Ground-Stone Tools and Implications for the Use of Space and Social Relations at 'Ain Abu Nukhayla, a PPNB Settlement in Southern Jordan

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The demography and social organization of early agricultural communities are among major research problems in archaeological investigations of the Neolithic Levant (e.g., Banning 1996; 2003; Byrd 1994; 2000; Flannery 1972; 1993; 2002; Garfinkel 2002; Kuijt 2000a; 2000b; Saidel 1993; Verhoeven 1999; Wright 2000). These sociological approaches to Neolithic communities have successfully added new insights into the developmental processes of early agricultural communities from a different perspective than those that emphasize ecological factors (e.g., Köhler-Rollefson 1988; 1992; Moore 1985: 52; Moore et al. 2000; Rollefson et al. 1992).

Nonetheless, these social investigations have tended to focus on settlements in the Mediterranean environmental zone, or "Levantine Corridor", where a number of early agricultural communities cluster. In contrast, such social examinations have been underdeveloped for settlements in arid, marginal areas. There, archaeological research has focused on investigation of the ecological aspects of prehistoric occupants (Bar-Yosef 1984; Goring-Morris 1993; Simmons 1981) and hunting strategies (Betts 1998; Rosen and Perevolotsky 1998; Tchernov and Bar-Yosef 1982).

Little is known about the social aspects of Neolithic communities in the arid regions except for brief remarks occasionally made by some researchers. They suggest that community organizations in the arid regions may have been composed primarily of small groups that were similar to those of preceding periods, based on the small, seasonal occupations of the sites, the abundant evidence for hunting and foraging activities, and the paucity of evidence for agricultural practices (Bar-Yosef and Meadow 1995; Byrd 2000; Gopher and Goring-Morris 1998; Simmons 1981).

However, recent re-investigations at 'Ain Abu Nukhayla, a Middle to Late PPNB site in arid Wadi Rum, southern Jordan, have recovered archaeological evidence for an extensive distribution of residential buildings and diverse subsistence practices, including cereal cultivation and animal herding as well as hunting and foraging (Henry et al. 2003). The site is densely covered with continuous architectural remains, most with curvilinear stone walls arranged in a so-called "beehive structure" (Goring-Morris 1993) or "honeycomb" layout (Kirkbride 1967) (Fig. 2). The walls are preserved up to a metre in height and enclose various features and archaeological deposits with remains such as chipped-stone tools, ground-stone tools, fauna, and botanical materials (Henry et al. 2003). These new archaeological finds from the arid zone may require us to reconsider the socioeconomic variability of Neolithic inhabitants in this zone. The aim of this paper is to obtain insights into the social relations at 'Ain Abu Nukhayla through an examination of how ground-stone tools are distributed in architectural spaces. During excavations at the site, archaeological remains were systematically collected with an emphasis on accurate recording of spatial information, which provides critical database for the spatial analysis in this paper.

Using the results of the spatial analysis of ground-stone tools, I will infer how domestic spaces were used by the inhabitants of 'Ain Abu Nukhayla. Although it is difficult to infer the entire range of domestic activities from the analysis of ground-stone tools, they do suggest several key domestic activities, such as food preparation, tool production, and tool maintenance.

Finally, I will interpret patterns in the use of space with regard to social relations at the site. In particular, I will

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Adherents of this approach assume that architecture and human behaviour are mutually influential, so that architecture constraints human activities to some degree, while human behaviour also contributes to the formation of various aspects of architecture.

discuss the relations among the groups of people who cooperatively conducted several domestic activities associated with ground-stone tools. The discussion focusses on uniformity and variability among the activity groups in terms of architectural traits, the range of domestic activities, and the intensity of food-processing activities. The results of this examination will provide a basis for inferring the social implications of these activity groups.

Approaching prehistoric communities through architecture and behaviour

As I point out in the introduction, Near Eastern archaeologists have often investigated social relations in Neolithic communities by examining architecture and the spatial organization of activities. The architectural attributes they have examined include histories of construction and modification of buildings (Banning and Byrd 1987), floor areas (Banning 1996; Byrd 2000), arrangements and accessibility of spaces (Banning 1996; Banning and Byrd 1989; Flannery 1972: Garfinkel 2002), and compartmentalization of spaces (Kuijt 2000b). The spatial analysis of activities usually involves examining how certain activities, such as tool production, storage, and food preparation, were spatially organized in settlements. The spatial organization of tool-production activities is usually discussed in the context of craft specialization (Conolly 1999; Quintero 1998), while the spatial organization of storage and food preparation is often regarded as indicating inter-household relations or household organizations (Byrd 1994;2000; Flannery 1972; 1993; Wright 2000).

The basis of examining both architecture and activities lies in anthropological theory based on the recursive relationship between architecture and human behaviour (Rapoport 1990) that assumes that architecture and human behaviour are mutually influential. From this perspective, architecture constrains human activities to some degree, while human behaviour also contributes to the formation of various aspects of architecture. I employ this approach to understand and explain the dynamic relationship between archaeological evidence (architecture and ground-stone tools, in this case) and human behaviour (social relations).

Formation processes of architecture and ground-stone tools

Aims of the examination of formation processes

In examining the association between architecture and artifacts, it is critical to separate “floor assemblages” from “house fill”. It is more likely that "floor assemblages" represent direct remains of past activities, while "house fill" probably includes dumped refuse or artifacts tumbled down from a second storey (Cameron 1990; Ciolek-Torrello 1984, Jorgensen 1975; Lowell 1991; Scarborough 1989; Schlanger 1991). However, a number of ethnoarchaeological studies of site-formation processes suggest that various accretion and depletion processes can alter archaeological remains before and after the abandonment of buildings (LaMotta and Schiffer 1999; Schiffer 1972; 1983; 1987). For example, “floor assemblages” can include secondary refuse or structure collapse in addition to de facto or primary refuse, while the “house fill” can contain de facto or primary refuse that resulted from the reuse of abandoned buildings (LaMotta and Schiffer 1999). Moreover, when house floors are made of penetrable materials, such as sand (the case at ‘Ain Abu Nukhayla), the ambiguity of floor surfaces and the artefacts’ vulnerability to post-depositional disturbances makes the spatial delimitation of “floor assemblages” difficult (Schiffer 1983: 690).

To this end, three datasets were examined to delimit “floor assemblages” and to assess their integrity (Fig. 1): (1) the morphological data of ground-stone tools, (2) the vertical and horizontal spatial data of ground-stone tools, shells, and charcoal, and (3) the architectural remains, including the location of hearths, the bottom level of walls, and cobble-pavement floors. In the architectural dataset, the spatial distribution of rubble, which represents collapsed walls or roofs, was also taken into account.

The following section only presents summarized results of this examination of formation processes for two reasons. The first is that analysis of the formation processes of house deposits appears elsewhere in detail (Kadowaki in press). The second is that the focus

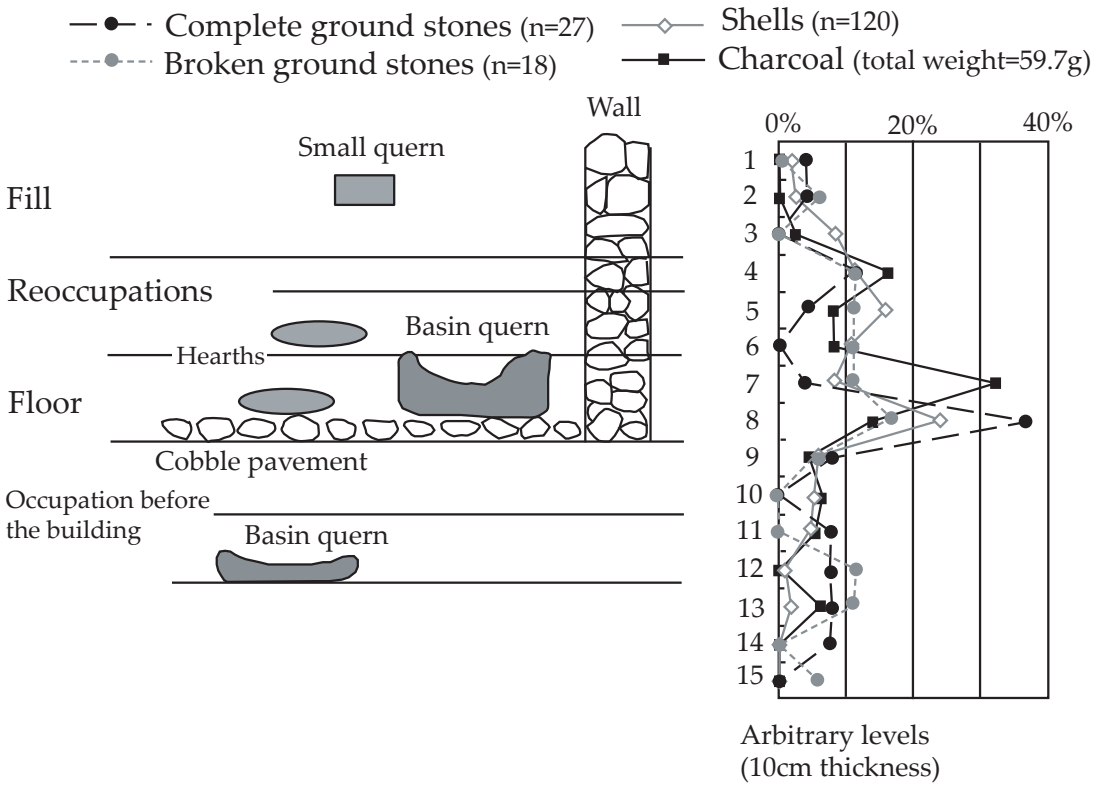

Figure 1: Stratigraphic diagram of house deposits in Locus 20

of this paper is on the next stage of analysis: examining the use of space by analysing the distribution of ground-stone tools that are likely to represent activities performed in the spaces.

Delimitation and assessment of "floor assemblages"

Figure 1 illustrates the stratigraphy of house deposit in Locus 20. On the left of the diagram are depositional phases that were identified through examination of the above three datasets (Kadowaki in press). The three main depositional phases are floor occupation, reoccupation, and fill. However, only the floor occupational phase, described here, is directly relavant to the present study.

Although floors are defined by architectural features, such as pavement, hearths, and the bottom level of walls, the "floor assemblages" need to be delimitated by examining the formation-sensitive attributes of refuse. The refuse recovered in floor levels is generally characterized by a high density of refuse, as seen in the stratigraphic diagram of Locus 20 (Fig. 1). Other characteristics of the refuse in the floor levels are a size-sorted distributional pattern, a high proportion of complete ground-stone tools, and the functional coherence of ground-stone tools (e.g., milling toolkits or pigment-processing toolkits).

However, these characteristics sometimes suffer distortion by several cultural factors, such as subsequent scavenging (at Locus 5), relaxed cleaning activities before the anticipated abandonment of the building (at Loci 5 and 25), or the dumping of refuse into abandoned rooms (at Loci 5 and 25). The close examination of the formation-sensitive attributes of refuse allows us to identify these kinds of depositional events and to assess their influence on the integrity of remaining tool assemblages.

In the next section, I infer the use of space at 'Ain Abu Nukhayla by examining the ground-stone assemblages recovered in the floor levels. When interpreting the use of space, I will also take into account the possible distortions of original ground-stone assemblages during the life-histories of buildings.

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Approaching the use of space from ground-stone tools

Activities indicated by ground-stone tools

For this study, it is critical to know the functions of ground-stone tools. Although it is difficult to reconstruct the specific functions of all the ground-stone tools, some tool types are likely to indi-

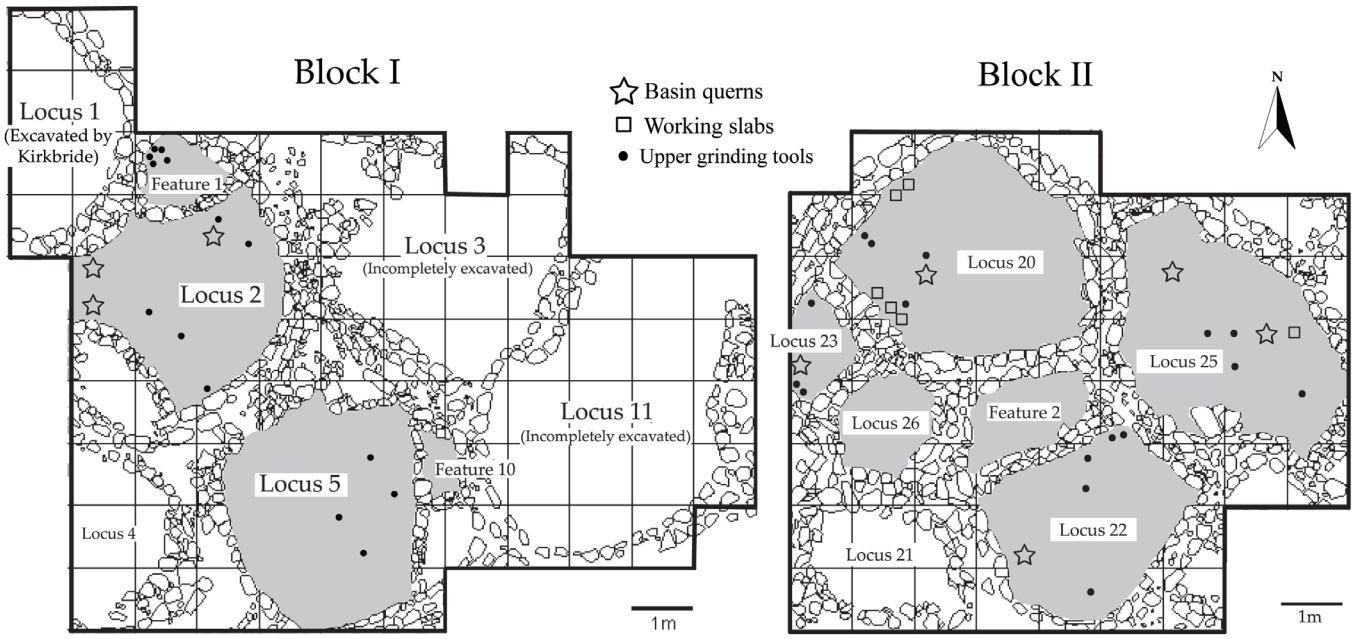

Figure 2: The distributions of complete food-processing tools in loci 2, 5, 20, 22, 23, 25, and features 1, 2, and 10

cate general categories of activities. This analysis classifies ground-stone tools into the following four categories of activities: (1) food preparation, (2) tool manufacture and maintenance, (3) pigment processing, and (4) others.

Food-preparation activities are indicated by several tool types: grinding querns, handstones, mortars, and pestles. The use of these tool types for food processing can be found in a number of ethnographic and archaeological examples (Bartlett 1933; Eddy 1964; Fullagar and Field 1997; Kraybill 1977). Although these tool types can be used for other purposes, such as processing hide (Adams 1988), for pulverizing temper and clay for pottery manufacture (Euler and Dobyns 1983; Rye 1981), for processing pigment, and for sharpening bone artefacts (Schneider 1993), it is reasonable to consider their principal use to have been food preparation. First, these ground-stone tool types developed in the Levant from the late Epipalaeolithic through the Neolithic period, coincident with an intensified exploitation of plant resources and the emergence of agriculture (Wright 1992; 1993; 1994). Second, the frequencies and morphologies of the above tool types at 'Ain Abu Nukhayla show strong similarity to those of food-processing tools at contemporary agrarian villages (Kadowaki 2002). The grinding querns and handstones at these Neolithic agrarian villages are likely to have served for processing plant foodstuffs (Miller 1992; Wright 1992, 1993, 1994).

Tool manufacture and maintenance are indicated by chopping tools, pounders, shaft straighteners, cutmarked slabs, preforms of handstones, and flaked debitage. Chopping tools and pounders are likely to have been used for flaking and pecking activities during the production and maintenance of ground-stone tools. The use of chopping tools and pounders for the production and maintenance of ground-stone tools is supported by ethnographic observations (Hayden 1987; Cook 1973), archaeological remains at prehistoric workshops (Hersh 1981; Hoffman and Doyel 1985; Roubet 1989; Runnel 1981; Schneider 1996), and the experimental manufacture of ground-stone tools (Hersh 1981; Wilke and Quintero 1996). In fact, various ground-stone tools from 'Ain Abu Nukhayla show traces of flaking and pecking on their lateral sides and working surfaces, indicating that flaking and pecking techniques were employed to modify blanks or to rejuvenate grinding surfaces to regain rough texture (Wright 1992: 134-5). This observation is also supported by the recovery of preforms of handstones and flake debitage.

Pigment processing is suggested by the presence of small, red sandstone tablets that show wear facets and abrasive scratches on surfaces. Red pigment is attached to the surfaces of some handstones and other ground-stone tools that were probably used to pulverise pigment.

Functions are unclear for the rest of ground-stone tools, such as ground knives, perforated stones, and worked cobbles and pebbles.

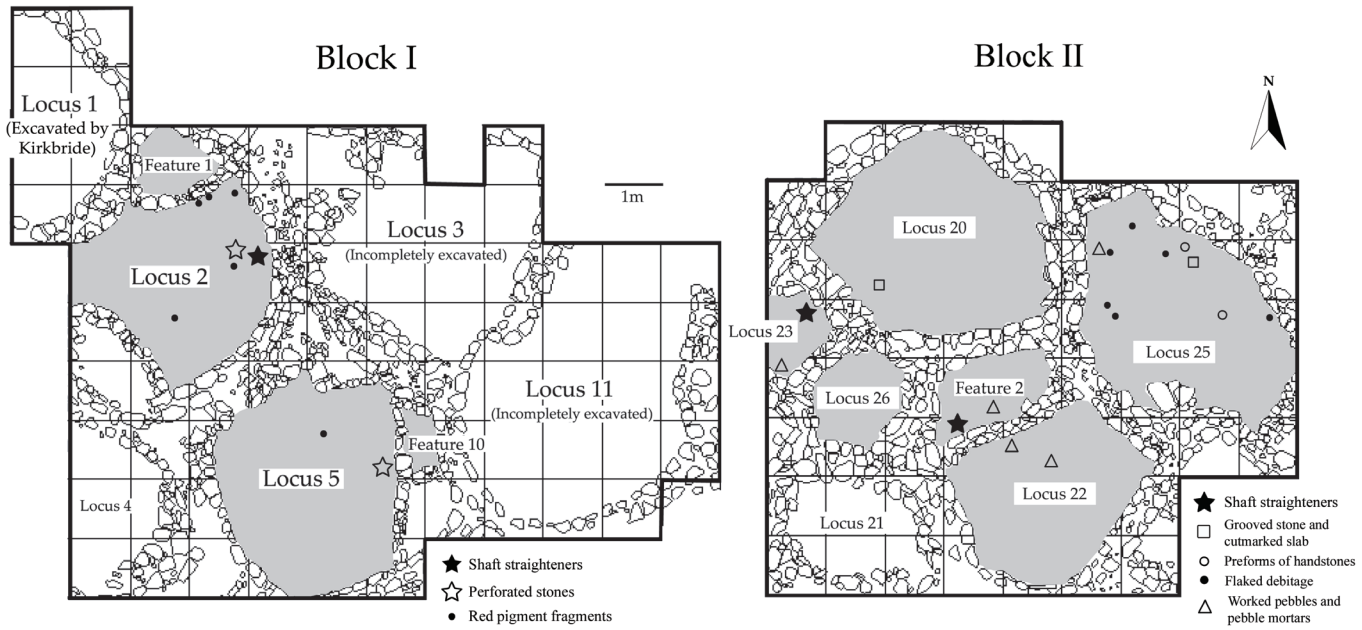

Figure 3: Distributions of various ground-stone tools that indicate activities such as tool manufacture, tool maintenance, and pigment processing

Distribution of ground-stone tools in architectural spaces

Figures 2 and 3 show the distributions of ground-stone tools associated with floor occupations of the buildings. The distributional maps do not include probable secondary refuse (Kadowaki in press). Figure 2 shows the distributions of complete food-processing tools. These tools are distributed in Loci 2, 5, 20, 22, 23, 25, and Feature 1 of Locus 2. The concentration of handstones in Feature 1 of Locus 2 likely represents a cache of handstones. In contrast, no food-processing tools occur in Loci 26, Feature 10 of Locus 5, and Feature 2 of Locus 22.

Figure 3 shows the distributions of various ground-stone tools that indicate activities such as tool manufacture, tool maintenance, and pigment processing. The figure shows that red pigment tablets were recovered in Loci 2 and 5. In the latter locus, the pigment tablet was associated with a broken, perforated stone that was partly covered with stains of pigment, indicating that the tool was used to process the pigment. Locus 2 also contains a perforated stone and a shaft straightener that suggests tool-production activities. Tool production and maintenance are also indicated at Locus 25, which contains flaked debitage and preforms of handstones. Other loci, such as 20, 22, 23, and Feature 2 of Locus 22, also contain some ground-stone tools that indicate tool production and maintenance or other unknown activities. Locus 26 does not contain any ground-stone tools.

Table 1, which summarizes the ground-stone tools recovered at floor levels of various loci, indicates that multiple activities were practiced at some loci, while other loci contain very scarce traces of activities. In the next section, these occurrences of ground-stone tools will be examined in light of architectural attributes, such as floor areas and the occurrence of hearths.

Patterns in the use of space

Figure 4 examines the occurrence of complete ground-stone tools relative to two architectural attributes: floor area and the presence of hearths. This allows us to group the loci into three categories.

The first group of loci includes Loci 2, 5, 20, 22, and 25. These loci are characterized by relatively large floor area, the presence of hearths (except for Locus 5), and large numbers of ground-stone tools that indicate food processing and other kinds of activities, including tool production and pigment processing. These characteristics suggest that this group of loci is likely to represent general activity areas.

In contrast to the first group, loci of the second and third groups are both small in size and lack hearths. These two groups differ from each other in the density of ground-stone tools; the density of ground-stone tools is higher in the second group of loci (Locus 23 and Feature 1 of Locus 2), while loci of the third group (Locus 26, Feature 2 of Locus 22, and Feature 10 of Locus 5) contain only a few or no ground-stone tools. The high density of ground-stone

tools in the second group may represent caching or storage of tools, while the use of the third group of loci is difficult to identify with available data. Two loci in the third group (Locus 26 and Feature 10 of Locus 5) also contain very few chipped-stone tools. The small quantity of refuse from these loci and their small floor areas may indicate their use for storage of other (perishable) materials.

The three groups of loci can be described in terms of their use of space. Spaces of the first group have a relatively large floor area, usually have hearths, and were used for multiple activities, including food preparation, tool production, tool maintenance, and pigment processing. Spaces of the second group are small, lack hearths, and were used for storage of groundstone tools. Although spaces of the third group are also small and without hearths, the small amount of artefacts at these loci suggests their use for storage of other materials.

To summarize, Figure 5 shows the spatial arrangement of loci by function. The three types of loci are spatially arranged in such a way that general activity areas are usually associated with storage, creating recurrent spatial units for multiple activities. For example, Locus 2 and Feature 1 of Locus 2 constitute one unit, while Locus 5 and Feature 10 of Locus 5 belong to another unit. In addition to these relatively clear examples, another unit of loci is formed by Loci 20, 23, and 26. Locus 22 and Feature 2 of Locus 22 also clearly constitute another unit. Locus 25 also appears to constitute a spatial unit with two small loci that are located on its northeastern side.

Implications for social relations at 'Ain Abu Nukhayla

Do recurrent spatial units of domestic activities represent household units?

As pointed out earlier, this paper employs the view that architecture and human behaviour are mutually influential (Rapoport 1990; Steadman 1996). Employing this framework for understanding material culture, the following discussion will focus on the implications of the identification of patterns in the use of space for our understanding of the social relations among the site's inhabitants.

The use of space at 'Ain Abu Nukhayla is characterized by recurrent spatial units of domestic activities, including food preparation, tool production, pigment processing, and storage (Fig. 5). These repetitive spatial units likely represent multiple cooperative groups of people who conducted particular kinds of activities.

These corporate activity groups may correspond to households, which are generally characterized by the practice of various cooperative activities (Wilk and Nettings 1984; Wilk and Rathje 1982), including residence, production, distribution, consumption, inheritance,

Table 1: Inventories of groundstone tools from floor levels; Number of complete tools / Total number of tools on floor

		Activity units									
Activities indicated by groundstone tools	Groundstone tool types	**2**	**2/F01**	**5**	**5/F10**	**20**	**23**	**26**	**22**	**22/F02**	**25**
Food preparation	Grinding slabs and querns	3/4	0	0/1	0	4/6	1/1	0	1/1	0/1	3/4
	Handstones	5/7	5/5	4/6	0	3/7	2/3	0	4/6	0	1/6
	Worked cobbles (upper grinding tools)	0	0	1/1	0	1/1	1/1	0	1/1	0	3/3
Tool production and maintenance	Grooved stones (shaft straightners / cutmarked slabs	1/1	0	0	0	1/1	0/1	0	0	1/1	1/1
	Debitage / handstone preforms	0	0	0	0	0	0	0	0	0	4/8
Pigment processing	Red pigment fragments	5/5	0	1/1	0	0	0	0	0	0	0
	Perforated stones (used in processing pigments)	0	0	1/1	0	0	0	0	0	0	0
Other unkown activities	Perforated stones	1/1	0	0	0	0	0	0	0	0	0
	Pebble mortars	0	0	0	0	0	0	0	1/1	0	0
	Worked pebbles	0	0	0	0	0	1/1	0	1/1	0/1	1/2
	TOTAL	15/18	5/5	7/10	0	9/15	5/7	0	8/10	1/3	13/24
Numbers of complete food processing tools		8	5	5	0	8	4	0	7	0	7
Floor area (m^2)		7.6	1.2	8.9	0.45	10.4	1.4	1.8	6.9	1.9	9.8
Density of food processing tools (number per m^2)		1.1	4.2	0.6	0.0	0.8	2.9	0.0	1.0	0.0	0.7

and child-rearing (Wilk and Nettings 1984; Wilk and Rathje 1982). However, in contrast to this cooperative and homogeneous aspect of households, they also have a conflictive and heterogeneous aspect that is characterized by their internal diversity and dynamic organization (Blanton 1994; Goody 1969; Steadman 1996; Tringham 1991). This heterogeneous aspect is often detectable in the use of space, labour organization, and power relationships among different genders and ages within households (Blanton 1994; Goody 1969; Oetelaar 2000; Tringham 1991). In this way, households can be understood from two contrasting viewpoints: cooperative vs. conflictive or homogenous vs. heterogeneous.

In light of this potential ambiguity in household organization, the archaeological evidence examined in this paper does not allow us to determine whether recurrent spatial units of domestic activities correspond to household units at 'Ain Abu Nukhayla. One spatial unit may represent a single household unit, or one household may be composed of multiple spatial units of activities.

We cannot be certain that the recurrent spatial units of domestic activities directly correspond with household units. The observed spatial units do allow us, however, to approach the groups of people who cooperatively conducted certain kinds of domestic activities, including food preparation, tool production and maintenance, pigment processing, and storage. The occurrence of these activities in architecturally delimitated spaces indicates that different groups conducted tasks autonomously. The group size seems quite small, as indicated by the mean floor area (ca. 8.7m^2) of activity spaces (excluding storage). In addition, these small groups of people appear to have had restricted networks for sharing domestic activities with other groups, as doorways were not preserved, at least in the remaining walls (preserved to heights of 25 to 100 cm).

Comparison among the activity groups

In order to understand the relations among activity groups, it is useful to examine the degree of variation among them on the basis of three material and behavioural characteristics:
(1) architectural traits, (2) the range of domestic activities, and (3) the intensity of food-preparation activities.

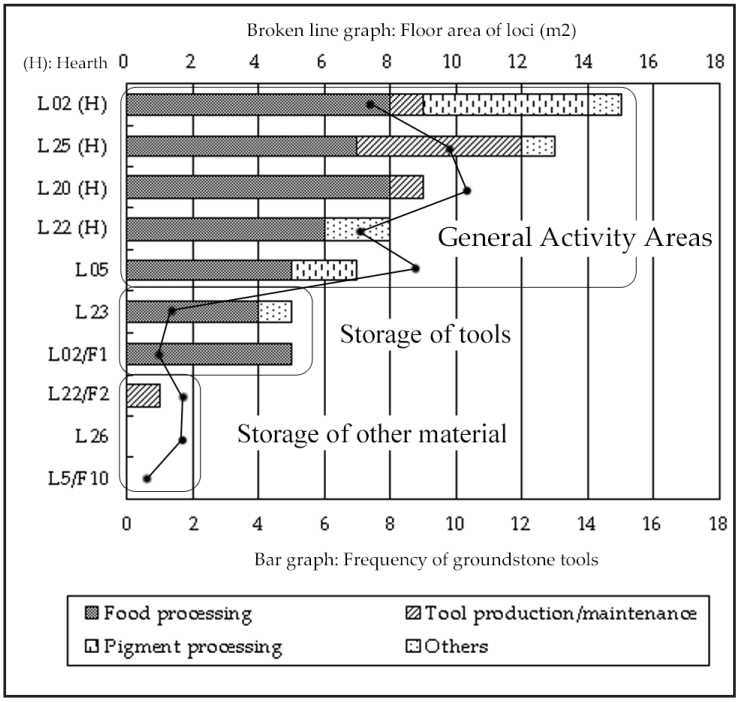

Figure 4: Comparison of the occurrence of complete ground-stone tools with two architectural attributes: floor area and the presence of hearths

Architecture

Several architectural traits indicate uniformity among activity groups. First, most activity areas are delimited by curvilinear stone walls that constitute contiguous rooms of round to semi-circular shape. These rooms are similarly characterized by the absence of doorways, even in walls preserved as high as 100 cm. In addition, the spatial units of activity groups are routinely composed of rooms of two different sizes. The larger rooms may be main activity areas (mean = 8.7 m^2, s = 1.5 m^2), while the smaller rooms likely served for storage (mean = 1.4 m^2, s = 0.6 m^2).

In contrast to these similarities, architectural differences are observable on floor surfaces and internal compartment walls. Cobble pavement occurs at Loci 4, 20, and 25, while others have loose sand floors or a flagstone pavement (Locus 26). Internal compartment walls only occur at Loci 2, 5, and 22.

Range of domestic activities

Although the range of domestic activities indicated by ground-stone tools is limited, food preparation and storage are the primary activities practiced by the groups identified in this study (Table 1). Other activities, such as tool production and pigment processing, were also practiced by the same groups. These activi-

Uniformity in activity groups is observable in house shape, floor size, the absence of doorways, storage, practices of food preparation and tool production, density of food-processing tools, and the design and efficiency of lower grinding tools.

ties are indicated by certain ground-stone tool types, such as shaft straighteners and red pigment fragments, recovered from general activity areas or storage spaces (Table 1). Tool production took place in all activity units except Locus 5, while pigment processing was restricted to Loci 2 and 5.

Intensity of food-processing activities

In order to evaluate the intensity of food-processing activities, I examine the density and the grinding efficiency of food-processing tools, which consist of upper grinding stones (handstones and worked cobbles) and lower grinding stones (grinding slabs and querns). The density of food-processing tools (the number of tools per square metre of floor in the locus, Table 1) is high in storage areas, as seen at Feature 1 of Locus 2 and Locus 23, but these loci are excluded from this analysis because these areas presumably represent tool curation, rather than food-processing activity. I assess the efficiency of food-processing tools by examining the size of grinding areas and the morphological traits of the tools. Experimental uses of manos (upper grinding tools) indicate that larger grinding surfaces allow greater grinding efficiency (Adams 1998; Mauldin 1993). In addition, flat working surfaces of grinding slabs allow more efficient grinding than concave surfaces of basin querns (Adams 1998; Eddy 1964). I assume that the intensity of food processing is proportional to the efficiency of the tools (Adams 1996: 35-6).

Density of food-processing tools

As Table 1 shows, the densities of food-processing tools vary little among the general activity areas, ranging from 0.6 to 1.1 tools/m^2. Among these, Loci 5 and 25 have the lowest densities of food processing tools (0.6 and 0.7 tools/ m^2).

However, the analysis of formation processes suggest that some food-processing tools are likely to have been removed from Loci 5 and 25. Two grinding querns appear to have been scavenged during the subsequent reoccupation at Locus 5 and relocated to the upper levels. With these two grinding querns included, the density of food-preparation tools in Locus 5 increases to 0.8 tools/ m^2. Likewise, the recovery of only one handstone at Locus 25 may have resulted from the removal of handstones after occupation. Post-depositional disturbance of Locus 25 is indicated by the shallow deposit above the floor levels and the random distribution of tools in the floor levels (Kadowaki in press). To summarize, the food-processing loci appear to have a uniform density of food-preparation tools.

Design and grinding efficiency of upper grinding tools

Table 2 shows the proportions of the various types of upper grinding tools recovered from the food-processing loci. Here, I assume that worked cobbles and irregular handstones are less efficient than regularly shaped handstones, such as loaf-shaped, oval, rectilinear, and discoidal handstones. Locus 2 is distinct from other loci in the use of only regularly shaped handstones, while other loci include both regular and irregular handstones or worked cobbles (Locus 5, 20, 22, and 25). The higher proportion of regular handstones in Locus 2 may indicate more efficient food processing at this locus than in others.

Differences in the size of upper grinding tools among the loci also suggests different grinding efficiency between Locus 2 and other loci (Table 2). Handstones from Locus 2 are longer than those from other loci, although this difference does not show statistical significance.

In sum, the design of upper grinding tools varies between activity groups. In particular, the upper grinding tools of Locus 2 are larger and more regularly shaped than those of other loci, indicating greater grinding efficiency at Locus 2.

Design and grinding efficiency of lower grinding tools

Basin querns are associated with all the food-processing loci, except for Locus 5, where the querns were probably scavenged after its abandonment. Loci 20 and 25 also include working slabs. As shown by a t-test, the working surfaces of the slabs in Loci 20 and 25 (Mean area = 1731 cm^2, s = 495.5 cm^2) are significantly larger than those of the basin querns in other loci (Mean area = 763 cm^2, s = 204.8; t = -5.56, df = 13, $p < 0.01$). Thus, these working slabs may have allowed more efficient grinding at Locus 20 and 25 than in other

		L 02 (n=5)	L 05 (n=5)	L 20 (n=4)	L 22 (n=5)	L 25 (n=4)
Worked cobbles		0 %	20%	25%	20%	75%
Handstones (irregular forms)		0 %	20%	0%	20%	0%
	Rectilinear	0 %	20%	0%	0%	0%
Handstones	**Discoidal**	60 %	20%	25%	20%	0%
(regular forms)	**Oval**	20 %	20%	50%	40%	0%
	Loaf	20 %	0%	0%	0%	25%
TOTAL		100%	100%	100%	100%	100%
Length (mm)	**Mean**	126.8	99.2	112.0	114.3	102.5
	Standard deviation	36.0	33.0	24.1	23.8	43.7

Table 2: Proportions of various types of upper grinding stones recovered at food-processing loci

activity areas. However, these working slabs are scarcely modified, while the basin querns show extensive production traces, such as flaking and pecking scars. In addition, the flat surfaces of the working slabs do not show clear grinding traces, such as striations that are clearly visible on the working surfaces of the basin querns. These observations suggest that the primary use of the slabs was not for grinding food. Thus, despite their large size and flat surfaces, the working slabs from Locus 20 and 25 do not indicate a significant difference in the grinding intensity between these loci and the other food-processing loci.

To summarize, the design of lower grinding tools appears fairly consistent among the activity areas except for the occasional occurrence of working slabs. However, these slabs do not seem to have contributed primarily to food preparation.

Summary

The above examination compared the activity groups by focusing on three aspects: architecture, the range of domestic activities, and the intensity of food processing activities. The analysis identified several differences among the activity groups in floor surfaces, compartment walls, evidence for pigment processing, and the design and efficiency of upper grinding tools.

Despite these points of variability, uniformity among the groups appears more prominent. This uniformity is observable in house shape, floor size, the absence of doorways, the occurrence of storage, practices of food preparation and tool production, the density of food-processing tools, and the design and efficiency of lower grinding tools.

In sum, the activity groups identified through examination of the use of space is characterized by strong uniformity but some variation with regard to architectural traits, the range of domestic activities, and the intensity of food preparation.

Social implications of the activity groups

At 'Ain Abu Nukhayla there were fairly uniform groups for certain domestic activities, including food processing, tool production and maintenance, pigment processing, and storage. This inference is based only on ground-stone tools recovered in domestic spaces, which do not reflect all the activities that the site's inhabitants conducted. Other archaeological remains indicate a wider range of activities, including hunting, animal herding, cereal cultivation, production of chipped-stone tools and shell beads, and building construction. Some of these activities may have been carried out by the same activity groups identified in the examination of ground-stone tools, while others may have involved different social grouping.

Despite this limited view of activities practiced at the site, the autonomous practices of some domestic activities could be explained in terms of social processes in two ways: (1) the privatization of activities and (2) the fission of activity groups.

The first explanation involves a shift in the organization of activities from communal work to practices by individuals or small groups. This privatization process involves several domestic activities, including food preparation and storage. Some authors suggest that this process progressed during the Pre-

The patterns detected in the use of space may allow two possible explanations regarding the social processes at the site: the privatization of activities and the fission of activity groups.

Pottery Neolithic period in the Near East (Flannery 1993, 2002; Wright 2000). Moreover, this process is consistent with Byrd's argument that social networks for sharing domestic activities decreased among households at the PPNB settlement of Beidha (Byrd 1994). A similar process of social change may explain the autonomous practices of some domestic activities by small activity groups at 'Ain Abu Nukhayla.

In contrast, the second explanation suggests that the activity groups may have resulted from periodic fission of groups in their developmental cycle (Goody 1969). Based on his ethnographic observations, Goody suggests that groups of people who share a residence or certain activities split periodically in accordance with changes in their composition due to the birth, aging, and death of group members (Goody 1969). Banning and Byrd (1987) used this anthropological observation to explain the sequence of architectural renovations at 'Ain Ghazal in the Middle PPNB. This developmental cycle of domestic or activity groups might also explain the repetitive occurrences of spatial units for domestic activities at 'Ain Abu Nukhayla.

Thus, the patterns detected in the use of space allows for two possible explanations regarding the social processes at the site: (1) the privatization of activities and (2) the fission of activity groups. These two explanations operate over different time scales. The privatization process occurred over the PPNB period, while the fission of activity groups occurred over a shorter time, such as a generation. Therefore, it is possible that both social processes took place concurrently among the inhabitants of 'Ain Abu Nukhayla.

These social explanations need to be substantiated with more evidence in future research. For example, the privatization process of activities will need to be re-examined by analyzing the labour organization of a wider range of activities, including animal herding and the production of chipped-stone tools. In addition, we could obtain deeper insights into the developmental cycle of domestic groups through closer examination of the sequences of the construction and modification of residential buildings.

When conducting these further analyses, it is also important to consider the prehistoric built environment at a single moment. This built environment can be approached through examination of the site-formation processes and life-histories of building remains. For example, at 'Ain Abu Nukhayla (Kadowaki in press), some abandoned buildings were later reused as outside activity areas. Moreover, the proposed presence of outdoor activity areas implies the patchy distribution of contemporary houses in the settlement (see also Verhoeven, this volume). This suggestion is particularly significant at 'Ain Abu Nukhayla because of its settlement layout with a so-called "beehive structure" (Goring-Morris 1993), in which curvilinear buildings are densely distributed with no spaces between them. Despite this dense distribution of houses as archaeological residues, I suggest that the prehistoric built environment at 'Ain Abu Nukhayla was characterized by a patchy distribution of occupied houses with outdoor areas that facilitated movement and interaction among inhabitants. In sum, the high compartmentalization of space at the site is likely the result of the accumulation of successive building phases over a long period of time, while the prehistoric inhabitants of the site probably experienced a more open built environment.

Conclusion

This paper examines the use of space at 'Ain Abu Nukhayla, a PPNB settlement in the arid marginal zone, through the spatial analyses of architecture and activities inferred from ground-stone tools. The proposed use of space is characterized by the repetitive occurrence of spatial units for several domestic activities, including storage, food processing, tool production and maintenance, and pigment processing (Fig. 5). It is difficult to determine the relationship of these recurrent spatial units for domestic activities to household units because of the potential variability of household organizations. However, these recurrent units of spatial activity, delimited by architecture, still indicate that groups of people autonomously conducted certain kinds of domestic activities.

Finally, the social implications of these uniform activity groups are that two social processes were at work: (1) the privatization of activities, and (2) the fission of activity groups. The former

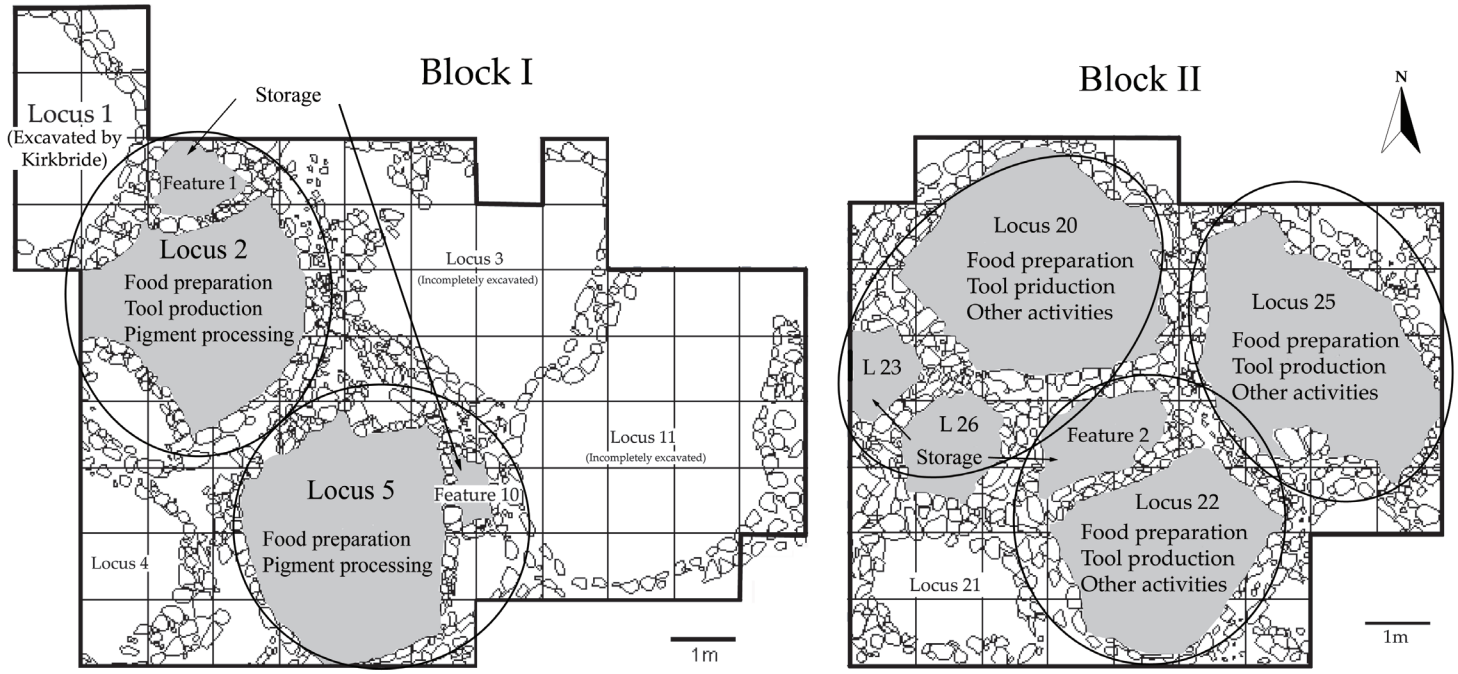

Figure 5: Domestic activities include storage, food processing, tool production and maintenance, and pigment processing

process principally represents long-term change in labour organization for production and consumption, and has been suggested by several archaeologists who examined the spatial organizations of architecture and domestic activities in Neolithic sites in the Levant (Byrd 1994; Flannery 1993, 2002; Wright 2000). In contrast, the fission of activity groups occurred over a shorter period, such as a generation, according to the developmental cycle of domestic groups (Goody 1969).

These two social implications need to be further examined in future. It is particularly necessary to continue research on the labour organization of other activities, such as the production of chipped-stone tools and animal herding, and on the sequences of the construction and modification of residential buildings. It is also important to consider the prehistoric built environment at a single moment by examining the life histories of buildings (Kadowaki in press). Several lines of further research are necessary better to illustrate social relations at 'Ain Abu Nukhayla and compare them with those at other Neolithic settlements in the Mediterranean zone. To this end, examinations of architecture, the use of space, and site-formation processes may remain useful analytical methods.

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