL-AMARNA

by

Charles A.I. French

14.1 Introduction

In conjunction with the 1981 season of excavations at el-Amarna, it was decided to make a small-scale study of the composition of selected mud brick and of naturally occurring sediments associated with the royal city of el-Amarna and its outlying sites, in particular the Workmen's Village. The sediments analyses were performed with three major aims in mind. Firstly, it was thought desirable to quantify the compositional range of the alluvial and marl bricks. Secondly, it might be possible to indicate whether different types and/or compositions of bricks had any significance with respect to constructional purposes. Thirdly, a comparative study of brick composition within the various parts of the city at el-Amarna, and that of the East Karnak material already examined (French 1981) might prove to be of value. The various natural features were analyzed to provide a general idea of the statistical characteristics exhibited by wind- and water-borne sediments in the area.

14.2 Sample locations (Table 14.1)

At the Workmen's Village, samples were taken from the enclosure wall (A:1-4), House Long Wall Street 6 (B:1-4), the north section face of square M18 immediately outside and to the south of the main village (C:1-3; Figure 14.4, and Kemp 1981:8-10, Figure 2, Plate II.2; Kemp 1983:8, Figure 3), the X1 sub-site (D:1-2), and the two possible marl quarries to the south of the site (E:1-2, F:1-2; Figure 14.1).

One sample of either collapsed marl brick or mortar was taken from the Stone Village (G:1; Figure 14.1; cf. Kemp 1978:26, Figure 4).

In the North City, samples were taken from a granary (K:1) and house (L:1-2) of the U24.1 estate (Kemp 1983:17-18). Samples of possible ingredients for the manufacturing of mud-brick (U:1-3) were taken from the working area within the U24.1 estate. Three samples were taken from the northern enclosure wall of the North Palace (J:1-3; Figure 14.1).

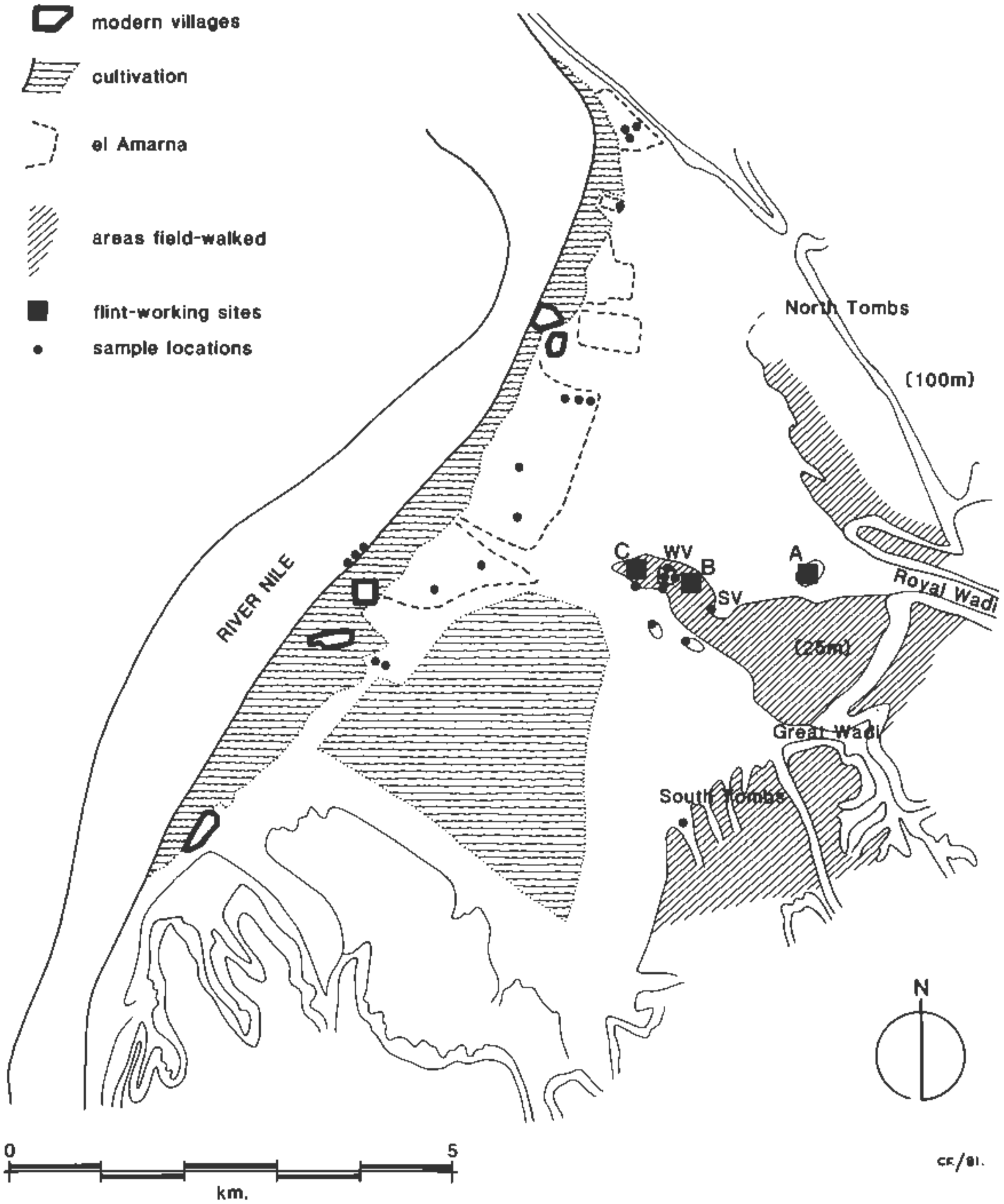

Figure 14.1. Map of the el-Amarna plain, illustrating work reported in Chapters 14 and 15.

In the Main City, samples were taken from the Small Temple (M:1-3), three random house sites (N:1-3), and a circular, perhaps ornamental pond structure (S:1-2; Figure 14.1).

Samples from wadi sediments (P:1-2), the River Nile (R:1-3), and desert sand (T:1) were also taken (Figure 14.1).

TABLE 14.1: SAMPLE LOCATIONS AT EL-AMARNA

Sample	Site	Alluvial brick	Marl brick	Natural feature
A:1	Workmen's Village enclosure wall	X		
2		X		
3		X		
4		X		
B:1	W.V.: House 6 Long Wall Street		X	
2			Mortar	
3			Mortar	
4			X	
C:1	M18:north section			wind-blown sand
2				grey mottled surface
3				bedded sandy loam
D:1	site X1	X		
2			X	
E:1	Quarry 1			marl with gravel
				marl with gravel
F:1	Quarry 2			marl
2				marl
G:1	Stone Village		X	
J:1	North Palace: enclosure wall	lower course		
2		upper course		
3		mortar		
K:1	North City: granary			
L:1	North City: House U24.1	upper course		
2		lower course		
M:1	Main City: Small Temple	east wall		
2		1st pylon		
3		2nd pylon		
N:1	Main City: 3 house sites			
2				
3				
S:1	Main City: circular structure	upper course		
2		lower course		
U:1	North City: U24.1 estate			gypsum (?)
2				alluvium
3				ash
P:1	wadi sediments			sand
2				gravel
R:1	Nile sediments			sand
2				silt
3				clay-silt
T:1	desert sediments			wind-blown sand

14.3 Methodology

Each sample was air-dried, gently ground and shaken through a 2 mm. mesh sieve to remove the gravel fraction and any other large inclusions. The gravel fraction (>2 mm.) was kept for further description (after Smith and Atkinson 1975). The sub-gravel fraction (<2 mm.) was further sub-sampled for the particle size analysis.

The hydrometer method of particle size analysis was used (Shackley 1975). Each 40 g. sample was dispersed with "Calgon" (sodium hexametaphosphate), mixed, and then the suspension poured and washed through a 0.062 mm. mesh sieve into a 1000 ml. graduated cylinder. The sand fraction so removed was air-dried, and then fractionated by dry-sieving. After bringing the suspension in the graduated cylinder up to volume and then thoroughly mixing, six hydrometer readings were taken at specific time intervals.

The results from the hydrometer readings and dry-sieving were then combined to construct cumulative frequency graphs. The character of the soil or sediments is named by the use of the triangular textural diagramme (Shackley 1975). The size grades of the United States Department of Agriculture (1951) were used to differentiate the sediments. The four statistical measures of mean size (Mz), standard deviation (σ) or the degree of sorting, skewness (Sk), and kurtosis (K_G) were calculated and plotted separately for the sand and silt fractions. The formulae of Folk and Ward (1957) were used. All calculations were performed on an Apple II micro-computer using a program specifically written for the author by Mr. G. D. Hathaway.

14.4 Mud Brick Samples: Description and Analysis

Samples A:1-4 from the Workmen's Village, D:1 from site X1, J:1-3 from the North Palace, K:1, L:1-2, M:1-3, N:1-3 and S:1-2 from the city of el-Amarna are all alluvial mud brick. Samples B:1-4 from the Workmen's Village, D:2 from site X1 and G:1 from the "Stone Village" are marl mud brick. The bricks range in size from c. 32-37 cm. in length, c. 15 cm. in width, and c. 10-11 cm. in thickness. [1]

The composition of the alluvial mud brick (10YR 6/3, 5/3) at the Workmen's Village displays a bimodal distribution and is dominated by medium sand with subordinate medium silt and clay fractions (Figure 14.3; Table 14.2). Samples from the main city display a more even mixture of all three fractions (Figure 14.2; Table 14.2), although medium silt is the most common size mode. The gravel content, mainly small limestone pebbles (2 mm. - 1 cm.) with some quartz, varies considerably from 0 to c. 75% by weight. The pebbles exhibit characteristics of wind and water abrasion. The sand fraction is very well sorted, with positive skewness indicating the dominance of the coarse mode

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[1] Detailed sets of brick measurements will be published in a later study.

TABLE 14.2: % CLAY, % SILT, % SAND

Sample	% Clay	% Silt	% Sand
A:1	07.5	17.5	75.0
2	07.5	21.25	71.25
3	06.25	18.75	75.0
4	10.0	20.0	70.0
B:1	18.75	25.0	56.25
2	17.5	18.75	63.75
3	13.75	15.0	71.25
4	18.75	18.75	62.5
C:1	10.0	05.0	85.0
2	11.25	07.5	81.25
3	15.625	10.625	73.75
D:1	13.75	21.25	65.0
2	12.5	15.0	72.5
E:1	11.25	28.75	60.0
2	12.5	52.5	35.0
F:1	06.25	38.75	55.0
2	08.75	48.75	42.5
G:1	18.75	30.0	51.25
J:1	06.25	26.25	67.5
2	13.75	36.25	50.0
3	10.0	27.5	62.5
K:1	10.0	28.75	61.25
L:1	08.75	31.25	60.0
2	06.25	28.75	65.0
M:1	08.75	18.75	72.5
2	11.25	46.25	42.5
3	12.5	65.0	22.5
N:1	05.0	32.5	62.5
2	03.75	20.0	76.25
3	06.25	18.75	75.0
S:1	08.75	26.25	65.0
2	03.75	51.25	45.0
U:2	11.25	05.0	83.75
3	08.75	12.5	78.75
P:1	03.75	06.25	90.0
2	06.25	06.25	87.5
R:1	02.5	02.5	95.0
2	17.5	58.75	23.75
3	26.25	73.75	00.00
T:1	00.00	02.5	97.5

(medium sand), and platykurtic kurtosis indicating a sub-equal mix of two populations within the fraction (Folk 1966), the medium and fine sand (Figure 14.3; Tables 14.3, 14.4, 14.5). On the other hand, the silt fraction is poorly sorted, but displays platykurtic kurtosis, and either positive or negative skewness depending on whether coarser or finer silt respectively is more dominant (Figure 14.3; Tables 14.3, 14.4, 14.5).

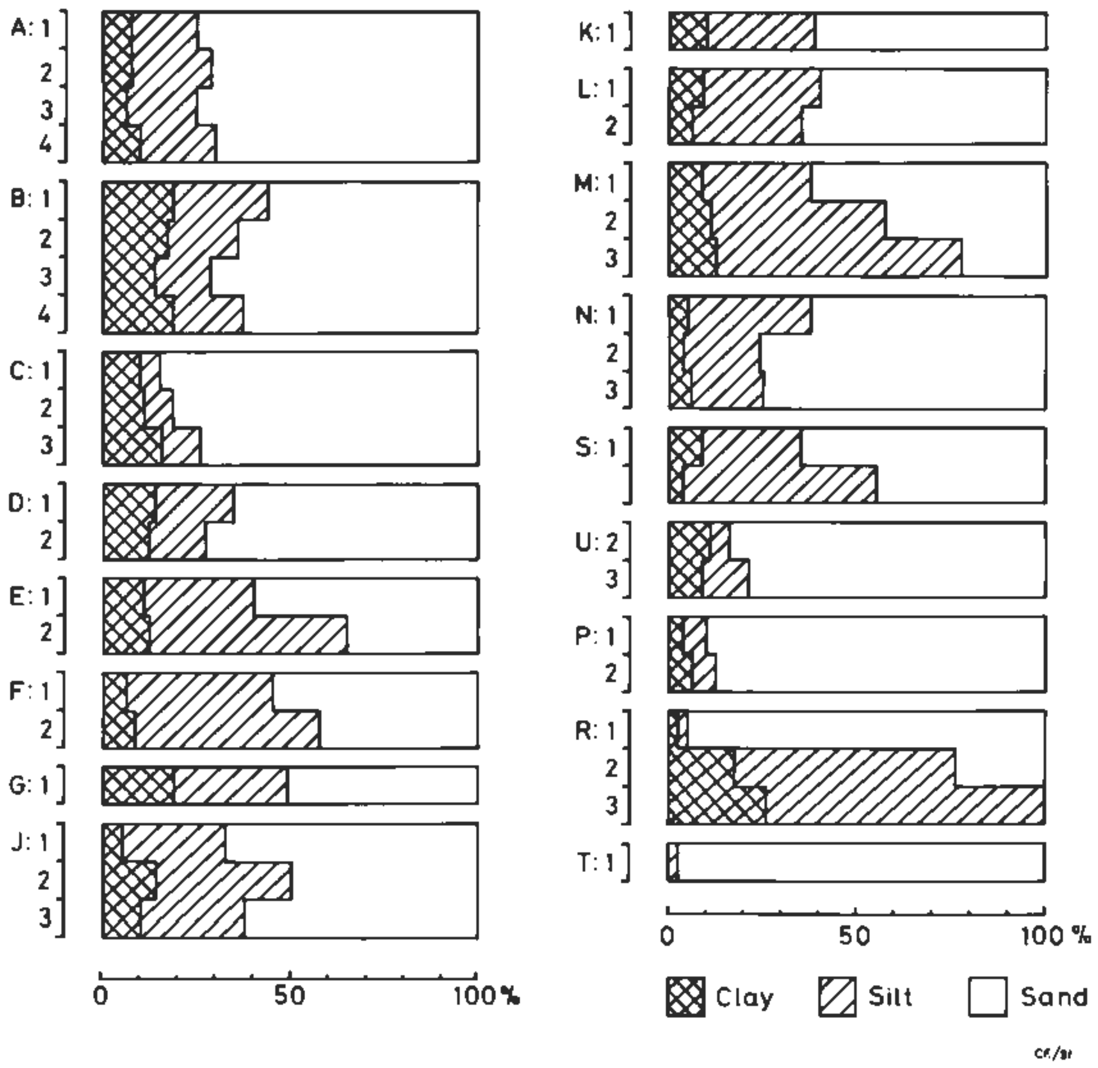

Figure 14.2. % clay, % silt and % sand for all samples.

The composition and statistical measures of these bricks suggest that the raw materials are all naturally occurring sediments in the el-Amarna area that have undergone some mixing and sorting *in situ*, as well as a result of their manufacture into brick. The uniformly high medium sand content suggests the influence of wind-blowing as an agency of transport and deposition. The "puddling" process during brick manufacture would tend to concentrate the finer size grades, the longer the suspension was allowed to settle.

A study of modern methods of making alluvial mud brick (French 1981) found that ash and/or straw are used as binding agents in the making of the brick. Excavation at estate U24.1 revealed a possible working yard with piles of dung/alluvium and ash, which may have been intended for use in the making of bricks. Other inclusions found in the bricks at el-Amarna are *halfa* grass, wood, seeds and pottery. This suggests that brick composition was very much a matter of what was easily and locally obtainable.

TABLE 14.3: THE FOUR STATISTICAL MEASURES FOR ALL THREE FRACTIONS WHERE POSSIBLE

Sample	Mz	σ	Sk	K_G
N:1	03.63	00.02	-0.39	00.84
2	02.98	00.26	-0.47	01.15
P:1	02.05	00.06	-0.1	01.39
R:1	02.51	00.73	-0.22	02.26
T:1	01.53	00.26	-0.13	01.77

By comparison, at Karnak two distinct types of mud brick composition were discerned. The first and most common type was a sandy loam containing sandstone fragments and broken pottery as well as ash and straw. The second type was a silt loam with no solid inclusions, only straw. But, as at el-Amarna, the sediment composition of the bricks at Karnak was dominated by the nature of the local alluvium. The variation in brick composition at el-Amarna is more probably due to the particular loci where the raw materials were collected and to the individual making the bricks, rather than being determined for specific constructional purposes. But it seems that bricks with greater and coarser amounts of gravel were more often used in the lower courses of buildings in the main city. It has been suggested for the Workmen's Village (Kemp 1980: 10-12) that a government agency may have supplied proper mud brick for enclosure walls and foundation courses, but the finishing was left to the inhabitants with whatever materials were at hand. This would account for the lack of consistency in brick composition as well as the use of marl brick.

The composition of the marl bricks (10YR 6/3 to 7.5YR 6/8) exhibits a unimodal distribution dominated by medium/fine sand with small, even amounts of other grain sizes. Marl bricks appear to have a much higher clay content than the alluvial bricks (Figure 14.2; Table 14.2). The sand fraction is well sorted, whereas the silt fraction is poorly sorted (Figure 14.3; Tables 14.4, 14.5). The kurtosis for both fractions is platykurtic or mesokurtic, depending on whether there is a sub-equal or equal mix of grain size populations within each fraction (Folk 1966), (Figure 14.3; Tables 14.4, 14.5). The skewness for both fractions is either slightly negative or positive, depending on whether there is a tail of coarser or finer grains respectively (Figure 14.3; Tables 14.4, 14.5).

The desert marl from the two possible quarry sites immediately to the south of the Workmen's Village is composed of almost equal proportions of sand and silt, with some clay. In particular, the process of making the marl bricks appears to have concentrated the medium modes of the sand and silt, whereas the natural sources displayed strongly coarse/fine bimodal sand and silt distributions. The statistical measures are very much the same as for the marl bricks (Figure 14.3; Tables 14.4, 14.5), thus indicating similar sorting characteristics and sources of sediment. But the variation in composition is again probably due more to the particular locus chosen for the quarrying of

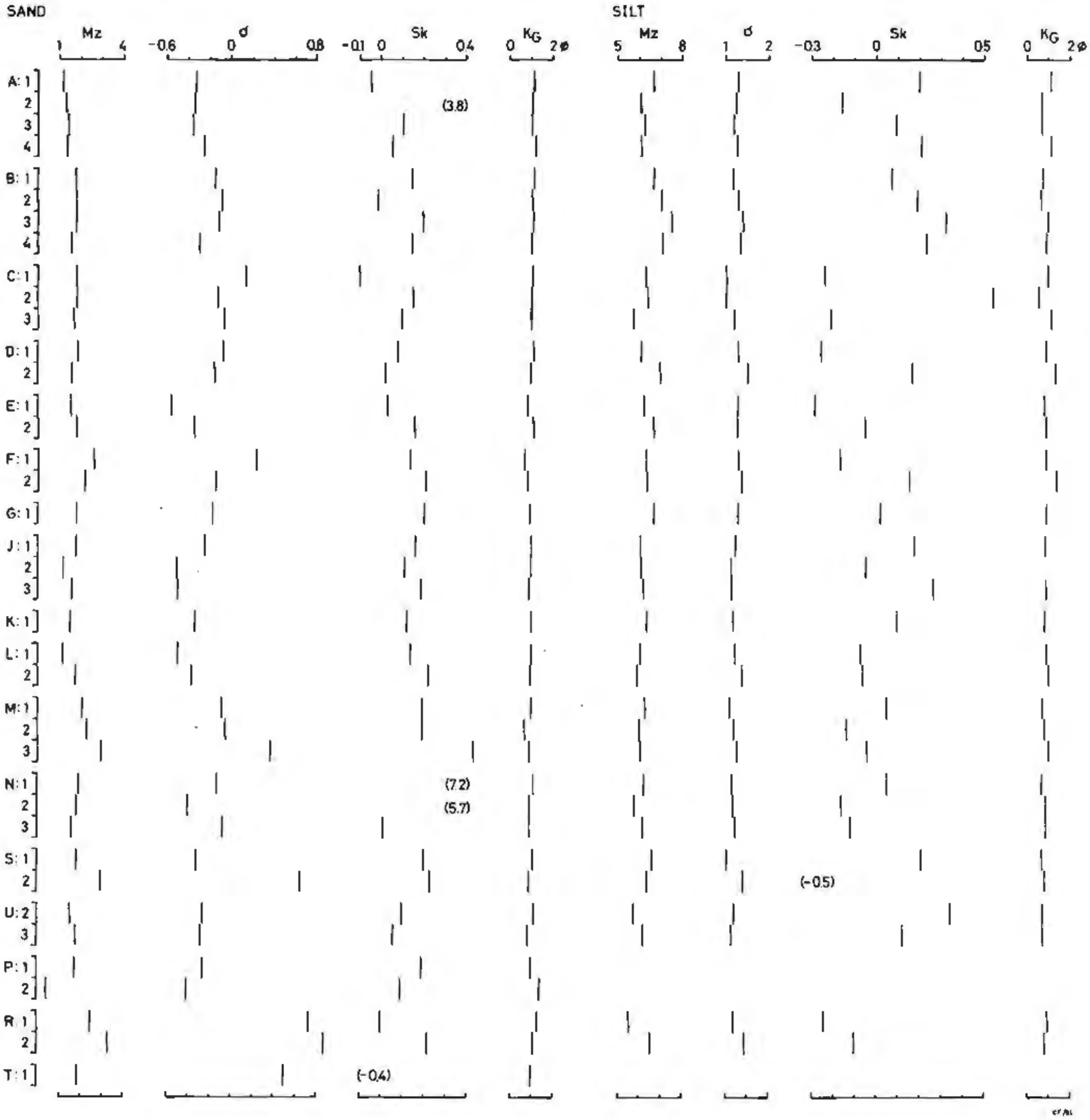

Figure 14.3. The four statistical measures for the sand and silt fraction of all samples.

the marl and the individual making the bricks. The distinctive reddish-yellow (7.5YR 6/8) colour of the desert marl is due to the high oxidized iron content.

14.5 Natural Feature Samples: Description and Analysis

The three natural features were investigated for comparative purposes. The bedded and water-lain sand and gravel (10YR 7/6; 10YR 8/1) in a wadi in

TABLE 14.4: FOUR STATISTICAL MEASURES FOR THE SAND FRACTION

Sample	Mz	σ	Sk	K_G
A:1	01.16	-0.33	-0.04	01.15
2	01.36	-0.34	03.77	01.11
3	01.45	-0.35	00.11	01.02
4	01.4	-0.25	00.05	01.22
B:1	01.78	-0.15	00.14	01.16
2	01.81	-0.08	-0.01	01.06
3	01.8	-0.11	00.09	01.09
4	01.6	-0.29	00.14	01.03
C:1	01.83	00.14	-0.1	01.08
2	01.85	-0.12	00.15	01.03
3	01.73	-0.06	00.09	01.0
D:1	01.85	-0.07	00.08	01.09
2	01.61	-0.17	00.02	00.97
E:1	01.55	-0.56	00.33	00.86
2	01.81	-0.34	00.16	01.11
F:1	02.61	00.24	00.14	00.68
2	02.2	-0.14	00.21	00.84
G:1	01.78	-0.17	00.2	00.94
J:1	01.81	-0.24	00.16	01.03
2	01.23	-0.5	00.11	00.99
3	01.58	-0.49	00.18	00.91
K:1	01.56	-0.33	00.12	01.02
L:1	01.18	-0.48	00.14	01.03
2	01.78	-0.36	00.21	00.94
M:1	02.11	-0.08	00.19	00.99
2	02.36	-0.04	00.19	00.7
3	03.01	00.38	00.43	00.92
N:1	01.95	-0.12	07.18	01.11
2	01.85	-0.05	05.68	00.91
3	01.58	-0.07	00.01	00.9
S:1	01.86	-0.32	00.21	01.07
2	02.96	00.45	00.23	00.93
U:2	01.55	-0.26	00.11	01.08
3	01.81	-0.28	00.05	00.85
P:1	01.76	-0.26	00.19	01.01
2	00.41	-0.41	00.09	01.39
R:1	02.5	00.53	00.00	01.28
2	03.3	00.67	00.21	01.07
T:1	01.88	00.3	-0.33	00.97

the lower desert are dominated by coarse and medium sand and rounded gravel and small stones. The faster the waterflow, the coarser is the gravel and sand modes. The wind-blown desert sand (10YR 7/6) is completely dominated by medium sand (Figure 14.2; Table 14.2). Thus, the combination of the wind and water sorting influences explains the dominance of medium sand in the marl brick samples. Also, as desert sands are rich in chlorides and sulphates (Hurne 1925) this explains the presence of salt precipitates in the marl bricks.

TABLE 14.5: FOUR STATISTICAL MEASURES FOR THE SILT FRACTION

Sample	Mz	σ	Sk	K_G
A:1	06.68	01.28	00.21	01.1
2	06.11	01.26	-0.25	00.72
3	06.3	01.21	00.09	00.73
4	06.13	01.28	00.21	01.15
B:1	06.68	01.18	00.07	00.78
2	07.06	01.28	00.14	00.71
3	07.48	01.43	00.32	01.0
4	07.11	01.35	00.23	00.88
C:1	06.33	01.01	-0.24	00.94
2	06.4	01.02	00.54	00.55
3	05.76	01.21	-0.21	01.13
D:1	06.11	01.29	-0.25	00.89
2	06.98	01.51	00.17	01.27
E:1	06.25	01.28	-0.28	00.79
2	06.68	01.29	-0.05	00.89
F:1	06.36	01.33	-0.17	00.89
2	06.38	01.37	00.16	01.35
G:1	06.7	01.33	00.02	00.89
J:1	06.11	01.25	00.17	00.85
2	06.13	01.15	-0.04	00.78
3	06.26	01.17	00.26	00.9
K:1	06.38	01.2	00.1	00.85
L:1	06.06	01.24	-0.07	00.93
2	05.95	01.39	-0.06	00.99
M:1	06.28	01.12	00.05	00.73
2	06.05	01.2	-0.13	00.83
3	06.11	01.27	-0.04	01.01
N:1	06.25	01.17	00.05	00.72
2	05.83	01.21	-0.16	00.88
3	06.21	01.27	-0.12	00.88
S:1	06.63	01.11	00.21	00.74
2	06.4	01.41	-0.52	00.84
U:2	05.75	01.2	00.34	00.75
3	06.2	01.15	00.12	00.75
R:2	05.55	01.2	-0.23	00.95
3	06.55	01.45	-0.1	00.86

The River Nile bank near el-Hagg Qandil is composed of bands of pale brown sand (10YR 6/3), brown silt (10YR 5/3) and dark brown silty clay loam (10YR 4/3). The bedding results from a combination of seasonal changes in the amount of sediment carried by the Nile and the changing velocity of river flow. The high medium silt content of the Nile mud is responsible for the high medium silt content in the alluvial mud brick.

The suspended matter which is brought down by the Nile and makes up the Nile mud is derived from the disintegration under weathering influences of igneous and metamorphic rocks (Ball 1939). The mineralogical character of the sand and silt fractions includes angular crystalline fragments of quartz, felspar, hornblende, augite, mica and other minerals derived from the disintegration of igneous and metamorphic rocks. The clay fraction is mainly kaolin, a clay mineral which is a common decomposition product in the weathering of felspathic rocks. Thus, the alluvial bricks probably have a similar mineral composition.

Consequently, both wind and water erosive forces, and the annual deposits of the Nile are the major sources of the sediments determining the composition of both types of brick at el-Amarna.

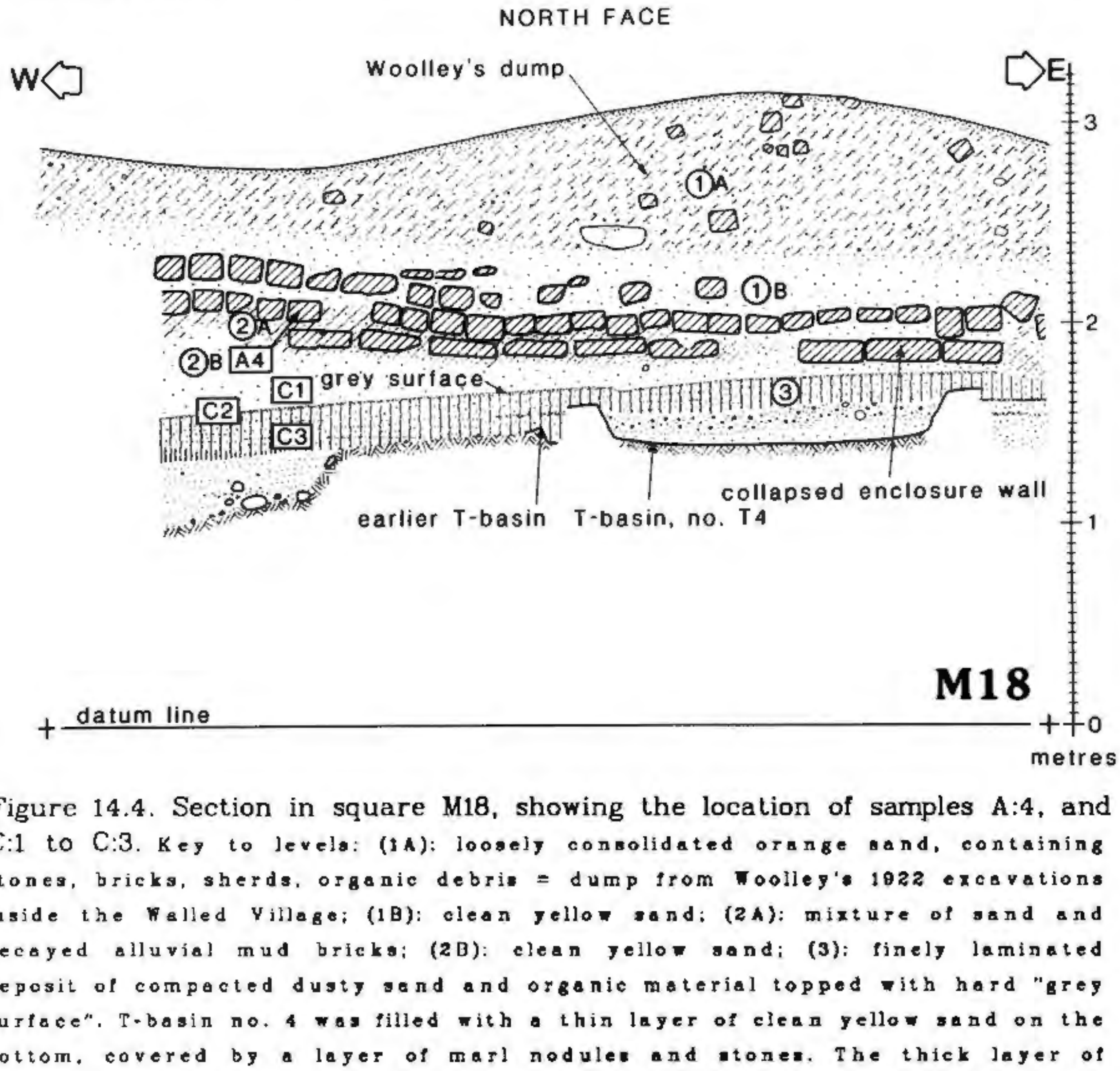

Figure 14.4. Section in square M18, showing the location of samples A:4, and C:1 to C:3. Key to levels: (1A): loosely consolidated orange sand, containing stones, bricks, sherds, organic debris = dump from Woolley's 1922 excavations inside the Walled Village; (1B): clean yellow sand; (2A): mixture of sand and decayed alluvial mud bricks; (2B): clean yellow sand; (3): finely laminated deposit of compacted dusty sand and organic material topped with hard "grey surface". T-basin no. 4 was filled with a thin layer of clean yellow sand on the bottom, covered by a layer of marl nodules and stones. The thick layer of loose bricks between levels (1) and (2) is the collapsed enclosure wall made from alluvial mud bricks.

14.6 The grey surface in front of the Walled Village [2]

Sample C:2 (Figure 14.4) is from a distinctive stratum at the Workmen's Village site. It forms the topmost surface of accumulations of organically rich debris. It spreads immediately in front of the village, covering the T-shaped basins and lapping over the wall stumps of the earlier range of animal pens (Building 350; Kemp 1981:7, Figure 2, Plate II.2; Kemp 1983:8, Figure 3). It occurs over parts of the undisturbed floor deposits of the later animal pens (Building 400). It reappears towards the upper end of the sloping rubbish fill in the main quarry (Kemp 1983:7, Figure 2). It occurs again at the *Zir* Area, in square J6, as a crust covering a deposit of soft, fine ashy material over the sand filling an ancient pit (Chapter 5). This surface is always very even, and is frequently, perhaps always, covered directly by clean, wind-blown sand (as in the case of sample C:2, see Figure 14.4). Its most distinctive visual feature is a white mottling of the pale grey surface. Small orange blotches also occur which are probably abraded sherds. The surface appears to be slightly more compact than the underlying material, and thus to have the "feel" of a crust during excavation.

Sediments analysis of the sample C:2 provides nothing distinctive in composition. But three possible causes of the grey colouration can be considered. It may be the result of waterlogging, or the eluviation of iron and organic matter as a consequence of leaching, or the presence of ash. It is improbable that the mottling results from the first process. It may be due to the presence of ash, and/or to the exposure of the horizon to the action of percolating water (i.e. "weathering"). The mottling is certainly not produced by the same phenomenon as produced the salt precipitate in the marl bricks.

It was noted in 1983, during the excavation of floor deposit in the later animal pens (Building 400), that where the floor deposit had been covered and protected by rubble from the collapse of walls, the pale mottled crust faded away. This observation helps to confirm that it is a product of long exposure to weathering, and adds weight to evidence that the older animal pens, Building 350, were ruined and eroded well before the site was abandoned.

14.7 Conclusions

1. The composition of alluvial bricks exhibits a bimodal distribution, either dominated by the medium sand size fraction with a subordinate medium silt content, or as a mixture of two sub-equal populations of medium sand and silt. The gravel and other inclusions vary at random.
2. The composition of the desert marl bricks, by contrast, has a unimodal distribution dominated by the medium sand size fraction. Gravel is the major inclusion, but its content varies at random.
3. The alluvial bricks at el-Amarna exhibit less uniformity of composition than

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[2] The following section is an addition to the original report, and was written jointly by French and Kemp.

the East Karnak alluvial bricks. Their composition is similarly dominated by the composition and sorting characteristics of the local alluvium.

4. There does not appear to be any correlation between brick composition and definite constructional purposes. The materials that were locally available, and the people making the bricks were probably mainly responsible for the compositional variation observed.

5. The process of "puddling" all the ingredients before moulding the bricks is also partly responsible for the concentration of the sand fraction, and, to a lesser extent, the medium silt fraction. The longer the ingredients are "puddled", the greater the concentration of finer material in the brick.

6. The three major natural sources of the sediments are wind and water transport, and Nile deposits. These processes mainly determine the sorting characteristics of the sand and silt fractions, and the mineralogical composition of the samples.

14.8 Acknowledgements

I would like to thank Mr. B. J. Kemp, director of excavations at el-Amarna, the Egypt Exploration Society, the Egyptian Antiquities Organization, Dr. R. MacPhail of the Institute of Archaeology, University of London, Mr. G. D. Hathaway and Mr. M. Jones.

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CHAPTER 15

GEOMORPHOLOGY AND PREHISTORY AT EL-AMARNA

by

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15.1 Introduction

In conjunction with the Egypt Exploration Society's 1981 expedition to el-Amarna, a preliminary field-walking survey was undertaken by the present writer to assess the prehistoric potential of the area with the view to a more extensive and systematic survey being conducted in a future season. All topographical/geomorphological units of the area were investigated (Figure 14.1) in approximately ten days of field-walking in a wide "zig-zag" pattern. Three possible flint-working sites of probable Middle/Upper Palaeolithic date were discovered, plus many diffuse flint scatters. In view of the limited time and resources it was possible only to note the approximate location of the sites on the existing small-scale map (Figure 14.1), and to describe and draw a very small selection of artefacts (Figures 15.1-6) to obtain some idea of the flint industries concerned.

15.2 Geomorphology

The royal city of Akhenaten at el-Amarna is situated on the east bank of the Nile about 190 miles (304 km) south of Cairo in Middle Egypt. It lies within a vast natural semi-circle with maximum distances of c. 6 miles (9.6 km) north to south, and c. 2 miles (3.2 km) west to east. The Nile river and narrow north-south strip of cultivation form the western boundary, and the c. 100-metre OD scarp face of the eastern high desert forms the eastern boundary of the el-Amarna plain. The royal city stretches north to south along the junction of cultivation and desert, whereas the Workmen's Village and "Stone Village" nestle in small valleys beneath the c. 25-metre erosion terrace within about three-quarters of a mile (c. 1 km) east of the foot of the 100-metre scarp face.

So as to place el-Amarna in its geomorphological setting, there follows a general discussion of the geology of the Nile valley and a more specific description of the el-Amarna area.

There is a generalized eight-fold division of the geological sequence for the Nile valley. The earliest is a pre-Nile sequence of oxisols (ferrallitic soils), vertisols (swelling clay soils), pediments, gravels and dune sands. This is succeeded by three periods of Nile aggradation, consisting of various sands, silts, clay-silts and gravels. Each period of sedimentation was followed by a period of desiccation which resulted in the erosion and down-cutting of the Nile channel. The fourth period of aggradation led to an accumulation of Nile sands and silts to a maximum of 5 metres above the flood plain. This was succeeded by a later and significant interval of erosion, and the final aggradation of the modern flood plain (Wendorf 1965).

This sequence has a broad date range from the Middle Palaeolithic to the third millennium B.C. The oldest industry associated with the pre-Nile deposit is classifiable as Acheulean. The industries associated with the first and second periods of aggradation are of Upper Palaeolithic age. The second and third periods of aggradation continue from the late Upper Palaeolithic to Neolithic times. The fourth period of aggradation probably continued into early historic times (Wendorf 1965).

Recent evidence has suggested that the modern Nile river system was in existence by the end of the Lower Palaeolithic (Hassan, in Wendorf and Schild 1976), earlier than previously envisaged (Wendorf 1965). The abundance of pyroxenes (a chain structure inosilicate [SiO_3]) and montmorillonite clay (a common weathering product of basalt) as revealed by heavy mineral and granulometric analyses (Hassan 1976a and 1976b) and X-ray mineralogy (Hassan and Attia 1976) respectively of Nile sediments has suggested that the modern Nile system was fully established with as great an influx of material from the Ethiopian tributaries, the Blue Nile and Atbara, as in more recent and present-day times. Prior to the later Lower Palaeolithic period, the Nile had no connection with the Ethiopian tributaries; it was fed from White Nile sources and local tributaries in Egypt and the Sudan (Hassan 1976a). But since later Pleistocene times the Nile has undergone various minor changes of course, widenings and deepenings. As a local example, there is an undated former Nile terrace edge in the north-west corner of the village of el-Hagg Qandil standing c. 1.5 metres above and c. 150 metres east of the present-day river's edge.

The geomorphology of the Nile valley in the el-Amarna area may be subdivided into four units (cf. Figure 14.1). The first unit consists of the high desert plateau to the east, the western edge of which forms the semi-circular scarp edge around the eastern circumference of the el-Amarna plain. It is composed of Middle Eocene limestone (Wendorf and Schild 1976), and forms a highly weathered, barren, gently undulating landscape.

The second unit or the valley border levels are situated at different heights above the alluvial plain and are bordered by steep slopes (Said 1975). They are composed of limestone and cemented limestone gravel with a well-weathered pebble and wind-blown sand covered surface. Intermediately soluble soil components such as gypsum ($CaSO_4$) and calcite ($CaCO_3$) (Bunting 1967) appear to be common. The valley border levels have either a structural or fluviatile origin, the upstanding levels resulting from a greater resistance to erosional processes because of harder underlying geological substrates. Water action must have been the major erosional force responsible for the topography (Hume 1925; Ball 1979).

The c. 25-metre erosion level is possibly the lowest level concerned (Vermeersch, et al 1978a), and appears to be the level on which probable Middle/Upper Palaeolithic flint-working sites are concentrated. In particular, they are concentrated on an irregular and much dissected triangular spit of land at the c. 25-metre level between the Royal Wadi to the north and the Great Wadi to the south (Figure 14.1). This may have formed a "peninsula" relatively free from and above the effects of periodic rivers emerging from the wadis and consequent erosion.

The third unit or the lower desert rises from the alluvial plain to c. 20 metres above it. Morphologically, it is composed of a series of sand and gravel fans, most of which are dissected into several layers by later wadi activity (Said 1975). On these fans there is a diffuse scatter of Middle/Upper Palaeolithic flints which are no longer ***in situ***. The Workmen's Village, "Stone Village" and the main city are all situated on this lower desert level.

Wadi sediments in the lower desert are of variable thickness and tend to mask older Nile and/or wadi deposits. Consequently no Nile deposit is exposed at the present surface. The highest Nile deposits in the lower desert are the Dendara silts, which texturally are heavy clays (Said, et al. 1970). They occur as high as c. 20 metres above the alluvial plain, and cover an undulating relief of Nile and wadi origin. The landscape evolution after the deposition of the Dendara clays forms the actual relief of the lower desert (Said 1975).

The fourth unit is the alluvial plain. This has gradually encroached upon the lower desert as a result of a combination of Nile sedimentation, the accumulation of sands and gravel from erosional activity upslope and to the east, and the relatively recent extension of the usable agricultural land by irrigation projects. For instance, the western two-thirds of the royal palace in the main city is now buried beneath cultivated alluvium. Also, the River Temple is situated on sand within the alluvial plain beneath the village of el-Hagg Qandil (Peet and Woolley 1923: 127). The presence of a probable Roman wall (Kemp 1979; P. French, personal communication) within the canal extension of the wadi which runs through the centre of the village of el-Till c. 2 metres below the present surface of the alluvial plain also attests to the considerable accumulation of material from erosion and wadi activity as well as the intrusion of Nile-borne sands and silts.

Thus, the geomorphology of the el-Amarna area, as for the rest of the Nile valley, has been shaped by the changing action of the Nile and continuing erosional processes since the later Lower Palaeolithic period.

15.3 Prehistoric sites

There are two natural types of flint/chert in the el-Amarna area. The most commonly used flint occurs as black nodules in the Middle Eocene limestone and as flint pebbles. The less common and poorer quality flint is a mottled brown flint which occurs in pebbles and in thin (c. 4 cms. thick) seams near the surface of the limestone, but apparently only in the area to the south-east of the Southern Tombs (Figure 14.1).

The three possible Middle/Upper Palaeolithic flint sites are located on the c. 25-metre level, immediately to the north and east of the Workmen's Village (Figure 14.1). They have probably been exposed by deflation and were seen as dense, black concentrations of flint, c. 10 square metres in area, against the greyish-white limestone background. A wide area of diffuse flint scatter was associated with Sites B and C on the prominence on which they are situated to the north of the Workmen's Village, and over the isolated "tump" on which Site A is located. These areas may have been utilized because the flint was naturally exposed and occurring in great abundance at these particular locations. Moreover, the c. 25-metre terrace level forms a natural "peninsula" of land, relatively out of reach of the erosional effects of the periodic flood waters which would have emerged from the Royal Wadi to the north and the Great Wadi to the south (Figure 14.1) during flash floods.

These three sites appear to belong to the same industry and will therefore be discussed together. The flints represent a poor industry, characterized by cores, core remnants, flakes, and a few blades, with few tools in evidence (Figures 15.1-4). The lack of tools and little evidence of utilization or retouching suggest that only the preliminary working of the flint was carried out on site. The finishing of the tools probably occurred elsewhere, possibly at habitation sites closer to the River Nile. The flints range from very fresh (Site A) to well weathered (Sites B and C) condition, and exhibit little patina. Two types of core were produced from flint pebbles and nodules: Levallois-type cores (Figures 15.1-4), and cores with striking platforms (Figures 15.1-2). The Levallois-type cores are more common, but are generally only core remnants; some appear to have been utilized as scrapers or denticulate tools (Figures 15.3-4). Rectangular and oval flakes (Figures 15.1-2, 4) were produced from these cores. The platform cores are less common, but produced fairly numerous blades and bladelets, many of which have been utilized (Figures 15.1-4). In this respect, the flints from all three sites are similar to, but very much the poor relations of the three sites found on the west bank of the Nile between Asyut and Nag' Hammadi in Middle Egypt at Beit Allam, Nazlet Khatin and el-Rifa (Vermeersch, et al. 1978a). But these sites were situated in the lower desert. Two Upper Palaeolithic sites in the same area at el-Gat'a and Beit Khallaf have been located at valley border levels, and are dominated by blade tools (Vermeersch, et al. 1978a). Consequently, the three el-Amarna sites may be a local transitional Middle/Upper Palaeolithic industry.

The lower desert area west of the Royal Wadi between the c. 25-metre level and the Northern Tombs (Figure 14.1) revealed a diffuse scatter of possible Middle Palaeolithic flint material, in particular Levallois flakes (Figure 15.5). As mentioned here, Middle Palaeolithic sites in similar topographical positions have been discovered elsewhere in Middle Egypt, such as at Beit Allam (Vermeersch, et al. 1978a). Thus, there is the possibility that future erosional processes may reveal sites in the lower desert at el-Amarna.

The high desert plateau is apparently devoid of flints. But, as only the first half kilometre, or so, east of the scarp face was investigated, there may possibly be sites further to the east.

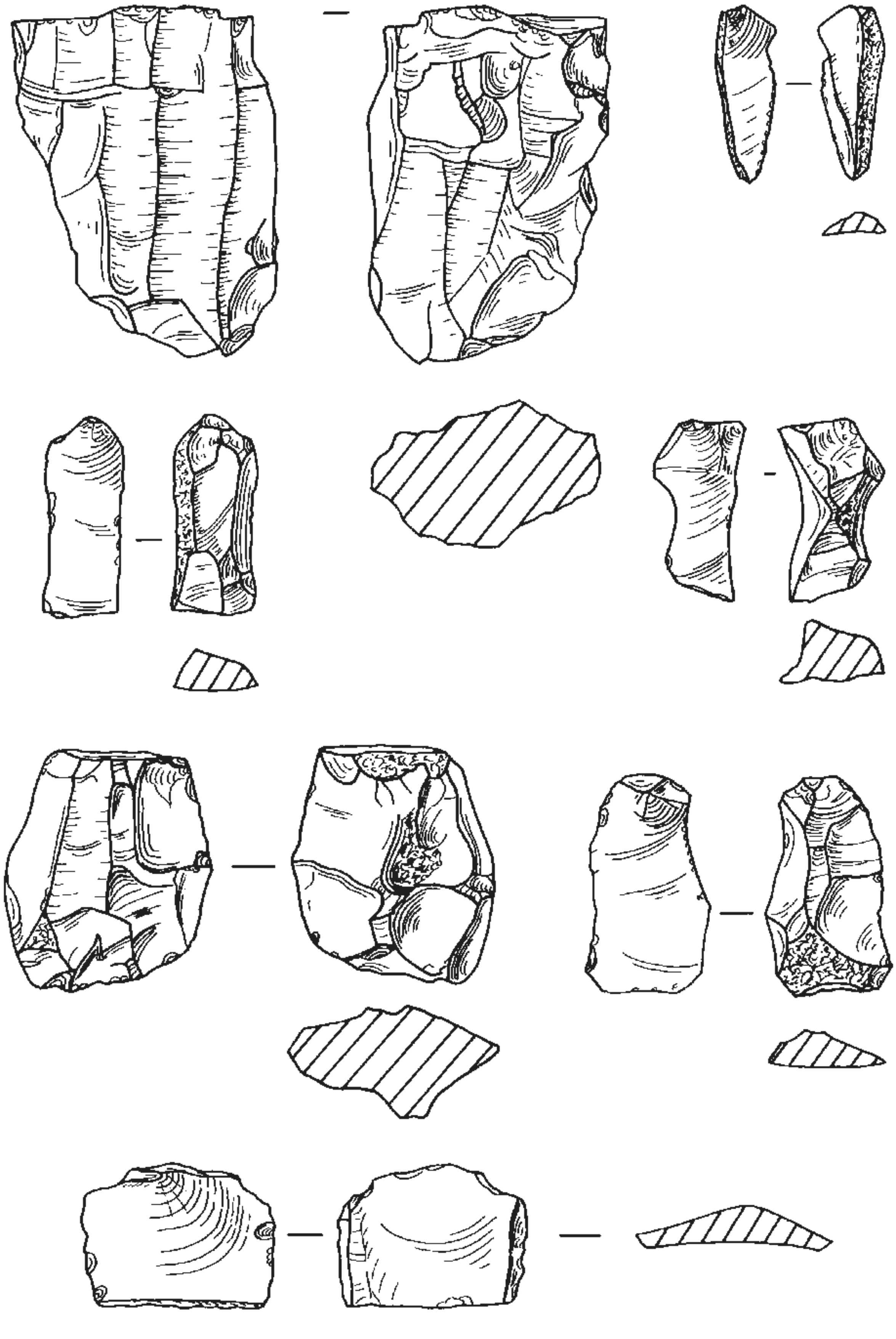

Figure 15.1. A selection of flints from Site A. Scale 1:1.

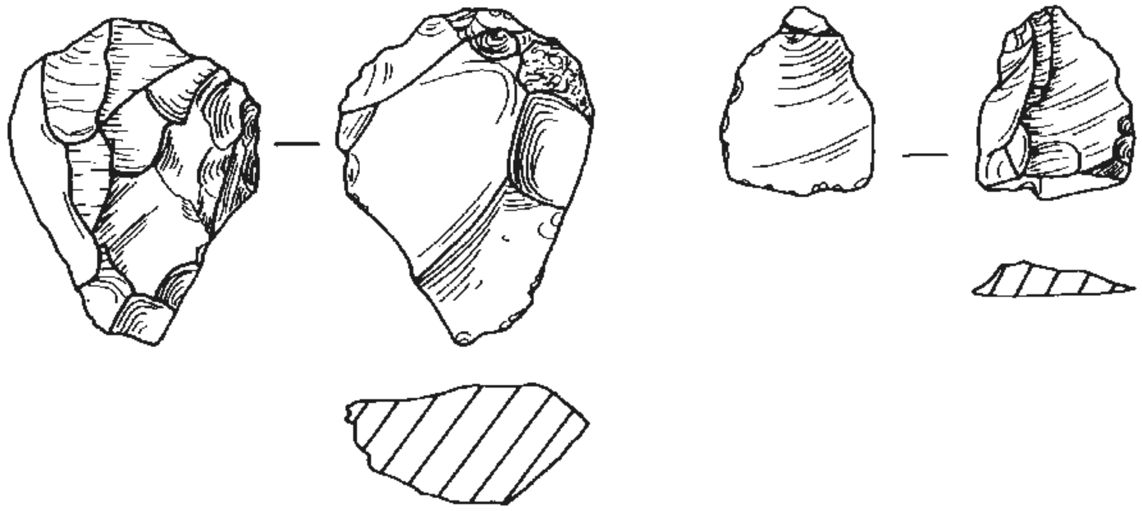

Figure 15.2. A selection of flints from site **A** (continued). Scale 1:1.

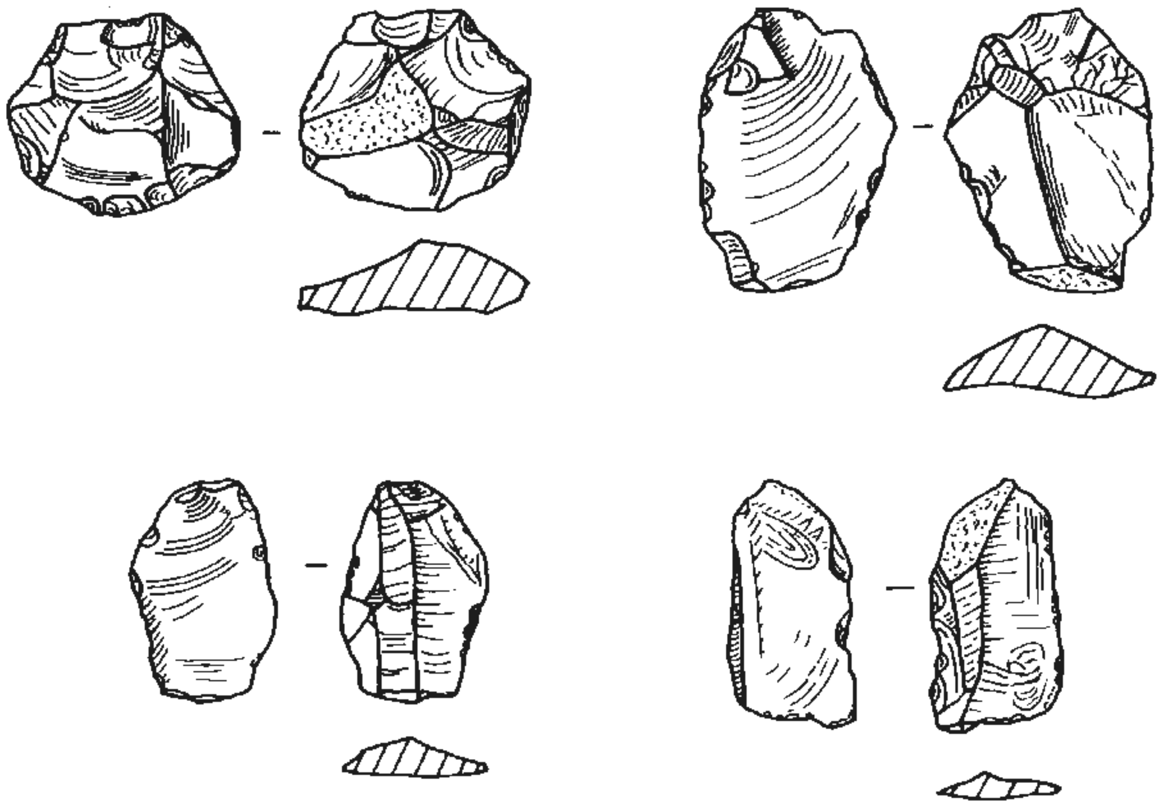

Figure 15.3. A selection of flints from Site **B**. Scale 1:1.

The area behind and to the south-east of the Southern Tombs (Figure 14.1) revealed only a few flint artefacts. They are mainly made of brown flint (Figure 15.6). This area is composed of highly eroded limestone at the c. 25-metre+ level, which is much dissected by wadi activity and the consequent accumulations of sand and gravel. It is possible that a combination of poor quality flint and the greater distance to the Nile made this an unsuitable area for flint working, or erosional activity may have removed or obscured the sites.

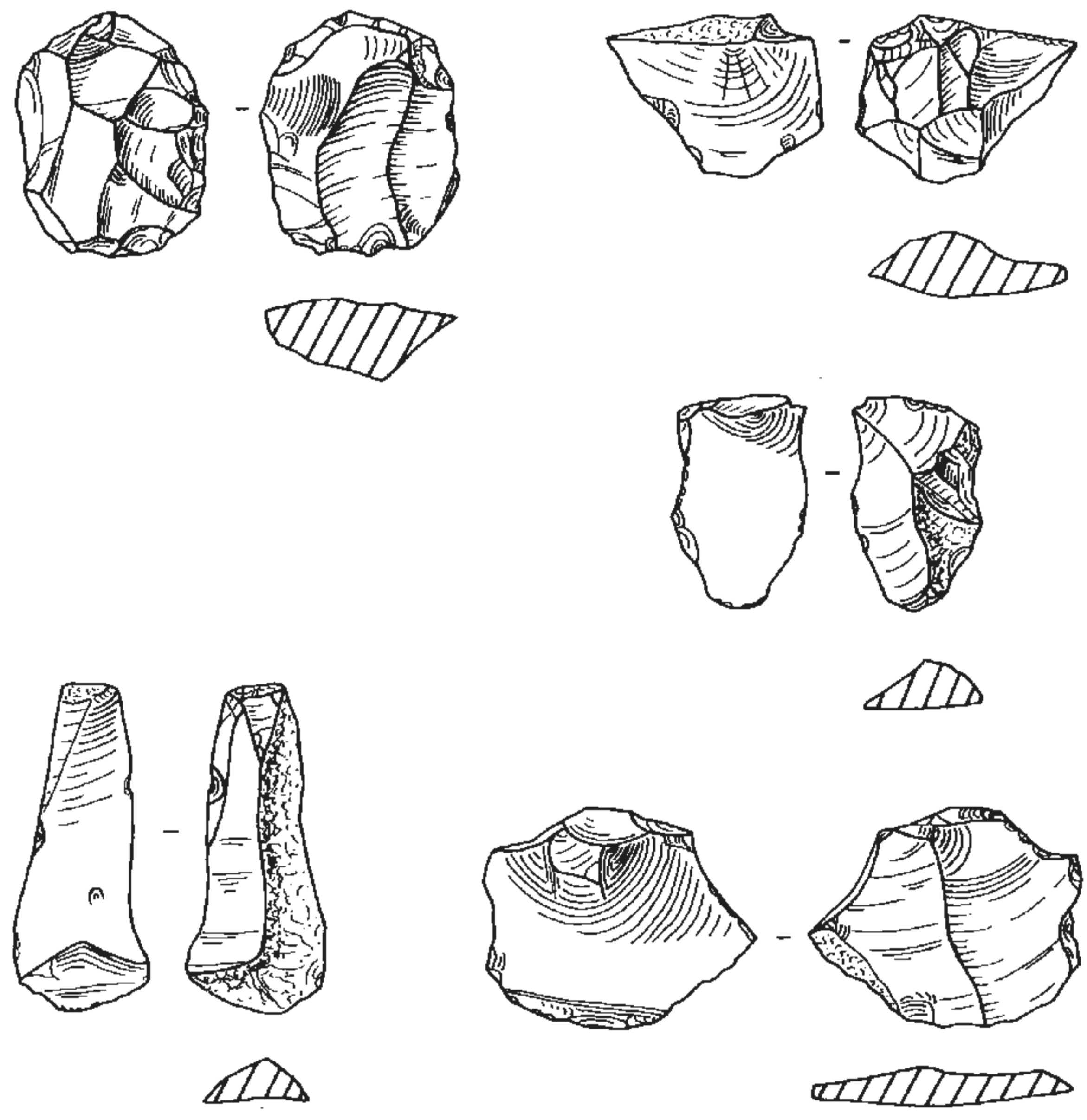

Figure 15.4. A selection of flints from Site C. Scale 1:1.

The alluvial plain is also apparently devoid of flint sites, but this is probably due to the aggradation and/or erosion of Nile sediments either burying or removing sites, rather than a real absence of sites.

15.4 Conclusions and Recommendations

1. There is sufficient Middle/Upper Palaeolithic flint material to justify a future systematic field-walking survey.
2. Before undertaking the survey, the lower desert and valley border levels must be accurately mapped at a large scale.
3. The most promising areas for intensive investigation are the lower desert and c. 25-metre level to the north and east of the Workmen's Village site at

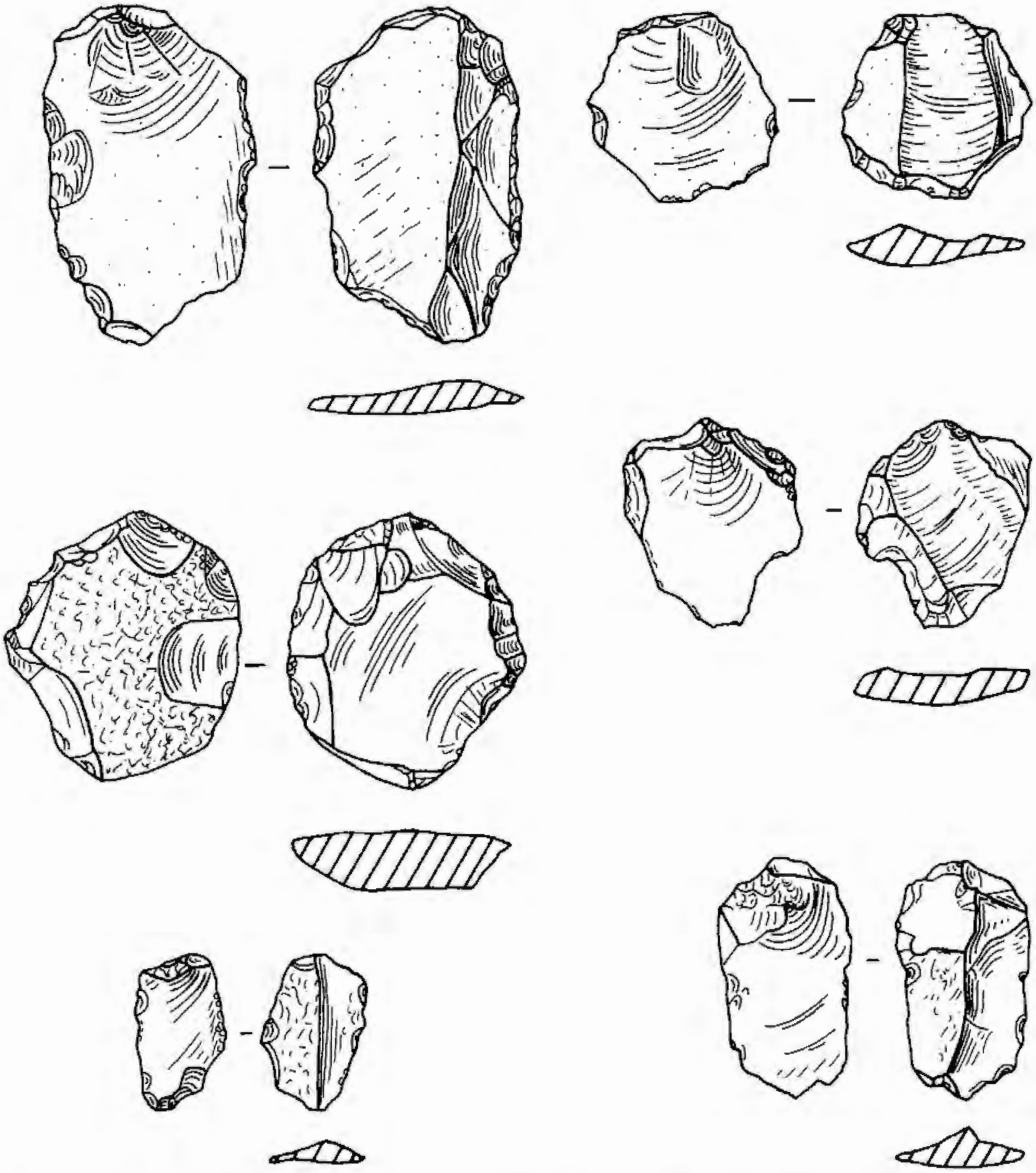

Figure 15.5. A selection of flints from the c. 25-metre level north and south of the Royal Wadi. Scale 1:1.

el-Amarna.
4. The flint material from Sites **A**, **B** and **C** appears to exhibit characteristics of both Middle Palaeolithic and Upper Palaeolithic industries. Deflationary processes may result in flints of several periods being found together at the same stratigraphic level.
5. Sites **A**, **B** and **C** warrant accurate recording and planning of every artefact *in situ*, and the recovery of a proportion of artefacts to be photographed, drawn and registered.
6. To complement the specific site evidence, a series of transections at

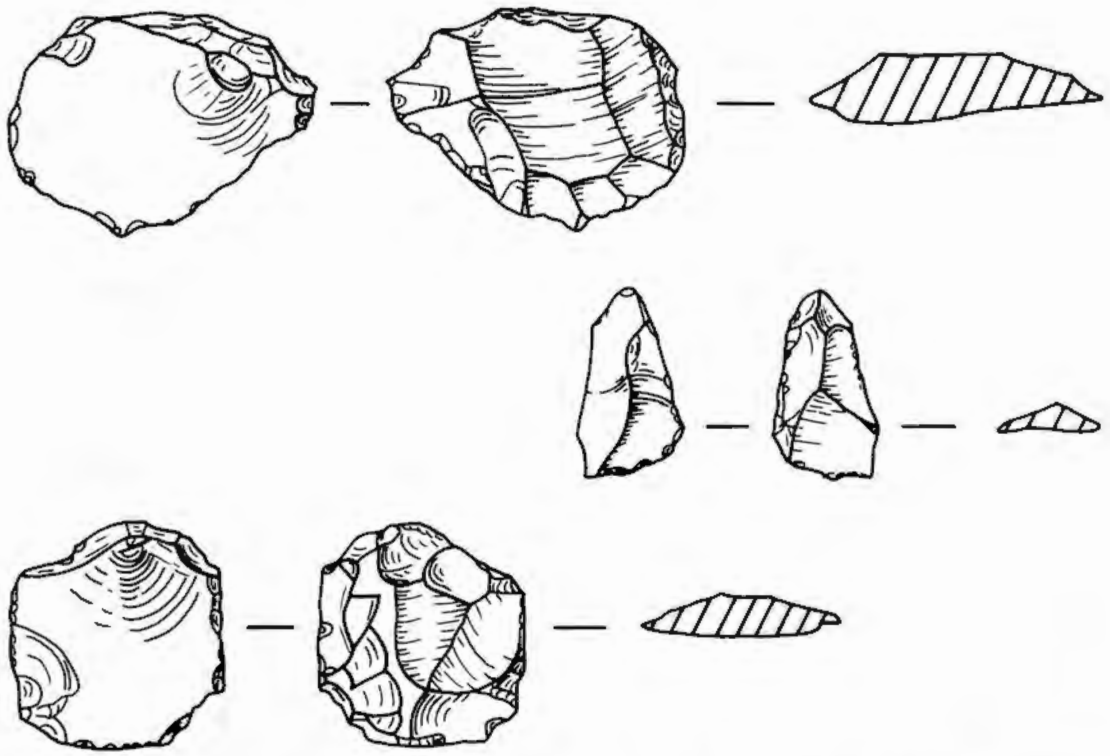

Figure 15.6. A selection of flints from the area south-east of the Southern Tombs. Scale 1:1.

intervals of 50 or 100 metres should be walked on the lower desert and c. 25-metre level, and the artefact distribution recorded.

15.5 Acknowledgements

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