Chapter 2.1

TOKEN FINDS AT PRE-POTTERY NEOLITHIC 'AIN GHAZAL, JORDAN A FORMAL AND TECHNOLOGICAL ANALYSIS

Harry Iceland

Abstract: *A collection of 137 clay and stone tokens from the Neolithic site of 'Ain Ghazal in Jordan was studied in terms of formal and technological characteristics. The assemblage includes spheres, cones, and other shapes that are well known from Near Eastern token collections. A visual technological classification based on surface and fabric characteristics was supplemented by petrographic and XRD studies of smaller samples of artifacts and local clay and stone raw materials. Results show some correlations between shapes and technological processes and close technological similarities among tokens recovered as groups, suggesting single episode production, use and discard.*
Key Words: *petrography*

INTRODUCTION

Several seasons of excavations at the Neolithic site of 'Ain Ghazal, Jordan, have recovered a total of 137 tokens, small clay and stone artifacts with geometric and occasionally naturalistic shapes (Rollefson *et al.* 1992). These objects have been shown to have served as counters used in the elite-dominated redistributive economies of Neolithic farming villages throughout the Near East (Schmandt-Besserat 1992, vol. I: 178). The various token shapes correspond to the kinds of products, especially cereals and herd animals, which entered the redistributive system. The 'Ain Ghazal tokens are dated principally to the Middle Pre-Pottery Neolithic B period (MPPNB), *ca.* 7250-6500 BC (uncalibrated radiocarbon dates), (Rollefson *et al.* 1992: 446), when technologies for the processing of clay and stone raw materials including pyrotechnology, were widely practiced but still in their formative stages.

In this study, we present the results of analyses of these artifacts, along with samples of local clays and chalk fragments. Several methodological approaches were used to examine both formal and technological characteristics. The technological features of the assemblage were studied using macroscopic and low magnification observations of material surfaces and fabrics to develop a set of technological categories. These categories, in turn, became the basis for additional studies using petrographic analysis and X-ray diffraction (XRD). These latter techniques were used to identify non-plastic inclusions and clay minerals, which might provide information concerning raw material selection and processing. The resulting data were examined for patterns relating to intra-site spatial distribution and possible temporal changes in the token assemblage. Our primary goals are to contribute to our understanding of how these objects were made and used, and what this information may suggest about Pre-Pottery Neolithic society in the Near East.

ARTIFACT SHAPES

The objects are classified by shape according to the main types and subtypes described in Schmandt-Besserat 1992 (vol. II: ix-xv). Figure 2.1.1 illustrates the numbers of token types present in the 'Ain Ghazal assemblage according to this classification.

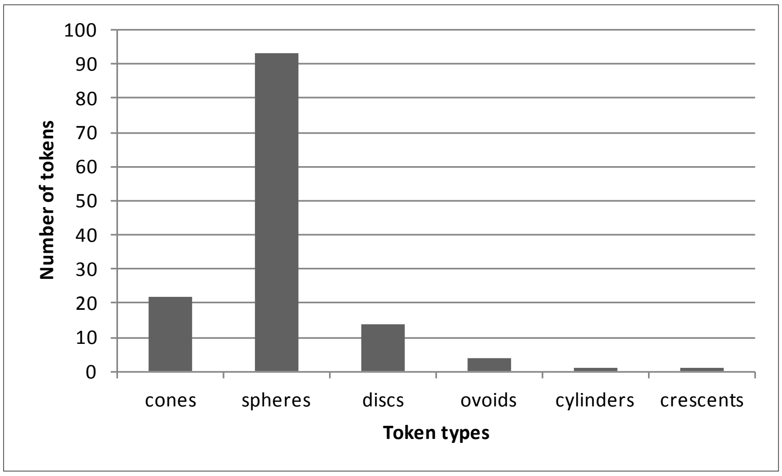


Fig. 2.1.1. Token shape types at ‘Ain Ghazal

It can be seen that about two-thirds of the samples are spheres, including a number of half spheres, and that there are progressively smaller numbers of cones, discs, ovoids, a single cylinder, and a unique crescent. Spheres, cones, and discs, which probably represent measures of cereals, are the most common shapes at most early Neolithic sites (Schmandt-Besserat 1992, vol. I: 168). These main types have also been further divided into a number of sub-types based on shape, size, and the presence of various kinds of markings.

A summary of the numbers of tokens in the ‘Ain Ghazal assemblage by type and subtype, according to the Schmandt-Besserat 1992 classification, is provided in Table 2.1.1. A catalogue listing and describing all objects in this study, numbered from 1-137 and organized by type and subtype, accompanies this report.

Cones (n=22)

Cones are the second largest category. Most (n=8) are classified as simple isosceles (Fig. 2.1.2a[a]), but several other subtypes are present, based on shape, size, and markings. Four larger cones are classified as “isosceles, >3.0 cm” (Fig. 2.1.2a[b]). These are also distinguished by a sharply expanding base and a distinctive yellow clay characteristic of technological category 2, discussed further below. Other subtypes found in this collection are “long” (n=1), “equilateral” (Fig. 2.1.2a[c]) (n=5), and “round apex” (n=1). This latter object (Fig. 2.1.2a[d]), shaped something like a chess pawn, is extremely well made with a smooth surface and a

TYPE/ subtype	No.	TYPE/ subtype	No.	TYPE/ subtype	No.	TYPE (subtype)	No.
TOTAL CONES	22	TOTAL SPHERES	95	TOTAL DISCS	14	CYLINDER (tapered ends)	1
isosceles	8	plain	76	undefined	2	OVOIDS (plain)	4
isosceles, >3 cm	4	large	2	flat	5	CRESCENT	1
two punctations	1	multiple lines	1	flat, large	1		
incised isosceles	1	half	8	lenticular	3		
long	1	with groove	7	indented	1		
equilateral	5	with punctation	1	reworked sherd	1		
large equilateral	1			half	1		
round apex	1						

Table 2.1.1. ‘Ain Ghazal token types and subtypes

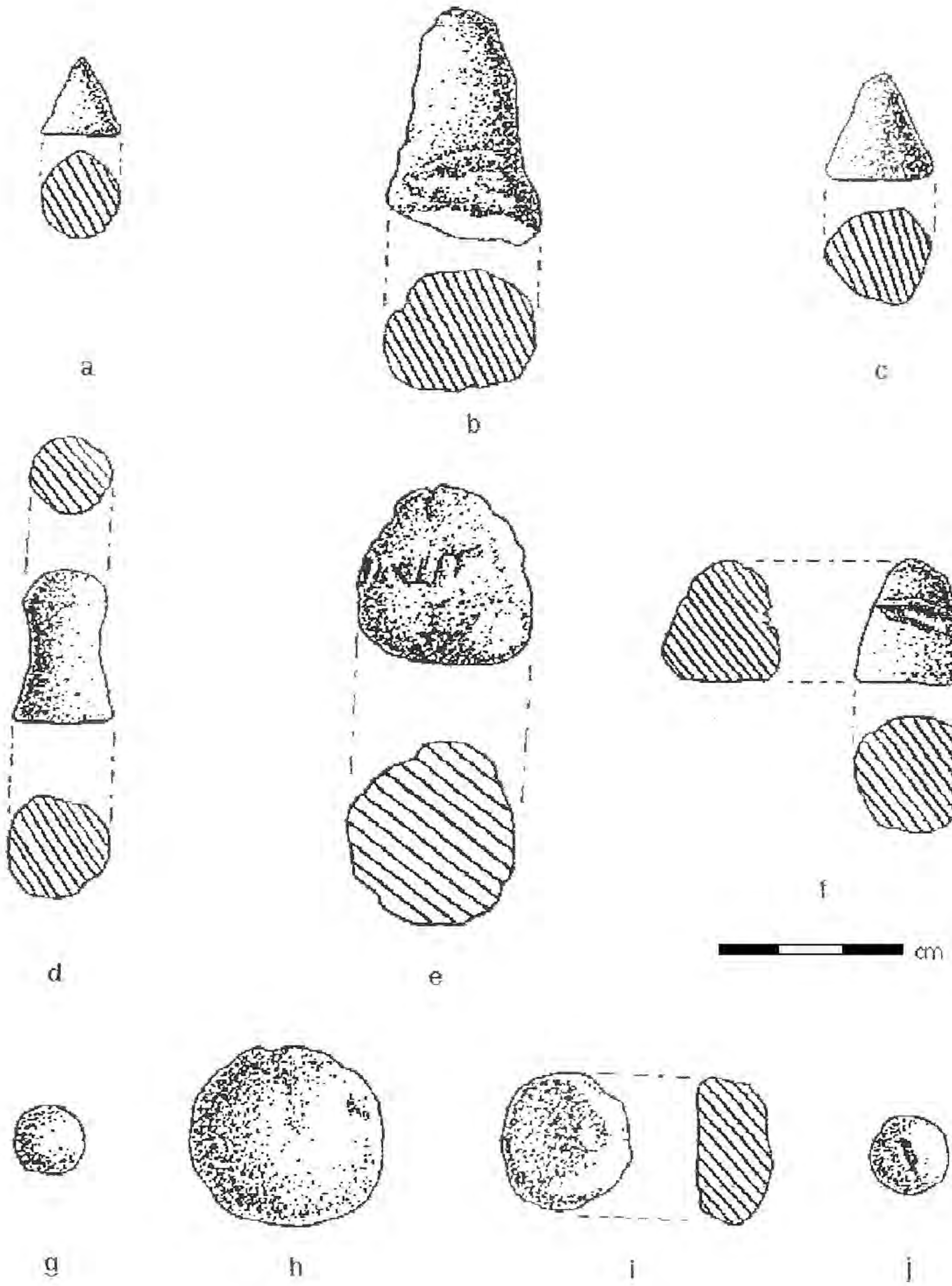


Fig. 2.1.2. ‘Ain Ghazal token types and subtypes: (a) simple isosceles cone; (b) large isosceles cone; (c) equilateral cone; (d) cone with round apex; (e) large equilateral cone; (f) incised isosceles cone; (g) simple sphere; (h) large sphere; (i) half sphere; (j) sphere with groove. Drawings by G. St. Clair.

sharp, symmetrical profile. It also has unusual technological characteristics. A single “large equilateral” cone (Fig. 2.1.2a[e]), while poorly shaped and highly eroded, contains an unusual mix of raw materials, most of which have not been entirely identified. The clay matrix is primarily of the yellow clay (technological category 2), but contains clay admixtures, as well as a cluster of unusual inclusions that may be organic.

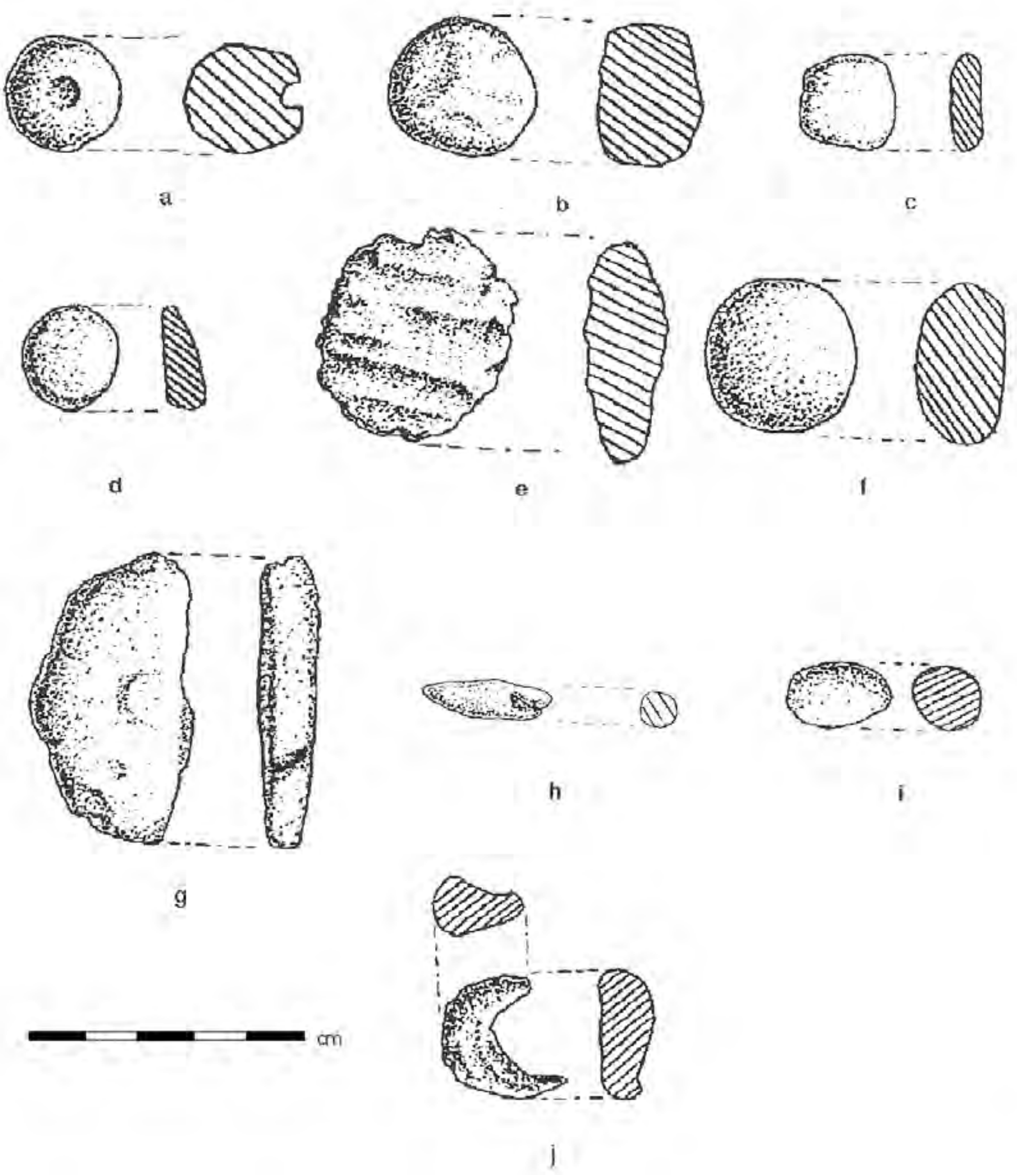


Fig. 2.1.3. ‘Ain Ghazal token types and subtypes: (a) sphere with punctation; (b) flat disc (stone); (c) flat disc; (d) flat disc; (e) large flat disc; (f) lenticular disc (stone); (g) half disc; (h) cylinder; (i) plain ovoid; (j) crescent. Drawings by G. St. Clair.

Two cones have markings. Markings, usually incised lines or punctations, are found in the earliest assemblages of simple tokens, but are rare until the proliferation of complex tokens at the first Near Eastern urban centers (Schmandt-Besserat 1992, vol. I: 24). One long cone has two punctations. A well-made specimen (Fig. 2.1.2[f]) has two deep incisions that first run parallel then intersect. Judging from the skill evident in shaping the object, it seems likely this wishbone-shaped marking was not applied carelessly, but conveyed some additional specific information about the goods in question.

Spheres (n=93)

By far the largest category of shapes consists of spheres. "Simple" spheres (n=76) make up 55% of the collection (Fig. 2.1.2[g]). These range from finely smoothed and precisely rounded objects to crudely made ones with generally rounded shapes. These differences presumably reflect a combination of the care with which they were made, raw materials utilized, and post-depositional conditions. Spheres range between 1.0 and 3.4 cm in diameter, with a median of 2.1 cm. Several rounded clay or stone objects with dimensions greater than 3.0 cm were considered too large to be classified as tokens and were removed from the study. A small number of larger rounded specimens (3.1-3.4 cm), however, that appear to belong to groups of tokens or, in one case, with token-like markings, remain in this category (Fig. 2.1.2[h]). The only subtype defined by shape is the "half sphere" (Fig. 2.1.2[i]) (n=8), one of which has a groove.

Nine other spheres also have markings of some kind. The most common marking is a simple groove (Fig. 2.1.2[j]) (n=7). One finely made specimen has a perfectly cylindrical punctation, which appears to have been made with a blunt stylus (Fig. 2.1.3[a]). Punctations appear on tokens in the earliest assemblages, but are usually less common than linear markings (Schmandt-Besserat, vol. I: 24). There is also a single example of a sphere with fine multiple lines. Spheres are found in all of the technological categories based on macroscopic observations of surfaces and fabrics (discussed below), with some of the largest made of stone.

Discs (n=14)

The discs are defined by a general flatness, but otherwise tend to vary considerably in shape. Those defined by shape include "flat" (Fig. 2.1.3[b-d]) (n=5), "large flat" (Fig. 2.1.3[e]) (n=1), "lenticular" (Fig. 2.1.3[f]) (n=3), and an unusual half disc (Fig. 2.1.2[g]) (n=1). One squarish disc is indented or grooved and one disc, from a Yarmukian context, appears to be a reworked, faceted sherd.

The half disc is a previously unknown shape. This distinctive object has a hard red surface with fire clouding that retains several features from shaping and smoothing before firing. At low magnification it can be seen that it was made by intentionally breaking a complete disc before firing, since the broken edge was minimally smoothed while the clay was still wet. Also, one face was flattened against a smooth surface while the other has a deep crescent-shaped mark, probably made by a fingernail.

The large flat disk, made of yellow clay, also has an impression on one face, which was left by the surface on which it was formed This impression consists of parallel ridges such as might be found on a split board. This may indicate the use of a table or bench top or simply of an expedient flat surface. One of the lenticular discs, made of an unusual buff-white clay, has a concave base where it was modeled against the thumb. Two small flat disks recovered together are of almost identical size and technological characteristics, although one is somewhat squarish in shape.

Cylinder (n=1)

This is a common shape elsewhere, represented by a single unmarked specimen in this collection (Fig. 2.1.3[h]).

Ovoids (n=4)

The four ovoids are all plain (Fig. 2.1.3[i]). They fall into three different technological categories.

Crescent (n=1)

The crescent is an unusual shape in the Neolithic token assemblages (Fig. 2.1.3[j]). This specimen is a finely made piece, with an approximately round cross section, fired red with fire clouding, slightly twisted tips and a large inclusion, probably chert, protruding from the surface.

COMPARATIVE NEAR EASTERN TOKEN ASSEMBLAGES

The ‘Ain Ghazal token assemblage can also be compared to those of other Neolithic sites in the Near East in terms of the kinds and variability of token shapes present. Three sites, Tell Aswad, Tepe Asiab, and Tell Ramad, were selected for comparison based on approximate contemporaneity and adequate sample size (Schmandt-Besserat 1992, vol. II). Figure 2.1.4 shows the relative proportions of various token shapes at the four sites and the accompanying table below shows the absolute numbers. The total numbers of tokens do not necessarily reflect intensity of token use at these sites, since the surface area (and volume) of excavation, length of occupation, and recovery techniques vary from site to site.

Levels I and II at Tell Aswad, in Syria, also date to the MPPNB. Estimated dates are in the mid-eighth to mid-seventh millennium BC range (Schmandt-Besserat 1992, vol. I: 36-37). The token assemblage from this site is relatively large, with 320 objects. It is similar to that of ‘Ain Ghazal in the predominance of spheres, and secondarily of cones, but contains much smaller percentages of other shapes, which together constitute only 3% of the assemblage, as compared with 15% at ‘Ain Ghazal. Five of the tokens in the Tell Aswad assemblage are of stone, including one sphere, three cylinders, and one rectangle.

Tepe Asiab, in the Zagros Mountains of Iran, is the earliest of these sites, with a single component dated to 7900-7700 BC (based on uncalibrated radiocarbon dates). The token collection, consisting of 193 objects, is somewhat larger than that of ‘Ain Ghazal. While spheres are again predominant with 52%, this collection also contains an unusually high proportion of cylinders (38%), compared with negligible numbers of this shape at the other three sites. Schmandt-Besserat (Personal Communication, 1996) suggests that the sandy soil at this site may have contributed to an overrepresentation of these small objects, which may have been more difficult to recover at other sites. The Tepe Asiab collection contains no stone tokens, which are rare at sites in Iran.

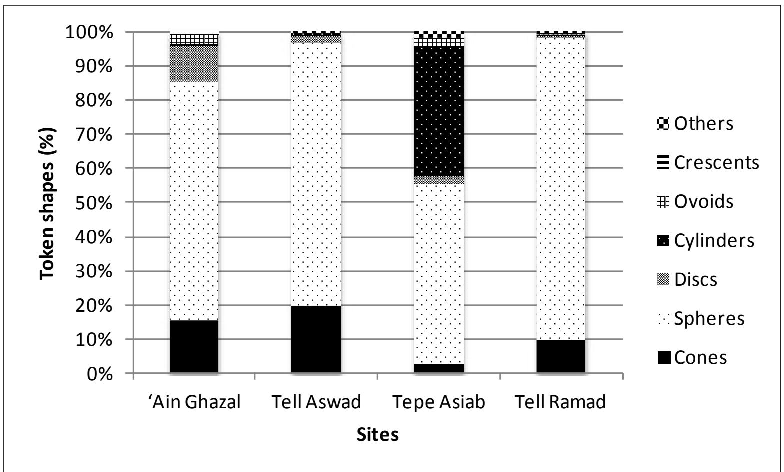


Fig. 2.1.4. Token distribution by shape at four Near Eastern Neolithic sites

Shapes	‘Ain Ghazal	Tell Aswad	Tepe Asiab	Tell Ramad
Cones	22	65	6	38
Spheres	95	245	101	335
Discs	14	5	5	2
Cylinders	1	3	73	2
Ovoids	4	0	4	1
Crescent	1	0	0	0
Others	0	2	4	2
Totals	**137**	**320**	**193**	**380**

Table 2.1.2. Token distribution by shape at four Near Eastern Neolithic sites

Levels I and II at Tell Ramad, also in Syria, date to the late seventh and early sixth millennium BC within the PPNB period. The token collection from this site is one of the largest available for study, with 380 specimens. It differs from the other three assemblages in the overwhelming predominance of spheres (88%), with cones constituting 10% and other shapes less than 2% of the collection. There are no stone tokens in this collection.

This brief inter-site comparison offers a useful perspective on the ‘Ain Ghazal token assemblage. It can be seen that the predominance of spheres in the ‘Ain Ghazal assemblage characterizes the other three Neolithic assemblages as well. Likewise, cones are the second most numerous shapes found at three of the four sites, including ‘Ain Ghazal, while cylinders are second in frequency at Tepe Asiab. The three sites selected for comparative purposes all contain a primary shape, spheres; a secondary shape, cones or cylinders; and negligible numbers of other shapes. The ‘Ain Ghazal assemblage, however, contains significant numbers of a third shape category, discs, which constitute 10% of the assemblage. In this respect, the ‘Ain Ghazal assemblage appears to be somewhat more diverse than those from the other three sites.

It seems likely that these inter-site differences in the variability of assemblage, in the predominance of certain shapes, and in the presence or absence of particular types, reflects differences in local production and specifically in the variety of goods entering the local redistributive systems. These data suggest continued relatively diverse productive activities and elite control of surpluses at ‘Ain Ghazal during the PPNB.

This comparative data also places the use of stone for making tokens at ‘Ain Ghazal in some perspective. While we do not have detailed technological information for these three comparative token assemblages, it is apparent that the great majority of tokens are made from some kind of clay. Stone tokens were apparently found only at Tell Aswad, where they constitute less than 2% of the objects. At ‘Ain Ghazal, there are as many as fifteen tokens (11%) that may be considered to be of some form of stone. As will be shown in the technological studies below, however, the identification and definition of stone objects can be problematic. It is possible that some of the objects found at these sites made of soft local stone, such as chalk, were not identified as such.

TOKEN CHRONOLOGY

The great majority of the ‘Ain Ghazal tokens (129 of 137) are from MPPNB contexts (*ca.* 7,250-6,500 BC) in the Central Field area of the site. The remaining tokens are from LPPNB (n=3), PPNC (n=1), Yarmukian (n=1) and mixed (n=3) contexts in the Central, North, and South Fields (see the token catalogue for details concerning provenience and context). The MPPNB is divided into five subphases, I to V, which are dated as follows (all based on uncalibrated radiocarbon dates):

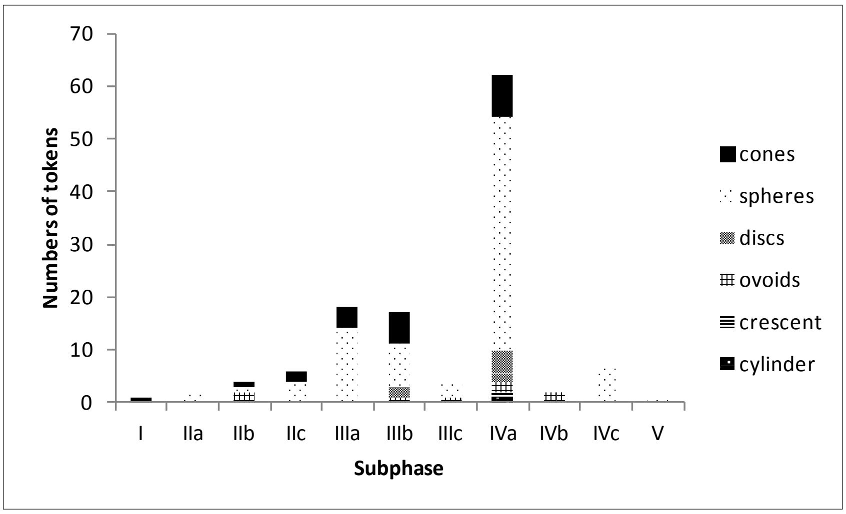


Fig. 2.1.5. Token types by MPPNB subphase

I.	7,250-7,100 BC
II.	7,100-7,000 BC
III.	7,000-6,900 BC
IV.	6,900-6,800 BC
V.	6,800-6,500 BC

Figure 2.1.5 shows the numbers of the various token types by subphase for the 120 tokens that could be dated to specific subphases of the MPPNB.

Considering the various token types by subphase, we see that:

1) The greatest numbers of tokens (83% percent of the total) are concentrated in the middle subphases of the MPPNB, between IIIa and IVa.
2) Exactly half of the tokens (60 of 120) are concentrated in phase IVa (approximately the middle of the sequence), which contains at least one example of each type;
3) spheres predominate in most phases (with the exceptions of I and IVb, which contain a single cone and two ovoids, respectively);
4) cones are concentrated in the phases of greatest token use and show a steady increase during these phases.

At this point we do not know if this concentration of tokens during subphases IIIa to IVa, *ca.* 7000-6800 BC, is related specifically to intensity of token use, to volumes excavated, or some other factors. If the phases are actually representative of token use, they appear to indicate a gradual increase in use during the MPPNB, followed by a decline towards the end.

TOKEN CONTEXTS

The overwhelming majority of tokens recovered in the ‘Ain Ghazal excavations come from contexts involving ash in one form or another (Rollefson, Personal Communication, 1996). Of 114 tokens for which an archaeological context could be ascertained, a total of seventy-seven come from contexts described as ash layers, ash dumps, ash pits, fire cracked rock fill, and ashy extensions of fire pits. Another twenty-six objects were recovered in similar midden and fill contexts. Over 90% of the total, then, were recovered in secondary (or tertiary) disposal contexts, many of them associated with burning. Only ten were found on floor surfaces, most of them exterior. Just three were found in contexts associated with specific activities: a fine incised cone in a lime-burning pit, a sphere in a burial pit, and another (of yellow clay) in a pit containing some of site’s renown plaster statues.

The ash, midden, and fill contexts of the great majority of tokens suggest that they were expediently disposed of after use. At ‘Ain Ghazal, tokens were not stored, cached or otherwise curated after their initial function had been served. Another implication of this association of discarded tokens with contexts involving burning is that determination of the firing conditions of these objects inevitably involves a degree of ambiguity concerning the circumstances of firing. While in some cases we may be observing the results of production technology, in others we may be looking at the consequences of discard or post-depositional conditions.

The contexts of token finds at other Neolithic sites are not well known (Schmandt-Besserat, vol. I: 93). At later major urban centers, such as Uruk and Susa, tokens were often found in proximity to the main temples. While reported contexts appear to vary widely, casual discard near public places may form a common pattern.

TECHNOLOGICAL CLASSIFICATION

All of the ‘Ain Ghazal samples were additionally classified according to surface and interior color, texture, and observed inclusions. This was determined visually, using a binocular microscope at low magnification (20X) as necessary, to get a rough idea of the variability in materials and possible production processes. This approach, while subjective in many respects, made it possible for us to try to generalize the results of additional, more objective, time-consuming, and destructive tests involving much smaller samples to the assemblage as a whole. Eight such technological categories (TCs) were initially developed.

Technological Categories:

1) white stone-like material (n=16)
2) fine yellow clay (n=14)
3) light brown clay with lithic/organic inclusions (n=54)
4) dark brown clay with lithic/organic inclusions (n=32)
5) hard red clay with fire clouding (n=6)
6) fine buff clay (n=1)
7) raw chalk (n=1)
8) other (n=13)

Figure 2.1.6 shows the relative proportions of these technological categories (TCs) present in the assemblage:

1) The objects in the first technological category (TC1) are white to pale yellow in color (typical Munsell reading: 2.5Y8/3), and have a relatively fine-grained, homogenous fabric. Most have a porous, friable surface, and are similar in weight to the clay objects, but some appear to be made of harder and denser material. Based on the results of petrographic analysis, discussed below, the majority of these objects are likely of chalk limestone. A small number, however, perhaps three of sixteen (none studied petrographically), appear to be of harder, fine-grained limestone. One of the objects in this category, which has fairly unique macroscopic characteristics as well, has been shown petrographically to be an unusual artificial mixture of chalk fragments and clay.

2) Those in category 2 are of a distinctive pale yellow clay (2.5Y8/4) with fine surface cracks, usually with no macroscopically visible inclusions.

3-4) Categories 3 and 4 are of similar coarse brown clays, pale brown (10YR6/3) in the case of the former and dark grayish-brown (10YR4/2) in the latter, containing coarse marl and chert and charred organic material; fragments are ordinarily of the same color interior and exterior. Impressionistically, there is

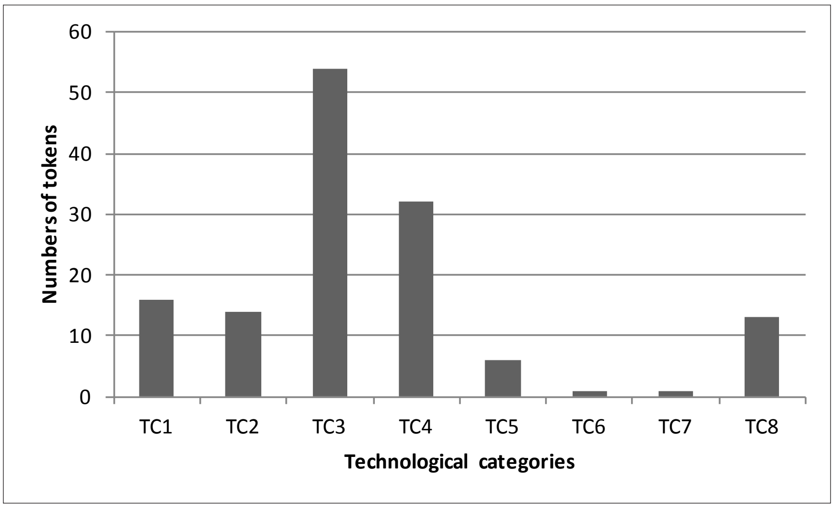


Fig. 2.1.6. ‘Ain Ghazal tokens by technological category

surprisingly little color gradation between the two categories. Chert inclusions are sometimes pebble-sized flakes, either protruding from the surface of the object or entirely buried in it (but visible in broken fragments).

5) Category 5 objects are light brown to pinkish-gray clay fabrics (7.5YR6/3), with smoothed, hard surfaces exhibiting fire clouding.

6) Category 6 consists of just two objects of smoothed fine very pale brown ("buff") clay (10YR8/3). One of these objects was used for petrographic analysis but removed from the token study because its fragmentary condition made its identification as a token questionable.

7) Category 7 consists of several white chalk fragments (5Y8/1). One of these fragments proved useful for the petrographic study, but otherwise these were removed from the study assemblage.

8) Category 8 is a miscellaneous group, but includes several clay objects with variable reddish and grayish colors, in some cases exhibiting layered differences in color in broken cross sections, likely indicating a variety of firing conditions. Most likely they were made from raw materials similar to those used for categories 3 and 4.

As can be seen from Figure 2.1.5, the majority of objects fall into categories 3 and 4 (63%), with similar, smaller proportions (10-12%) in categories 1, 2, and 8. Since these categories are further substantiated by petrographic and XRD analyses, discussed below, it is useful to discuss further patterns in their relationships with other variables.

Correlations between shape and technology are not especially strong, but some patterns do emerge. As noted above, all of the large cones (n=4) are made of the fine yellow clay (TC2), which in general appears to be reserved for less common forms. While most of the simple isosceles cones are made of light brown clay (TC3), only one of fourteen objects belonging to the other cone subtypes is made of "ordinary" TC3 or TC4 clays. All of the half spheres (n=6) are made of dark brown clay (TC4), but this clay (or clays) is also used for a variety of other forms. The objects made of stone or stone-like material (TC1) are found in a variety of shapes, including cones (n=3), spheres (n=9) and discs (n=4).

Correlations with provenience, in terms of excavation squares, are generally weak. The two large square clusters, however, 3081 and 3078, exhibit somewhat different patterns. Square 3081, with thirty-four tokens, contains only one sample belonging to category 4; and 3078, with forty-one objects, contains eight of the sixteen category 1 stone objects.

A useful line of evidence appears to be a close technological similarity among objects recovered together in groups. The individual objects are listed and described in the attached catalogue. The seven clay objects (object numbers 36-42) found together in 3081.113 (square.bag), for example, all belong to technological category 3, as do samples 46, 116, 47, from 3273.49. Similarly, samples 125, 30-32, 118 (3081.178) all belong to category 2; samples 78-80, 100 (3076.231) to category 4; and samples 60-61, 114 (3077.313) to category 3. Moreover, this pattern also holds for several two-sample groups, such as 118a and b, two small disks of virtually identical manufacture, and 137 and 8, the crescent and a cone, both belonging to technological category 5 and recovered from 3083.029.

In these latter and other cases the intra-group similarities extend to details beyond general technology; for example, samples 78-80, 100 appear to have been similarly formed and fired under similar reducing conditions. These patterns suggest that tokens of the same provenience were likely often made, used, and discarded together in a single episode, rather than curated, reused, randomly gathered, etc. It is possible, however, that in some cases exposure to similar post-depositional conditions may explain intragroup similarities.

Ts number	Project number	Techno category	Micritic matrix	Micro-fossils	Shell fragments	Fine quartz	Micritic clasts	Chert	Charred organics
1	27	1	x	x	x				
2	23	1	x	x	x				
3	29	1	x	x	x				
4	99	1	x				x		
5	28	1	x	x					
6	30	2	x	x	x				
7	31	2	x	x	x				
8	33	2	x	x	x				
9	38	3			x	x	x	x	x
10	43	3			x	x	x	x	x
11	37	3			x	x	x	x	x
12	69	4				x	x	x	x
13	115	4			x	x	x	x	x
14	81	4				x	x	x	x
15	87	5			x	x	x	x	x
16	--	6	x	x	x	x	x	x	x
17		chalk	x	x	x				
18	1 (cs)	clay	x	x	x				
19	2 (cs)	clay	x	x	x				
20	4 (cs)	clay				x	x	x	x
21	5 (cs)	clay				x	x	x	

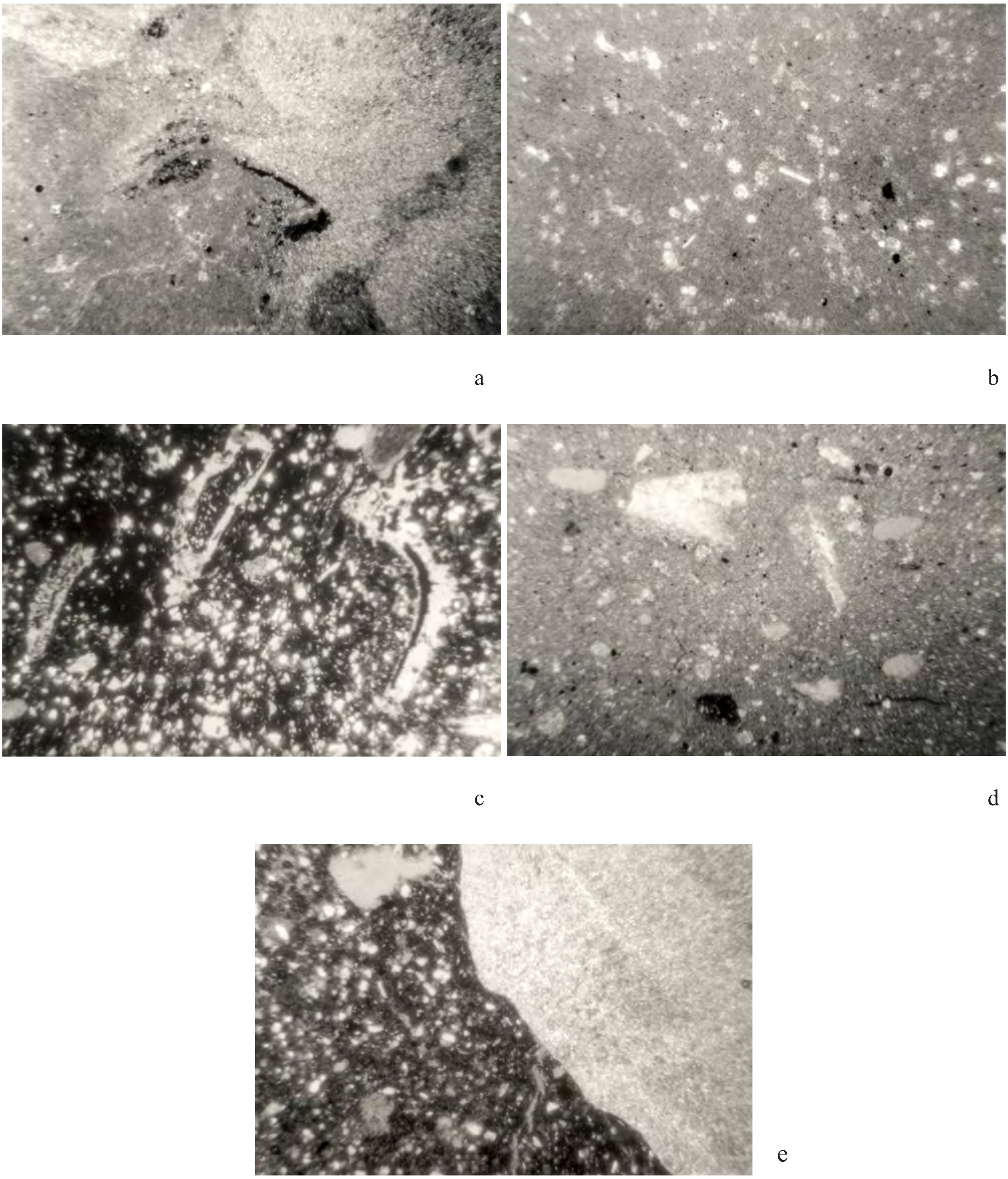
Table 2.1.3. Summary of thin section data (x=presence of variable).

PETROGRAPHIC ANALYSIS

Twenty-one petrographic thin sections were prepared from sixteen artifacts, four raw clay samples, and one raw chalk sample and these were analyzed using a polarizing microscope at low magnification (25X). Objectives were to obtain information about raw material provenience, production technology, and validity (or, at least, petrographic coherence) of the visual technological categories. Samples were selected from each of these technological categories and four additional thin sections were prepared from briquettes made from two clay samples from the site area, each of which was crushed and mixed with water, dried and divided into two, with one sample from each pair fired to 700°C.

The results of the analysis of these twenty-one thin sections are summarized in Table 2.1.3.

Thin section samples 1-3 and 5, all of which belong to technological category 1, are extremely similar petrographically as well. They are basically pieces of chalk that have been shaped into spheres by reduction, that is, by carving or abrasion of some sort. Chalk has been reported as abundant in the area of the site (Tubb and Grissom 1995: 439). These samples have a highly uniform yellowish brown matrix (with cross polarized



a b c d e

Plate. 2.1.1. a) Thin section sample 1, (chalk sphere), showing micritic matrix with frequent microfossils and shell fragments (25X with XPL, field of view is approximately 2 mm); b) Thin section sample 6, (yellow clay sphere), showing micritic matrix with iron-staining, few microfossils and shell fragments. Matrix variability probably results from processing (25X with XPL, field of view is approximately 2.5 mm); c) Thin section sample 14, (technological category 4 sphere), showing dark reddish brown matrix with frequent fine quartz and coarse charred wood inclusions, rounded micrite (25X with XPL, field of view is approximately 2.5 mm); d) Thin section sample 18, Project clay sample 1 (unfired wadi clay), showing micritic matrix with coarse shell fragments, few microfossils (25X with XPL, field of view is approximately 2.5 mm); e) Thin section 20, Project clay sample 4 (unfired terra rosa clay), showing reddish brown matrix with frequent fine quartz and pebble-sized chert inclusion (25X with XPL, field of view is approximately 2.5 mm). Photomicrograph by H. Iceland.

light [XPL]) of microcrystalline calcite (micrite), with coarse shell fragments, frequent marine microfossils, including foraminifera, coral, and ooids, and very rare fine quartz particles. These features are evident in Plate 2.1.1a, a photomicrograph of sample 1, taken with XPL at 25X.

Sample 4, also in category 1, is anomalous is several respects. Its extreme light weight was noticed immediately, suggesting it was made of some extremely porous material. In thin section it is seen to be composed of coarse, well-sorted inclusions of micritic clay and chalk with considerable void space and relatively little cement. These inclusions have oxidized rinds and no microfossils, indicating probable exposure to heat at some point before incorporation. This sample suggests that the collection may include other artificial objects made from odd recipes of mixed and modeled materials that are difficult to identify without destructive techniques such as thin section analysis.

Thin section samples 6-8, the yellow clay objects from category 2, form a homogeneous group petrographically as well. They resemble the category 1 samples, with a similar micritic matrix, microfossils, and shell fragments, but these matrices are much more variable and layered, with iron staining and void patterns that suggest a weathered marl clay which has been minimally processed and modeled. Microfossils, although present, are more altered and less frequent than in the category 1 samples. Plate 2.1.1b shows sample 6, with a highly micritic but variable matrix with scattered microfossils and shell fragments.

Thin section samples 9-11, corresponding to technological category 3, are quite different petrographically from the preceding samples. The reddish-brown clay matrix contains very frequent fine, angular quartz inclusions and barely detectable fine K-feldspar and mica, but is otherwise not easily defined petrographically. It exhibits no evidence of vitrification. Frequent coarse non-plastic inclusions include rounded micrite and angular chert, along with significant amounts of charred vegetal material, principally wood, and bone. Occasional fossil shell fragments are also present. Small fragments of similar category 3 samples dissolved quickly in a 5% solution of HCl, suggesting a calcareous clay. Some charred organic material was observed at low magnification after HCl treatment.

Thin sections 12-14, from category 4, are similar to those of category 3, especially in terms of non-plastic inclusions. The matrix is dark reddish-brown, unvitrified in appearance, with very frequent fine angular quartz. Rounded micritic particles (marl) and chert are also frequent, with especially coarse chert observed in sample 13. There are also occasional coarse unaltered chalk fragments. Charred organic material, including vegetal material and bone, is especially evident in these thin section samples. Again, we do not know when this charring occurred in terms of the production process. A burned-out straw stem in sample 12, however,

XRD sample no.	Ts sample no.	Project sample no.	Object/ technological category	Unit	kaolinite	quartz	calcite	feldspar	mica
1	9	38	sphere/3	3081.113	p	m	m	p	
2	10	43	sphere/3	3081.116	p	m	m		p
3	11	37	sphere/3	3081.113	p	m	m		p
4	12	69	sphere/4	3078.254	p	m	p		p
5	13	115	sphere/4	3078.255		m	p	p	m
6	14	81	sphere frag/4	3077.276	p	m	p		p
7	20	4 (cs)	clay sample (unfired)	Terra Rosa	p	m		p	p
8	21	5 (cs)	clay sample (fired)	Terra Rosa		m	p	p	p

Table 2.1.4. Summary results of XRD on artifact and local clay samples (m=major component, p=present).

appears to be direct evidence of firing of the clay object. A small fragment from the object corresponding to thin section sample 14 dissolved immediately in HCl solution, leaving a residue that contained considerable charred organic material. The presence in these objects of charred organic material, along with debitage-size chert flakes, strongly suggests that clay material from the site itself, derived from habitation waste, was used in their manufacture. Plate 2.1.1c shows sample 14, with coarse charred organic material, including vegetal material, very frequent fine quartz, and coarse rounded micritic clasts (*e.g.*, lower right).

Thin section 15, from a sphere belonging to category 5, which contains objects that appear more finely made and well-fired than those in categories 3 and 4, proved to be very similar petrographically to samples 9-14.

Thin section 16, from one of two samples in category 6, is from an object that appears, on reconsideration, to be a possible figurine fragment, rather than a token. It continues to be technologically interesting, but was removed from other aspects of the study. It is unique petrographically among the samples studied, although it contains the same basic constituents present in the other samples. It was clearly modeled, from a highly calcareous clay similar to that used for thin sections 6-8 (the yellow clay samples), and contains coarse shell fragments naturally present in the marly clay which, along with some chert particles, are clearly oriented and aligned with the surface of the object, as a result of the processing and forming techniques used in its manufacture.

Thin section 17 (category 7) is a chalk fragment recovered in the excavations at the site. This sample is extremely similar petrographically to thin section samples 1-3 and 5, with a highly micritic matrix containing frequent microfossils. The coarser shell fragments observed in the artifact samples are absent, but this may reflect the normal compositional variability found in the common local chalks.

Thin sections 18 and 19 were made from a raw clay sample collected from Wadi Fakhit, located northwest of the main site area. This material appears to be a marly mixture of clay and calcium carbonate that typically forms on a limestone bedrock. The sample consisted of several hard clay fragments, fine-grained and white-pale yellow in color (2.5Y.8/3), which were ground up at the laboratory, mixed with water, and minimally kneaded, flattened, and cut into briquettes, which were left to dry. This clay proved to be fat and easily worked. One of these briquettes, sample 19, was fired in an electric kiln to a maximum temperature of 700°C in an oxidizing atmosphere. This fired sample turned a pinkish gray (7.5YR.7/2). Thin sections were then made from both fired and unfired briquettes. Petrographically, thin section sample 18 (Plate 2.1.1d), which is unfired, exhibits a homogeneous micritic matrix; coarse shell fragments; comparatively few, decomposed microfossils; and argillaceous inclusions, probably unground clay (the bright objects in Plate 2.1.1d are shell fragments and most of the rounded features are voids in the clay matrix). Sample 19, in spite of the marked macroscopic change in color after firing, exhibits no obvious petrographic differences from sample 18.

Terra rosa clay samples were also collected, from the North Field area of the site. Terra rosa soils are residual red clays that also form on a limestone bedrock. Similarly, thin sections 20 and 21 were prepared from unfired and fired briquettes, respectively. The terra rosa clay is brown (7.5YR:5/4) in color and workable, but less sticky than the wadi clay. Petrographically, sample 20 (unfired) exhibits an extremely quartz-rich, dark brownish-yellow clay matrix containing coarse chert particles, micritic lumps, some mica, and fine hematite. Plate 2.1.1e shows sample 20, with fine quartz and a pebble-sized chert inclusion (lower half of field). An inclusion of this size in our experimental sample illustrates the ease with which they might have unintentionally found their way into casually processed objects. Sample 21 (fired) is very similar petrographically to sample 20. Charred organic particles are present in these samples, but very infrequent.

It is apparent from Table 2.1.3 that all of these samples fall into two large petrographic groups that are fairly homogeneous in their essential components. The first group consists of locally available natural chalk and petrographically similar marly clays and mixtures of chalk and clay. The stone artifacts in this group were shaped by carving or abrading, while marly clays were minimally processed, modeled, and probably exposed to heat. One object in this group (sample 4) contains various kinds of micritic material likely processed with minimal effort. Petrographically, the samples in this group are characterized by a micritic matrix in most cases containing both microfossils and coarser shell fragments. Samples 1-8 and 16-19 fall into this group.

The second group is characterized by a quartzitic, reddish (probably iron-stained) clay matrix and coarse chert, rounded micrite, and charred organic matter. Some metamorphic material is present in small proportions as well, but this is more clearly detectable using XRD. Samples 9-15 and 20-21 belong to this group. Samples 9-15 apparently represent clays collected in various areas of the site, modeled with minimal processing, and exposed to heat.

X-RAY DIFFRACTION ANALYSIS

Eight samples from the second petrographic group (all except sample 15) were examined by powder X-ray diffraction (XRD) using copper K-alpha radiation on an instrument equipped with a graphite monochrometer diffracted beam attachment. This sub-sample, then, consisted of three samples each from technological categories 3 and 4 and two terra rosa clay samples, one fired and the other unfired. XRD was carried out in order to further define the mineralogy of the clays, to look for patterned similarities and distinctions within and between the previously defined groups, and to provide evidence concerning possible firing temperatures. Samples from the first petrographic group were not studied with XRD because calcite was considered to be the only major component. Table 2.1.4 provides the summary results of this XRD study.

The three tokens (XRD samples 1-3) previously assigned to technological category 3 (light brown clay matrix, various coarse non-plastics) are shown by XRD to contain quartz and calcite as the principal constituents of the clay matrix. Possibly this predominance of calcite accounts for the lighter shade of brown, which distinguishes this category from category 4. It was thought that these two categories might be distinguished by differences in organic content or firing conditions, as found by Affonso (1996) in her work with early Neolithic Anatolian figurines. It seems likely that a number of factors are involved in these color variations.

Samples 2 and 3 are virtually identical, with minor proportions of kaolinite and mica as well, while the results for sample 1 indicate small amounts of kaolinite with a stronger feldspar peak. It had been expected that samples 1 and 3 would show closer similarities, since they represent two members of a cluster of category 2 objects recovered together, but the differences between them may represent the vagaries of sampling or raw material variability. If iron is present in the samples in this petrographic group, which seems likely in view of the characteristic reddish color, it is likely in a hydrated form that does not diffract well, in which case it could be present in several percentages without causing significant XRD peaks. In spite of minor differences, it appears that all three category 3 samples share a common mineralogy and were made from similar kaolinite-mica clays.

The three tokens belonging to technological category 4 (XRD samples 4-6) show marked mineralogical differences from the category 3 samples, as well as more pronounced intra-group differences. While they have strong quartz peaks similar to the category 3 samples, they have much weaker calcite peaks, indicating use of different, less calcareous clays. XRD sample 5, moreover, differs from the other two category 4 samples as well as from the category 3 samples in that it is the only token sample that has no kaolinite and contains instead a micaceous mineral, possible muscovite, as a major constituent. This may indicate it was made from a different clay, or, alternatively that it was fired above 500°C, the temperature at which kaolinite decomposes. The other two category 4 samples are fairly similar to each other, although XRD sample 4 also has a very weak kaolinite peak.

The two terra rosa clay samples (XRD samples 7 and 8) show strong quartz peaks similar to the other samples, but weak or no calcite peaks, unlike the six artifact samples. Kaolinite is present in the unfired clay sample but predictably absent in the fired sample, since the 700°C firing temperature was well above that at which kaolinite decomposes. Mica (which decomposes at 900°C) and feldspar are also present.

There is no direct match between the terra rosa clay, fired or unfired, and any of the token samples, but there are intriguing similarities between the fired terra rosa sample (XRD sample 8) and the anomalous token sample 5. In addition to the mutual absence of kaolinite, sample 5 also has a relatively weak calcite peak, as well as strong mica and feldspar peaks. It is possible, then, that sample 5 represents use of a kaolinite-mica clay very similar to our terra rosa samples which was fired above 500°C, a temperature easily achieved in an open fire (Rice 1987: 156). If the inhabitants were intentionally selecting kaolinite-mica clays for making tokens, this would make this explanation of the observed mineralogy of sample 5 more plausible than the use of clay from a unique source for this particular object.

These XRD results indicate that tokens in these two technological categories, 3 and 4, which comprise the majority of the artifacts in the ʻAin Ghazal assemblage, were made using kaolinite-mica clays similar to the kaolinite-mica clays collected in the area of the site, while differing from them in some respects. They further support the utility and integrity of the technological categories as reflecting differences in the materials and processes used in the production of these artifacts. They indicate a certain amount of variability in the materials used which is difficult to interpret, possibly reflecting modest differences in firing temperature or exploitation of variable local sources over a wide area. The presence of kaolinite in all but one artifact sample shows that they could not have been fired above 500°C, and were therefore likely heated in an open fire, such as a hearth, rather than an oven or kiln.

FIRING TEMPERATURES

Other lines of evidence tend to support the conclusions of XRD analysis that the clay tokens were ordinarily fired, but at low temperatures. Macroscopically, many of the tokens have a pinkish or reddish tinge, or a gray coloration suggesting firing under oxidizing or reducing conditions, respectively. Some broken objects exhibit differential coloration on the surface and interior and others have fire clouding.

Most of these characteristics were noted but not studied systematically. Petrographic analysis of the kaolinite-mica clay artifacts, however, which appear to comprise about three quarters of the assemblage (technological categories 3-5, most of 8), also provides evidence of firing at low temperatures. While some of the charred organic material in these samples likely was present as habitational waste in the raw clays, at least some voids of burned-out and partially burned-out organic forms appear to be clear indicators of firing at low temperature. On the other hand, the absence of vitrification in the clay matrix supports the evidence of XRD that even moderately high temperatures (<850°C) were not reached (Rice 1987: 431).

The micritic clay artifacts (categories 2 and 6) offer fewer clues concerning firing. Microfossils in micritic clays are potential indicators of firing temperature. Tests on marl samples from ʻAin Ghazal reported by Tubb and Grissom (1995: 439) indicated that microfossils began to decompose at 650°C and had completely disappeared at 700°C. In thin section, the chalk sample (ts 17) and the unfired shaped chalk artifacts in technological category 1 contain frequent, varied, and relatively unaltered microfossils. Micritic clay artifacts in categories 2 and 6 also contain microfossils, but considerably fewer and more altered, which may be evidence of firing at low temperature.

These artifact samples, on the other hand, also closely resemble the samples of wadi clay, unfired sample 18 and fired sample 19, which also contain very few, altered microfossils, and which cannot be distinguished petrographically. It seems likely that the clay microfossils in these clay samples became altered by weathering or other natural processes, but apparently were not significantly affected by firing up to 700°C. Macroscopically, unfired sample 18 closely resembles the pale yellow category 2 samples, while fired sample 19 resembles the well-made, buff-colored category 6 samples in color. Our firmest conclusions would appear to be that the category 2 samples were fired at low temperatures, while the two category 6 objects may have been heated to higher temperatures, possibly up to 700°C.

SUMMARY AND DISCUSSION

We have studied a collection of tokens from the Pre-pottery Neolithic site of ‘Ain Ghazal in terms of shapes and production technology. Using comparative data from three additional early Neolithic sites, Tell Aswad, Tepe Asiab, and Tell Ramad, we have shown that the suite of shapes present at ‘Ain Ghazal is similar to those found elsewhere in the region, but apparently somewhat more diverse. All of the assemblages contain predominantly spheres, while the ‘Ain Ghazal collection contains significant numbers of two additional shapes, cones and discs. There is also some evidence that stone may have been used more frequently at ‘Ain Ghazal than at the other three sites, although this may reflect the focus of this particular study. A closer look at raw materials, such as afforded by the ‘Ain Ghazal collection, reveals a variability among stone, clay and artificial materials that likely exists in all such collections.

We approached the questions of raw materials and production processes by using a series of methods involving progressively smaller nested sample groups. We began by sorting all of the objects according to surface and interior color, texture, and observed inclusions, as we might an unknown sherd collection. In this way, we developed eight technological categories. Twenty-one thin sections were then prepared from samples selected from these categories, along with chalk and clay samples from the site.

Petrographic thin section analysis largely supports the validity of our technological classification. Petrographically, the samples can be divided into two groups. The first group, characterized by fossiliferous micritic material, includes the samples from technological categories 1, 2, and 6, the raw chalk fragment, and the wadi clay samples. The second group, characterized by a quartzitic clay matrix with a variety of coarse inclusions and charred organic material, contains the artifact samples from technological categories 3-5 and the terra rosa clay samples.

The samples in the former group are made of materials similar to those reported in other studies of contemporaneous artifacts. Affonso (1996), also using thin section petrography, reports that soft carbonate stones were carved to make figurines at Neolithic Nevali Cori, in Anatolia. This basic production technology appears to be similar or identical to the carving and abrading of chalk to make most of the tokens belonging to technological category 1 at ‘Ain Ghazal.

Tubb and Grissom (1995:438-439) discuss the use of simple processing techniques involving similar materials to make the ‘Ain Ghazal statues recovered in two caches in 1983 and 1985. Since they used scanning electron microscopy, involving considerably higher magnification than this study, our results are difficult to compare directly. They find that a crushed fossiliferous chalk was used as filler to extend the lime plaster used to make the statues recovered in the 1983 cache, while the 1985 cache statues were made from a marl plaster. Both materials contain microfossils and small amounts of quartz in a micritic matrix, but the latter is also composed of significant amounts of clay, apparently with less frequent microfossils.

The microfossil-rich chalk crushed for use as filler in the case of the first statue group corresponds to the unprocessed chalk used to make the technological category 1 tokens in this study. The relationship between the statue materials and the technological category 2 tokens in terms of raw materials and processing is less clear. The second statue group and the tokens both appear to contain lower frequencies of microfossils than appear in the raw chalk. Both groups also have very low percentages of quartz. In the case of the category 2 tokens, this has resulted in the characteristic fine surface cracks resulting from shrinkage. These two groups may also have a similar micritic clay matrix, but the clay fraction of the category 2 token samples was not studied petrographically and none of these token samples were analyzed with XRD. The characteristics of the material used for the second group of statues appear to be consistent with the use of local marl heated to low temperatures (<700°C). These statues and the technological category 2 tokens may have shared some basic production techniques involving the use of marl or marl clays and low-temperature firing, while differing in other important respects.

XRD carried out on fragments from eight of the samples studied in thin section also confirmed some of our previous characterizations and revealed unforeseen complexities. It shows that most of these objects (with one exception) could not have been fired at higher than 500°C. It suggests that the visual distinction between technological categories 3 and 4, which comprise the majority of tokens, may be based on somewhat different kaolinite-mica clay mineralogies.

CONCLUSIONS

Formal and technological analyses of the ‘Ain Ghazal token assemblage offer few clear-cut answers, but do offer some insights into aspects of production, exchange, and social organization during the time of the PPNB occupation of the site, *ca.* 7,250-6,500 BC The tokens appear to be for the most part expediently produced by processing a variety of locally available materials. A small number of tokens were made by minimally shaping natural carbonate stones, including locally available hard limestones and chalks, by means of carving and abrading. The great majority of the tokens at ‘Ain Ghazal, however, were made using kaolinite-mica clays, probably gathered in the immediate vicinity of the habitation areas and fired in hearths or other open fires. Pebble-size chert inclusions evidence disinterest in clay processing, and modeling and marking (when present) is similarly cursory. Clearly, functional communication took priority over considerations of craftsmanship or esthetics.

A smaller group of tokens was made using a yellow marly clay petrographically similar to the wadi clay and chalk samples. The technology used to produce these objects appears to overlap with that of some of the lime plaster statues, which made use of low-fired marl (Tubb and Grissom 1995: 439). These yellow clay tokens are also casually made, but there is a close correlation between this particular clay and certain shapes, such as large isosceles cones, which also suggests that factors other than expediency may have come into play. There are also a few exceptional examples, such as the artifacts in technological categories 5 and 6 (*e.g.*, crescent, half disc, “pawn-shaped” cone), which provide evidence of more varied shapes, finer modeling, and higher firing temperatures, but the data are insufficient to determine whether these represent special functions, unusual individual skills, technological advances, or some other factors.

This minimal effort expended in token manufacture is consistent with their apparent casual discard. Tokens were apparently made for use in specific redistributive transactions, after which they were disposed of as expeditiously as they were produced. The technological homogeneity of several groups of tokens recovered together provide further evidence for this kind of single episode production, use, and discard. If tokens were curated for re-use as needed, we would expect to see significant intra-group technological variability, resulting from the varying circumstances of manufacture of the individual tokens. Instead, we find that the tokens in these groups tend to be made of similar clays, similarly modeled and fired. The reported contexts for token finds at ‘Ain Ghazal also provide evidence for expedient discard after use. The great majority of tokens appear to come from contexts involving burning, refuse deposits, and fill. It seems likely that groups of tokens were quickly incorporated into waste deposits near the structures where they were used. We might speculate that these discard locations were associated with the residences of village headmen where goods were collected for periodic redistributive events, but we have no direct evidence of this.

Analyses of the shapes present in the ‘Ain Ghazal token assemblage and comparison with approximately contemporaneous sites in Iran and Syria provide some evidence of differences in local production and redistribution within a context of cultural and economic uniformity over a wide region. The increasing number of token types and subtypes that appeared with the advent of more complex, stratified societies in the fourth millennium BC suggest a direct relationship between the diversity of token shapes and increasing productive and social complexity (Schmandt-Besserat, vol. 1: 179-180). All four Pre-Pottery Neolithic sites appear to share the same general suite of token shapes and predominance of certain forms. The ‘Ain Ghazal assemblage, however, has a somewhat greater diversity of token shapes that may indicate a greater variety of products entering the redistributive system and subject to elite control than at the other three sites.

The variety of raw materials and processing techniques evident in the assemblage is more difficult to evaluate on a comparative basis, since few technological studies are available. It seems likely, however, that this low level application of pyrotechnology is related to the production of plaster for architectural purposes, common throughout the Neolithic Near East (Kingery *et al.* 1988), and the mixed technology of the ‘Ain Ghazal statues, which it resembles in some ways. The functional requirements differ for each of these applications, so it is not surprising that, although they involve some of the same raw materials, the kind and degree of processing appears to vary considerably. These various uses of clay, chalk, limestone, and pyrotechnology may have served similar functions, however, in the social realm as symbolic and technological innovations employed to strengthen the prestige and central economic role of local Pre-Pottery Neolithic elites.

Acknowledgments: I would like to thank a number of people for their advice and assistance with this project. Dr. Hugo Steinfink and Dr. Steve Swinnea of the School of Chemical Engineering of the University of Texas at Austin conducted the XRD and patiently helped interpret the resulting data. I am especially appreciative of the advice of Dr. Robert Folk of the Department of Geological Sciences of the University. Rae Beaubien, of the Smithsonian Museum Conservation Institute, also provided helpful suggestions and Dr. Julie Hansen and Dr. Paul Goldberg of Boston University kindly commented on the report in draft. Jessie Johnson managed the curation of the objects at the Texas Memorial Museum Conservation Laboratory. University of Texas students Jennifer White, Jesse Casana, Clint Ballinger, and Lisa King provided valuable assistance and George St. Clair is responsible for the illustrations of the tokens. I am especially grateful to project co-director Dr. Gary Rollefson and to Dr. Denise Schmandt-Besserat, whose pioneering work on the origins of writing forms the basis of this study, for the opportunity to collaborate on the ‘Ain Ghazal project.

Dr. Harry Iceland
Research Collaborator in the Paleo-Indian Program
Smithsonian Institution National Museum of Natural History

BIBLIOGRAPHY

Affonso M.T.
1996 Petrographic and chemical analysis of early Neolithic clay figurines from Nevali Cori, Eastern Anatolia, Turkey. Paper presented at the 30th International Symposium on Archaeometry. May 1996. Urbana, Illinois.

Kingery W.D., Vandiver P.B., and Prickett M.
1988 The beginnings of pyrotechnology, part II: production and use of lime and gypsum plaster in the Pre-Pottery Neolithic Near East. *Journal of Field Archaeology* 15: 219-244.

Rice P.M.
1987 *Pottery Analysis: A Sourcebook*. Chicago: University of Chicago Press.

Rollefson G.O., Simmons A.H., and Kafafi Z.
1992 Neolithic cultures at ‘Ain Ghazal, Jordan. *Journal of Field Archaeology* 19: 443-470.

Schmandt-Besserat, D.
1992 *Before Writing, Vols. 1 and 2*. Austin: The University of Texas Press.

Tubb K.W. and Grissom C.A.
1995 Ayn Ghazal: a comparative study of the 1983 and 1985 statuary caches. In K. ‘Amr, F. Zayadine, and M. Zaghloul (eds.), *Studies in the History and Archaeology of Jordan V*: 437-448. Amman: Department of Antiquities of Jordan.