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Ground Stone Tools, Refuse Structure, and the Life Histories of Residential Buildings at Ayn Abū Nukhayla, Southern Jordan

Seiji Kadowaki

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The examination of site-formation processes is essential to dtaw plansible interpretations about the relationship between space and past human behavior. This is because archaeological remains are usually the result of complicated accretion and depletion processes before and after the abandonment of artifacts or building structures (LaMotta and Schiffer 1999). Thus, taphonomic analyses of artifacts and buildings are critical for the reliable reconstruction of prehistoric practices aud the built environment (Hodder and Cessford 2004; Quintero 1998; Verhoeven 1999; Wright 2000).

This paper aims to examine the life histories of residential buildiugs at Ayn Abū Nukhayla, a late-middle Pre-Pottery Neolithic B (PPNB) site in southern Jordan (Fig. 15.1; Henry *et al.* 2003), in an attempt to obtain an accurate picture of the relationship between the built euvironment and domestic activities. The aualysis of architectural life histories is particularly significant at this site because the buildings are densely distributed in the settlement with apparently no open space between houses (Figs. 15.2 and 15.3). The curvilinear buildings abut each other, and adjacent buildings often share the same walls. This settlement layout is called a 'beehive structure' (Goring-Morris 1993) or a 'houeycomb' layout (Kirkbride 1967) in the southern Levant, and characteristically appears during the PPNB period (approximately from 9,600 to 8,000 uncalibrated BP). The height of preserved building walls at Ayn Abū Nukhayla is 25–100 cm (Henry *et al.* 2003), and the absence of entrances indicates that they may have been located at higher levels or on a roof.

From these circumscribed spaces, a vatiety of artifacts and ecofacts were recovered, indicating that various domestic activities were conducted in private indoor spaces. The presence of hearths and partition walls in most buildings also supports this idea (Henry *et al.* 2003). Thus, the built environment at Ayn Abū Nukhayla appears highly compartmentalized, and the most daily practices of households seem to have been conduced in intimate, less visihle settings (Joyce and Hendon 2000: 155).

This preliminary picture of the on-site landscape at Ayn Abū Nukhayla appears similar to those at other mid to late PPNB settlements, such as 'Ain Jammam, Ba'ja, Basta, Beidha, and 'Ain Ghazal, where the highly compartmentalized built enviroument accommodated the habitual use of interior spaces for domestic activities (Banning 1996; Kuijt 2000; Kuijt and Goring-Morris 2002; Rollefson 1997; Wright 2000). However, there are several significant differences between Ayn Abū Nukhayla and other contemporary settlements. For example, the mean floor area at Ayn Abū Nukhayla (ca. 10 sq m) is smaller than those settlements (20–30 sq m), where the typical residential buildings

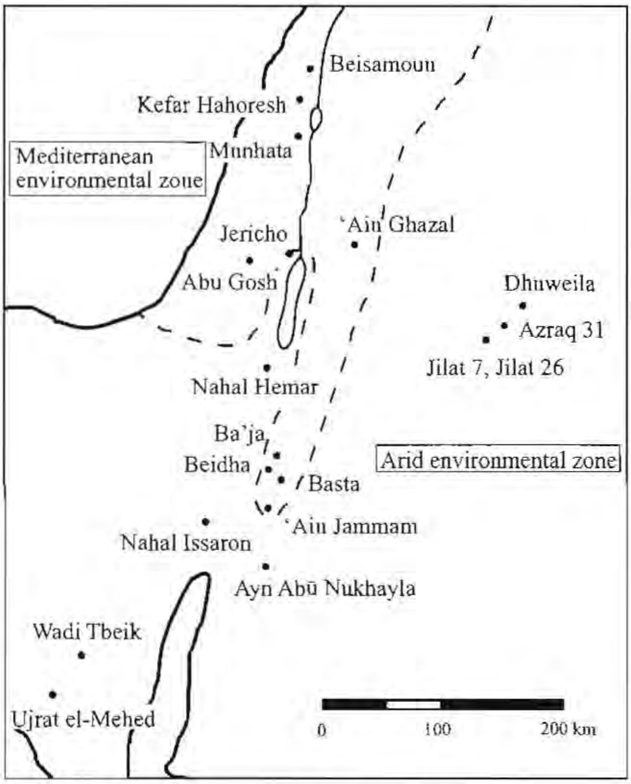

Figure 15.1 Map of the southern Levant showing Pre-Pottery Neolithic B sites mentioned in the text and an approximate boundary (dashed line) between the Mediterranean and arid environmental zones.

likely had two stories (Banning 1996). Moreover, the people at Ayn Abū Nukhayla appear to have been more dependent on hunting and foraging than the inhabitants of the latter sites despite the probable use of domesticated plants (barley) and animals (sheep and goats) (Henry *et al.* 2003). Finally, if inhabitants at Ayn Abū Nukhayla practiced seasonal transhumance between the site and the Ma'an plateau (at the southern edge of the Mediterranean environmental zone: see Fig. 15.1), their settlement system must have been different from those of more sedentary agricultural villages in the northern areas (Henry *et al.* 2003). These overall differences probably reflect adaptation to the arid environmental conditions around Ayn Abū Nukhayla in contrast to the other sites located in the Mediterranean environmental zone (Fig. 15.1; Henry *et al.* 2003).

The above differences in architecture, subsistence, and settlement systems between Ayn Abū Nukhayla and other contemporary villages indicate the heterogeneous nature of the PPNB culture in the southern Levant. Given this overall picture, it should be worthwhile delving into the built environment and the use of spaces at Ayn Abū Nukhayla in order to clarify its place in the PPNB culture. To this end, this paper aims to reconstruct the life histories of residential buildings through the spatial analysis of refuse, including ground stone tools.

One way of examining the formation processes of residential buildings would be to separate 'floor assemblages' from 'house-fill', based on the assumption that the former is more likely to represent direct remains of past activities, while the latter deposit probably includes dumped refuse or artifacts tumbled down from the second story (Cameron 1990; Ciolek-Torrelo 1984; Jorgensen 1975; Lowell 1991; Scarborough 1989; Schlanger 1991). However, numerous formation-process studies suggest the effects of various accretion and depletion processes on archaeological remains before and after the abandonment of buildings (LaMotta and Schiffer 1999; Schiffer 1972; 1983; 1987). 'Floor assemblages' can include secondary refuse or structure collapse in addition to *de facto* or primary refuse, and the 'house-fill' can contain *de facto* or primary refuse resulting from the reuse of abandoned buildings (LaMotta and Schiffer 1999). Moreover, when honse floors are made of penetrable materials, such as sand (the case at Ayn Abū Nukhayla), the spatial delimitation of 'floor assemblages' is difficult because of the ambiguity of floor surfaces and the artifacts' vulnerability to post-depositional disturbance (Schiffer 1983:690). From this perspective, I examine the refuse structure of entire bouse-deposits according to 10 cm arbitrary levels to clarify the depositional processes of residential huildings instead of employing *a priori* distinction between 'floor assemblages' and 'house-fill'.

The datasets consist of 1) breakage patterns of ground stone tools, 2) vertical and horizontal spatial distribution of ground stone tools, shells, and charcoal fragments, and 3) architectural contexts, such as the location of hearths, cobbled floors, and the bottom level of walls. The spatial distribution of rubble resulting from the collapse of walls or roofs is also taken into account.

According to LaMotta and Schiffer (1999), a structure's life history can be largely divided into three stages: habitation, abandonment, and post-abandonment. In each stage of the life history, various kinds of accretion and depletion processes can take place. Under this general framework, I clarify depositional processes of residential buildings through the examination of the above dataset.

Analytical Framework: A Brief Review of Formation Process Studies

Ground Stone Tools as Refuse

As mentioned in the introduction, this study aims to clarify the formation processes of house-deposits. Specifically, the breakage patterns of ground stone tools and the spatial distributions of ground stone tools, shells, and charcoal will be examined in light of architectural contexts. However, these archaeological remains do not represent the total site assemblage. The examination of chipped stone tools and animal bones are in progress (Henry *et al.* 2003) altbough their data are not used in this study.

In contrast to the use of chipped stone tools (Behm 1983; Clark 1986; 1991; Schiffer 1983; Stevenson 1985) or pottery (Bradley and Fulford 1980; Cameron 1990; Deal 1985; Scarborough 1989; Tani 1995) for the identification of site-formation processes, less attention seems to have been paid to ground stone tools. If the principles of least-effort are useful in understanding the abandonment processes (LaMotta and Schiffer 1999:22), large and bulky ground stone tools are likely left behind as *de facto* refuse because of the large transport costs. However, it is also possible that formal milling tools, such as grinding slabs, mortars, handstones, and pestles, are transported or scavenged away because of their high replacement cost, as indicated by experimental manufacturing studies (Wilke and Quintero 1996) and ethnographic observations (Euler and Dobyns 1983; Hayden 1987). In fact, examples of scavenging and transportation of grinding slabs exist at several archaeological sites in the American Southwest (Adams 1998; Schlanger 1991).

Thus, one cannot easily regard the general bulkiness of ground stone tools as indication of *de facto* refuse. On the contrary, a number of studies about refuse-discard behavior suggest that larger, heavier and more obstructive objects are likely to be removed from activity areas, such as the vicinity of hearths or building floors (Binford 1978; Clark 1986; 1991; Hayden and Cannon 1983; Kuijt 1989; LaMotta and Schiffer 1999; Murray 1980; Schiffer 1983; 'The McKellar Hypothesis', 1987; Simms 1988). In light of this observation, large and bulky ground stone tools are generally more likely to be a target of cleaning activities, in particular, if activity areas have multiple purposes (Tani 1995; see below).

There are, nevertheless, abundant archaeological sites where ground stone tools, particularly grinding slabs, are recovered on floor surfaces, indicating that they were left as *de facto* refuse (Brooks 1993; Byrd 1994; Schiffer 1983; Wright 2000). This phenomenon raises a question originally asked by Binford and Schiffer: '[T]o what extent can remains at a site be expected to occur at their use locations as opposed to any other, when found in archaeological context?' (Schiffer 1972:161). What factors affect inhabitants' decision-making about refuse disposal? This question will be discussed in the next section.

Activity-Area Maintenance as Cultural Formation Processes

Tani (1995) argues that two kinds of factors, i.e. refuse components and activity components, determine the structure of cultural formation processes. The refuse components involve properties such as size, hazardousness, and obtrusiveness.

Tani stresses the importance of activity components, which influence the decision-making about activity-area maintenance. According to him, cultural formation processes 'can generally be arranged along the axis of intensity of activity area maintenance' (Tani 1995:238), the practice of which includes various refuse-disposal behaviors, such as dropping, tossing, dumping, placing, and provisional discard. He then emphasizes the relationship between the occurrence of activity-area maintenance and the activity organization, which is represented by intensity, duration, and diversity of activities. He suggests that as the intensity, duration, and diversity of activities increases at activity areas, they receive more frequent maintenance or cleaning (Tani 1995:240–2). This suggests that we can obtain insights into activity organization at a site through the investigation of refuse-management behavior. Specifically, Tani raises three aspects of site occupation, i.e. the occupation span, the number of occupation episodes, and the location of activities, which can be inferred from the examination of refuse characteristics, or 'refuse structure'.

Tani's argument is derived from Schiffer's suggestion (1972:161–2) that refuse-discard behavior in sedentary villages differs from that in limited activity locations, such as kill/butchering sites and quarry sites. This observation is supported by a number of ethnoarchaeological investigations on the variability of refuse-management activities in terms of various behavioral factors, including anticipated duration of site occupation (Kent 1991), site functions (Bartram *et al.* 1991; Clark 1991), mobility patterns (O'Connell 1987), the degree of sedentism (Murray 1980), and abandonment modes (Brooks 1993; LaMotta and Schiffer 1999:22–4).

In light of this argument, one might ask how we can obtain the traces of refuse-discard behavior. At the onset of formation-process studies in early 1970s, Schiffer pointed out the importance of spatial dimensions of formation processes (Schiffer 1972:160–1). He states that 'the various stages and processes of an element's systemic context should be reflected spatially' (Schiffer 1972:161), indicating the significance of the spatial analyses of archaeological remains.

Analysis of the Spatial Structure of Refuse

Schiffer points out the underdeveloped situation of the spatial examination of refuse for the identification of depositional processes (Schiffer 1983:685; 1987:280–1). He specifically states that 'even recent compilations of techniques of intrasite spatial analysis fail to consider the contributions of formation processes to artifact distributions' (Schiffer 1987:281). However, spatial analyses of refuse distribution increased after that remark. For example, the studies in Kroll and Price (1991) analyze intrasite spatial organization with attention to site-formation processes. Several ethnographic studies in that volume examine the relations between observed spatial organization of activities and their resultant spatial patterns of material remains (Bartram *et al.* 1991; O'Connell *et al.* 1991). Carr's examination (1991) of the horizontal distribution of chipped stone tools, bone fragments, and red ochre at Pincevent habitation No. 1 aims to critically incorporate Binford's (1980) discard-behavior model into the exploratory empirical analysis of the archaeological record. Binford's model is also used by Stapert and Street (1997) to detect the traces of Paleolithic huts based on the distribution of lithic scatters around hearths. Thus, intra-site spatial analyses of archaeological remains are becoming an essential component to achieve 'high definition archaeology' (Gowlett 1997).

It should he noted, however, that most spatial analyses for site-formation processes are conducted for open-air sites whether they are ethnographic or archaeological studies. In contrast, spatial analyses of refuse in house-deposits seem relatively underdeveloped. The latter studies usually focus on the examination of refuse recovered from pre-determined 'floor' or 'house-fill' contexts (Brooks 1993; Cameron 1990; Ciolek-Torrelo 1984; Scarborough 1989; Schiffer 1983:694–6; Schlanger 1991). For example, several functional studies of Pueblo rooms use the sherd density of room-fill as an indicator of secoudary refuse disposals (Ciolek-Torrelo 1984; Lowell 1991); the rooms with high sherd density are classified as early abandoued rooms, while the rooms with low sherd density are regarded as retaining the integrity of the systemic context. However, this approach seems too simplistic given a variety of accretion or depletion processes that cau affect the nature of floor assemblages (LaMotta and Schiffer 1999).

It may be true that 'house-fill' is likely to include secondary refuse, artifacts tumbled down from the second story, or ritual refuse, particularly in pithouses in the American Southwest (Cameron 1990; Ciolek-Torrelo 1984; Jorgensen 1975; LaMotta and Schiffer 1999:24; Lowell 1991; Scarborough 1989; Walker 1995). If this is the case, spatial patterns of refuse in 'house-fill' may only show disposal patterns of secondary refuse or a random pattern of roof collapse. However, this expectation may not be correct for other cases hecause the refuse management is a culturally constructed behavior, and it varies in different spaces and times (Lightfoot *et al.* 1998).

As noted in the introduction, numerous studies of formation processes strongly suggest that the conventional distinction between the 'floor assemblage' and the 'house-fill' does not necessarily mean the systemic integrity of the former remains (LaMotta and Schiffer 1999). '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 as a result of the reuse of abandoned buildings (LaMotta and Schiffer 1999). Therefore, it is essential to conduct spatial analyses of refuse for the entire house-deposits in order to clarify the formation processes of building structures.

Several recent studies of the formation process of midden deposits show that the close examination of the spatial structure of refuse can help us identify specific cultural behaviors or socio-economic events that result in refuse-dumping episodes (Lightfoot *et al.* 1998; Needham and Spence 1997). I suggest that spatial analyses of house-deposits can also provide us with critical evidence to identify individual episodes of refuse accretion or depletion processes, a better understanding of which should provide us with detailed pictures of activity events that took place in a structure's life history (LaMotta and Schiffer 1999).

Spatial Analysis of Refuse Structure and the Life Histories of Residential Buildings

Data and Methods of Spatial Analysis

The following analysis examines the refuse structure of house-deposits in order to clarify the depositional processes that took place in a structure's life history. The datasets consist of 1) breakage patterus of groundstone tools, 2) vertical and horizontal spatial data of ground stone tools, shells, and charcoal fraguients, and 3) architectural contexts, including the location of hearths, the bottom level of walls, aud cobbled floors. The spatial distribution of rubble resulting from the collapse of walls or roofs is also taken into account. Brief descriptions of these datasets are given below

Table 15.1 Inventory of ground stone tools from Ayn Abū Nukhayla.

Wright's tool types	Block I		Block II		Total
	# of tools	% of complete tools	# of tools	% of complete tools	
Grinding Slabs/Querns	27	51.9%	22	72.7%	49
Mortars	2	50.0%	2	100.0%	4
Handstones	64	65.6%	67	47.8%	131
Pestles	2	100.0%	2	50.0%	4
Pounders	1	100.0%	1	100.0%	2
Polishing Pebbles	0	NA	2	50.0%	2
Worked Pebbles and Cobbles	13	69.2%	57	71.9%	70
Ground Axes and Celts	1	0.0%	5	60.0%	6
Grooved Stones	1	100.0%	8	75.0%	9
Perforated Stones	3	33.3%	2	0.0%	5
Debitage	2	100.0%	19	52.6%	21
Unidentifiable ground stone fragments	1	1.0%	4	25.0%	5
Total, Mean % of complete tools	*117*	*61.0%*	*191*	*58.8%*	*309*

Ground Stone Tools, Shells and Charcoal Fragments

The assemblage of ground stone tools consists of more than 300 specimens, and the tool types are dominated by handstones (42.5%), worked pebbles/cobbles (22.7%), and grinding querns/slabs (15.9%) (Table 15.1; for rool typologies, see Kadowaki 2002; Wright 1992). Handstones, some of the worked cobbles, and grinding querns/slabs are food processing tools with the first two types functioning as upper grinding tools and the grinding querns/slabs functioning as lower grinding tools. Other types of gronnd stone tools include small mortars, pestles, chopping tools, ground knives, grooved stones, and perforated stones. Grooved stones include shaft straighteners and cutmarked slabs. Perforated stones consist of connterpoise weights and a single spiudle whorl.

Table 15.1 also shows that the substantial portion of ground stone tools were broken (ca. 40% on average). Based on the assumption that potentially usable complete tools may have undergone different discard processes than broken tools, I will compare the spatial distribution between complete and broken tools.

The size of gronnd stone tools varies from large grinding querns (around 50 cm in length) to small worked pebbles and pigment (3-5 cm in length), but most tool types measure from 10 to 15 cm in length.

A large number of shells were recovered (ca. 450 specimens). All shells were imported to the site for the production of beads, and are quite small (around 1 cm) compared to ground stone tools.

All pieces of charcoal fragments are also small (less than 1 cm), and ca. 160 pieces were recovered with their spatial data.

I chose these three artifactual types because most ground stone tools are distinctively larger than shells and charcoal fragments. Based on the above argnments regarding cultural formation processes, particularly, activity-area maintenance (Schiffer 1983:679; Tani 1995), I hypothesize that the size difference among refuse affected the inhabitants' disposal practices and refuse management, which can be detected in the distributional patterns of refuse.

Spatial Data

The vertical distribution of archaeological remains was recorded according to arbitrary 10 cm levels. Figure 15.4 illustrates the vertical distributions of ground stone tools, shells, and charcoal fragments recovered in house-deposits. The percentage represents the proportion of the number of items in each level to the total number of items in the entire house-deposit. These diagrams show the relative densities of refuse at different levels.

The horizontal distribution of archaeological remains was recorded by each quadrant (50 cm square), the smallest unit of excavation grids. The horizontal distribution of large ground stone tools, such as grinding querns/slabs, handstones, and worked cobbles, was also photographed at the site to make precise distributional maps. Figures 15.5–15.11 show the horizontal distributions of ground stone tools, shells, and charcoal fragments at different levels.

Architectural Context

Architectural remains provide secure contextual data to identify depositional processes since they are immovable (Schiffer 1972:161). Figures 15.4–15.11 show stratigraphical and horizontal locations of architectural remains. House floors are easily recognized when they are associated with architectural features, such as cobble pavements, stoue-built platforms, and hearths. The matrix of house-deposits at Ayn Abū Nukbayla is loose sand, which also composes building floors unless floors are paved by cobbles. Thus, when a cobble pavement is abseut, it is difficult to detect floor surfaces, and floor levels are esrimated by the presence of hearths and stone-built platforms and the bottom level of walls. Only one hearth was lined with stones, and others were composed of the concentration of fire-cracked stones and dark ashy soil. In addition to hearths on floors, two hearths were recovered within house-fill, neither stone-lined.

Figure 15.12 shows the horizontal distribution of rubble recovered from house-deposits. Rubble from different levels is sbown on the same map, and some levels in house-deposits are devoid of rubble. This was confirmed by referring to site photographs during excavations.

Refuse Structure of House-Deposits

I examine the refuse structure of house-deposits according to each building (called Locus) and each internally subdivided space (called Feature). Among twelve loci and six features revealed by excavations at Block I and II, nine loci and two features have been analyzed; Locus 02, Feature 1 of Locus 02, Locus 4, and Locus 5 are located in Block I, and Locus 20, Locus 21, Locus 22, Feature 2 of Locus 22, Locus 23, Locus 25, Locus 26 are located in Block II (Figs. 15.2 and 15.3). Analyses of other loci and features are in progress. The following describes five loci (Loci 2, 5, 20, 22, and 25) and one feature (Feature 2 of Locus 22).

Locus 02. As shown in Figure 15.4, level 8 is characterized by the high density of ground stone tools and charcoal, while shells are present in moderate quantity. Level 8 corresponds to the bottom level of building walls. Figure 15.5 shows that three grinding querns at level 8 are located near the walls and so are most other ground stone tools. In contrast, shells are distributed in the center of the room although the pattern is not clear because of the small sample size. The quantity of charcoal is also too small to show a clear distributional pattern. However, there is a size-sorting in the horizontal distribution of refuse; only ground stone tools are distributed at the periphery of the room. A similar size-sorted distributional pattern is detected at level 7. Three ground stone tools recovered at level 7 are all distributed at the northeast corner of the room, overlapping the distribution of tools at level 8, indicating that the tools at level 7 belong to the same assemblage at level 8. These spatial data suggest that level 8 corresponds to the initial occupational surface of Locus 2. The size-sorted distribntional pattern may represent a result of activity-area maintenance. It is also notable that same tool types are distributed in clusters, e.g. pigment, handstones, and grinding querns. The high proportion of complete tools (84%) indicates that most tools still retain utility and thus are not likely to be secondary refuse. The refuse structure at level 8 (and its continuation to level 7) strongly indicates that the tools in this deposit are likely to represent *de facto* refuse.

Levels 5 and 6 are associated with a hearth. They contain a relatively large quantity of shells, a few ground stone tools, and one piece of charcoal (Figs. 15.4 and 15.5). All ground stone tools

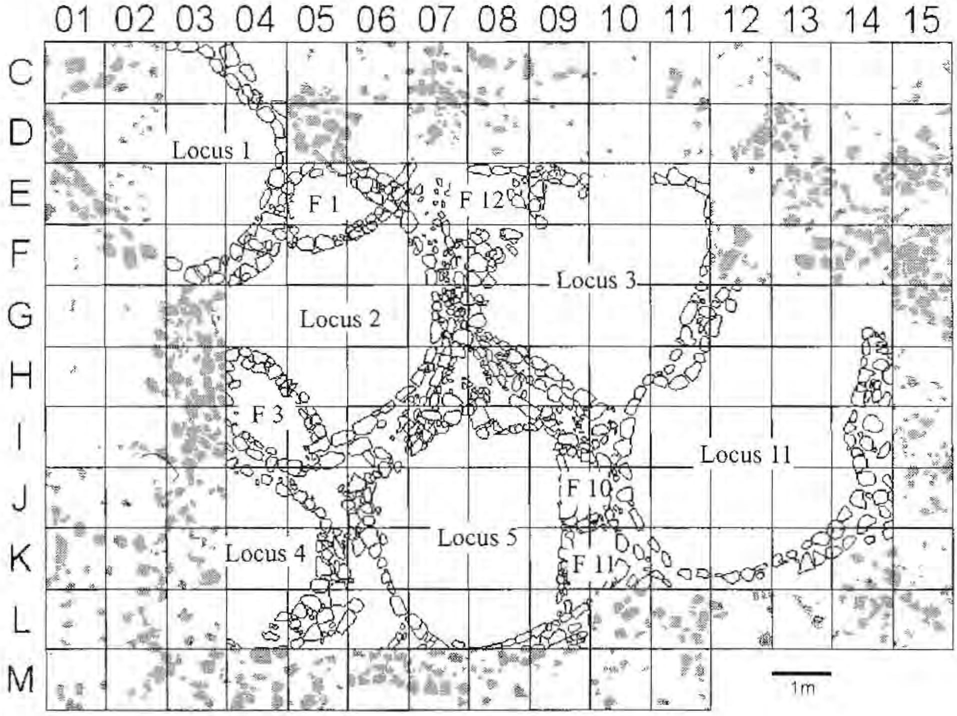

Figure 15.2 Building plan map at Block I at Ayn Abū Nukhayla (after Henry *et al.* 2003).

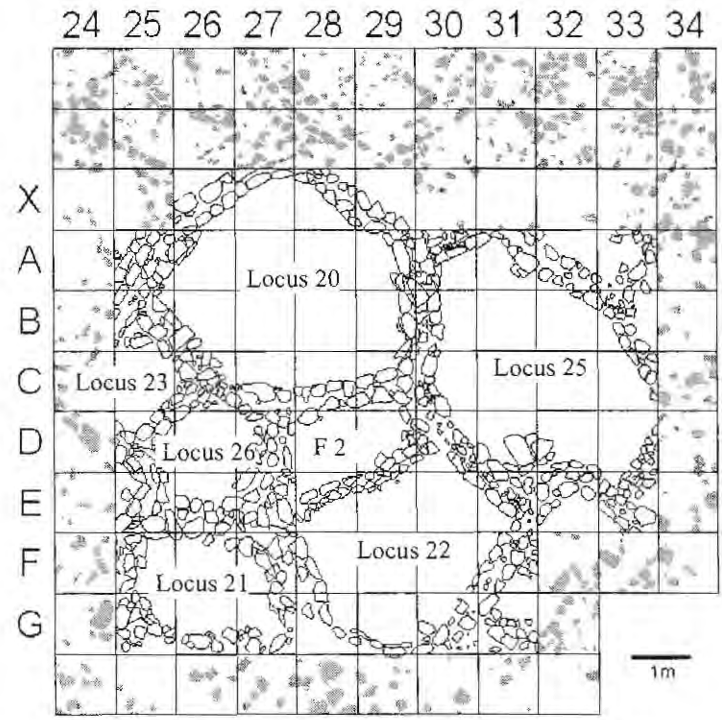

Figure 15.3 Building plan map at Block II at Ayn Abū Nukhayla (after Henry *et al.* 2003).

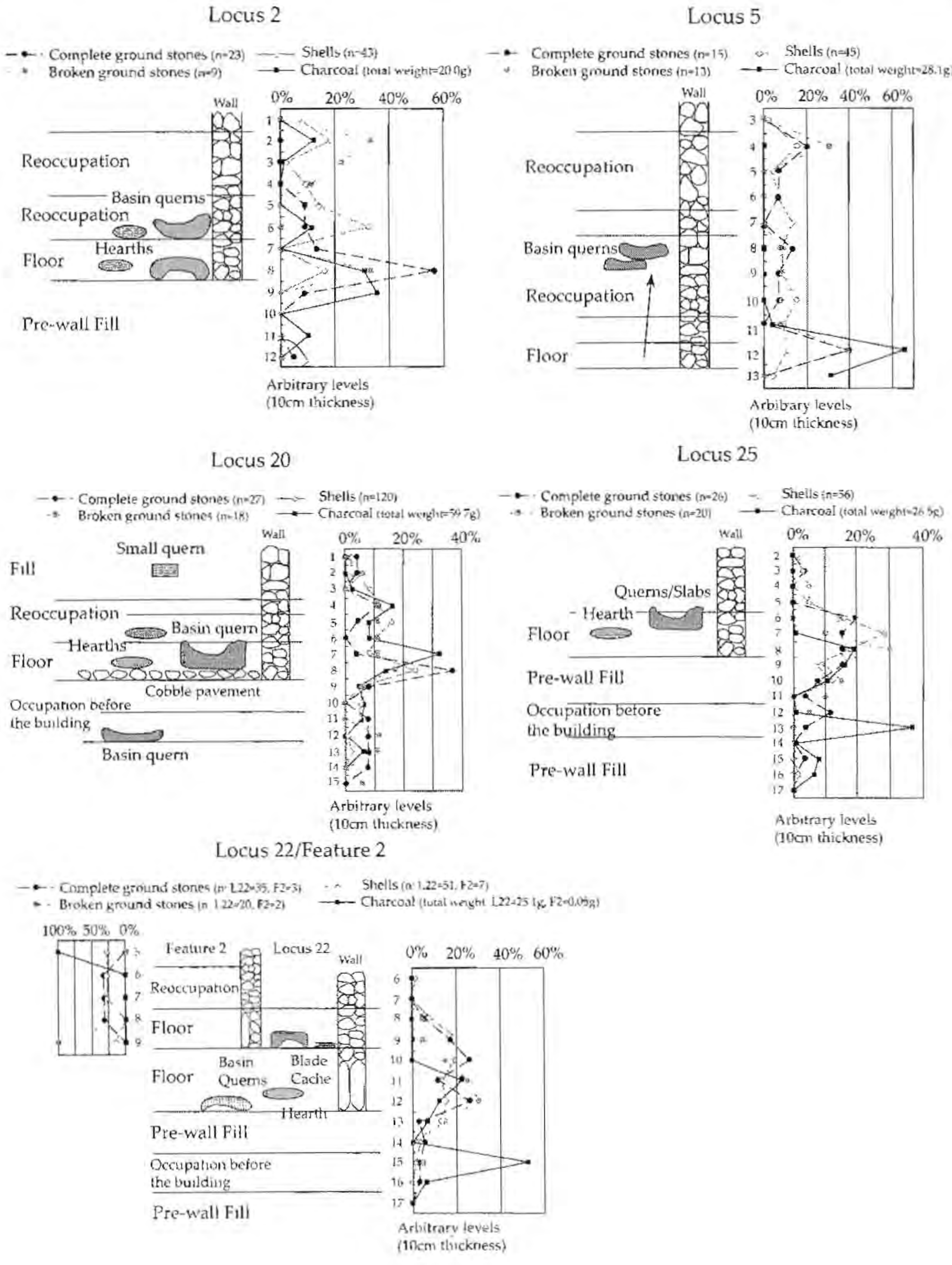

Figure 15.4 Stratigraphical diagrams of house-deposits at Ayn Abū Nukhayla.

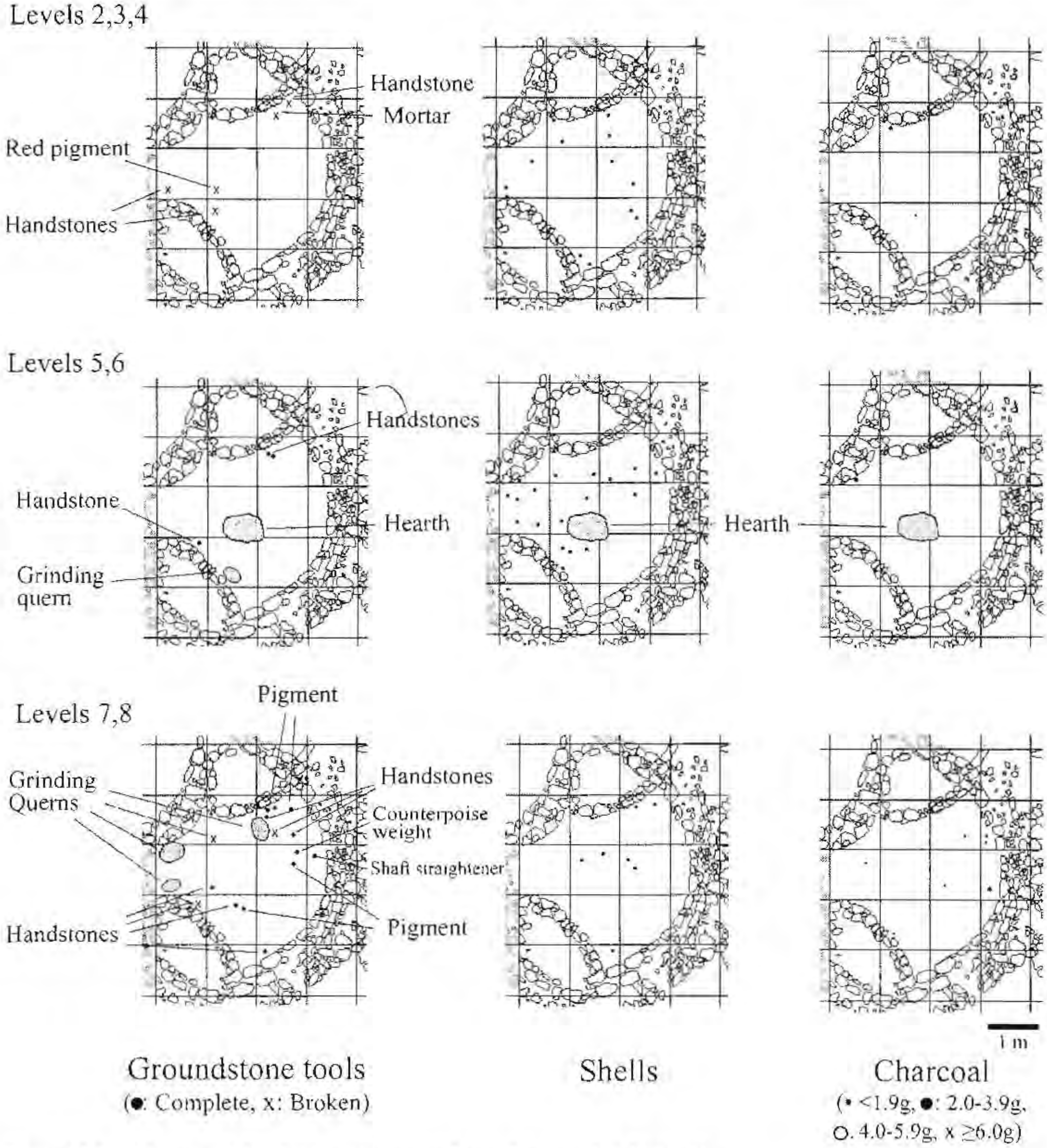

Figure 15.5 Horizontal distribution of refuse at Locus 2 in Ayn Abū Nukhayla.

are complete and consist of handstones and one grinding quern, probably representing a milling tool kit. As shown in Figure 15.5, they are distributed close to the building walls, while shells are more widely distributed. This size-sorted pattern is very similar to what was detected at level 8, suggesting a result of activity-area maintenance. It is unlikely that the deposits of levels 5 and 6 are the continuation of floor-fill because they are separated from the floor-fill of level 8 by the deposit of level 7 that contains rubble and very few archaeological remains. The establishment of a new hearth also indicates that the building was reoccupied at levels 5 and 6 during the post-abandonment period.

Levels 2, 3, and 4 contain moderate quantities of ground stone tools, shells and charcoal fragments. Figure 15.4 shows that the high density of refuse is located at level 2. In contrast to the underlying layers, ground stone tools from these levels are all broken, indicating their low utility and the secondary nature of depositional processes. However, the horizontal distribution of refuse shows a clear size-sorted pattern with ground stone tools located at the periphery of the room and shells widely distributed (Fig. 15.5). How can we explain this apparently contradictory phenomenon? I suggest two possibilities. The first is the disposal of ground stone tools as secondary refuse near the walls. The second scenario is that ground stone tools were intentionally placed at the periphery of the room to clear the activity space whether the ground stone tools are *de facto* refuse or secondary refuse discarded before the cleaning activities. At this point, it is difficult to determine which formation process is true, but the observation of rubble distribution appears to favor the second possibility. Figure 15.12 shows that Locus 2 contains less rubble than its neighbor loci (3 and 5). This may have resulted from activity-area maintenance of Locus 2.

Locus 5. The high densities of ground stone tools and charcoal characterize level 12, which is located at the bottom level of building walls (Fig. 15.4). This level is most likely to represent the floor of this building. The ground stone tools at this level are composed of upper grinding tools (handstones and worked cobbles) and a pigment-processing toolkit (pigment and a perforated stone with red stains of pigment). There are no grinding querns/slabs despite the abundance of handstones. One or both of the grinding querns at level 8 may have been scavenged from level 12 for reuse (Fig. 15.4). At level 12 the horizontal distribution of refuse (Fig. 15.6) shows no size-sorted distribution for ground stone tools, shells, and charcoal, indicating the absence of activity-area maintenance, although other lines of evidence strongly indicate that this level corresponds to the floor. Three possible depositional processes may explain this phenomenon. The first is that the scavenging for the grinding querns at level 12 also disorganized the original spatial arrangement of ground stone tools at this level. The second scenario is that the abandonment of this building had been planned in advance, and the practice of activity-area maintenance was relaxed (Brooks 1993; Tani 1995). The third possibility is the disposal of secondary refuse, which is also indicated by the relatively low proportion of complete tools (55%; 62% even if scavenged querns are included).

Level 11 contains very little refuse and separates the floor-fill at level 12 from the overlying deposits (Figs. 15.4 and 15.6). Levels 8, 9, and 10 are combined together because the deposits at these levels are likely to have accumulated under the same formation process. The ground stone tools include only food processing implements with handstones and grinding querns. They are clustered near the west wall except for one quern fragment, apparently secondary refuse. Interestingly, shells also appear to be distributed in a cluster at the northwest side of the room although their distribution is still wider than that of ground stone tools. This correspondence of horizontal distribution between ground stone tools and shells appears to be related to the distribution of rubble (Fig. 15.12). Tumbled large wall-stones are distributed at the east side of the room, especially in units J8, J9, K8, K9, leaving clear space at the west side of the room. How can we explain this situation? Two lines of evidence indicate that the open space devoid of rubble was used for some activities. First, the retrieval of grinding querns from level 12 suggests the purpose of their reuse. Second, four handstones, two complete, are associated with the grinding querns. This interpretation also explains the distribution of shells avoiding a rubble-strewn area because they would be distributed more randomly if they had been dumped as secondary refuse.

Level 7 contains very little refuse, separating the deposits at levels 8, 9, and 10 from the overlying layers at levels 4, 5, and 6. As shown in Figure 15.4, level 4 has higher densities of ground stone tools and shells than levels 5 and 6. These three levels were lumped together because of the horizontal proximity of ground stone tools, shown in Figure 15.7. Four out of eight ground stone tools are broken, including querns and handstones, while the four complete tools include a pestle, a small

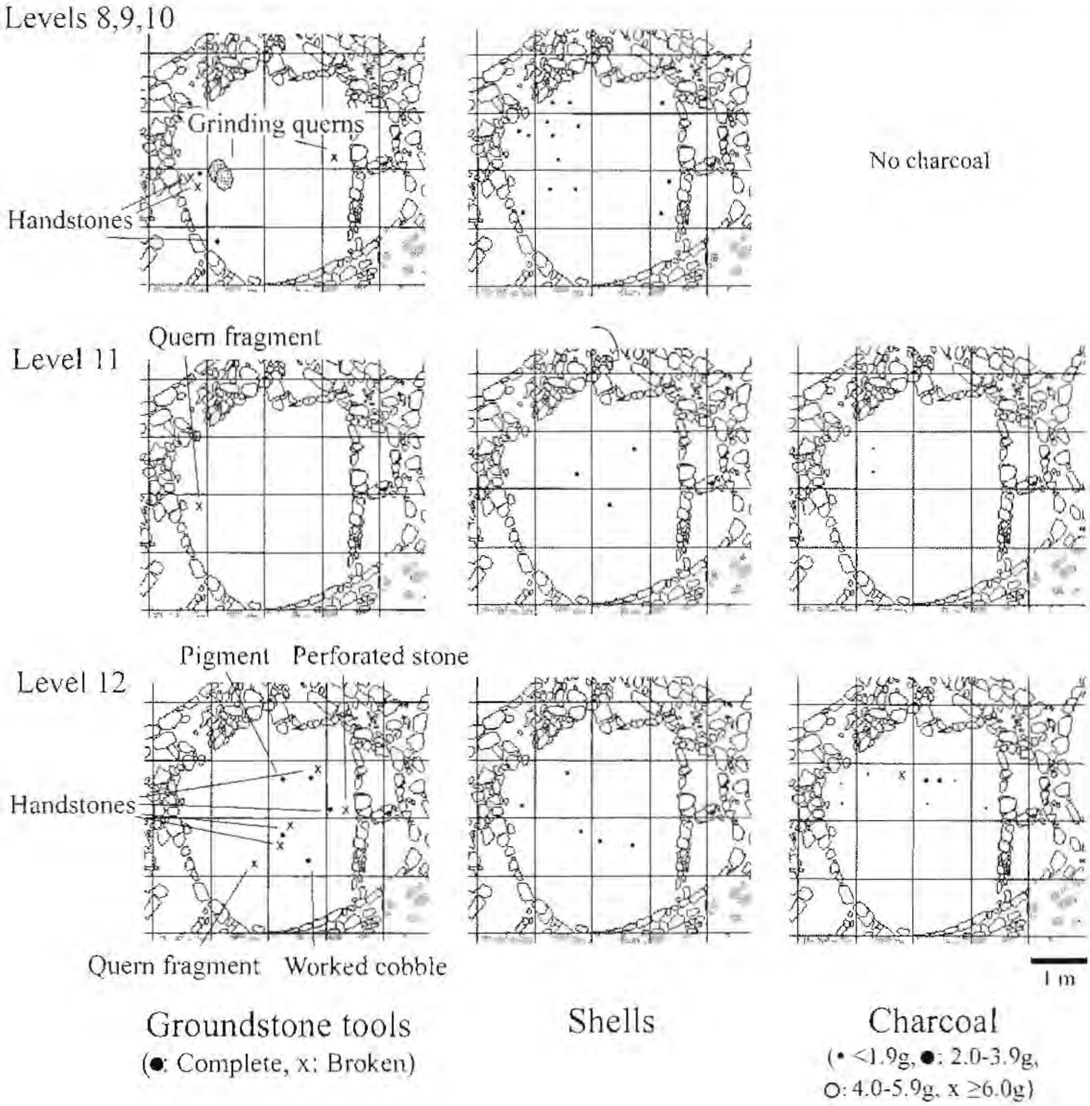

Figure 15.6 Horizontal distribution of refuse at Locus 5 in Ayn Abū Nnkbayla.

mortar, and two handstones. All were located near the northwest wall except for one small mortar found near the wesr wall. Shells are more widely distributed although they avoid a rubble-strewn area in the east. This spatial relationship between ground stone tools, shells, and rubble is quite similar to the pattern at levels 8, 9, and 10. However, a significant difference between these two groups of levels is that the ground stone tools at levels 4, 5, and 6 appear to include more secondary refuse as indicated by broken querns and handstones. Despite this possibility of the inclusion of secondary refuse, the reoccupation of the building is still indicated by the occurrence of complete tools with functional concordance, i.e. a pestle, a mortar, and handstones, and a size-sorted distribution of refuse avoiding a pile of rubble.

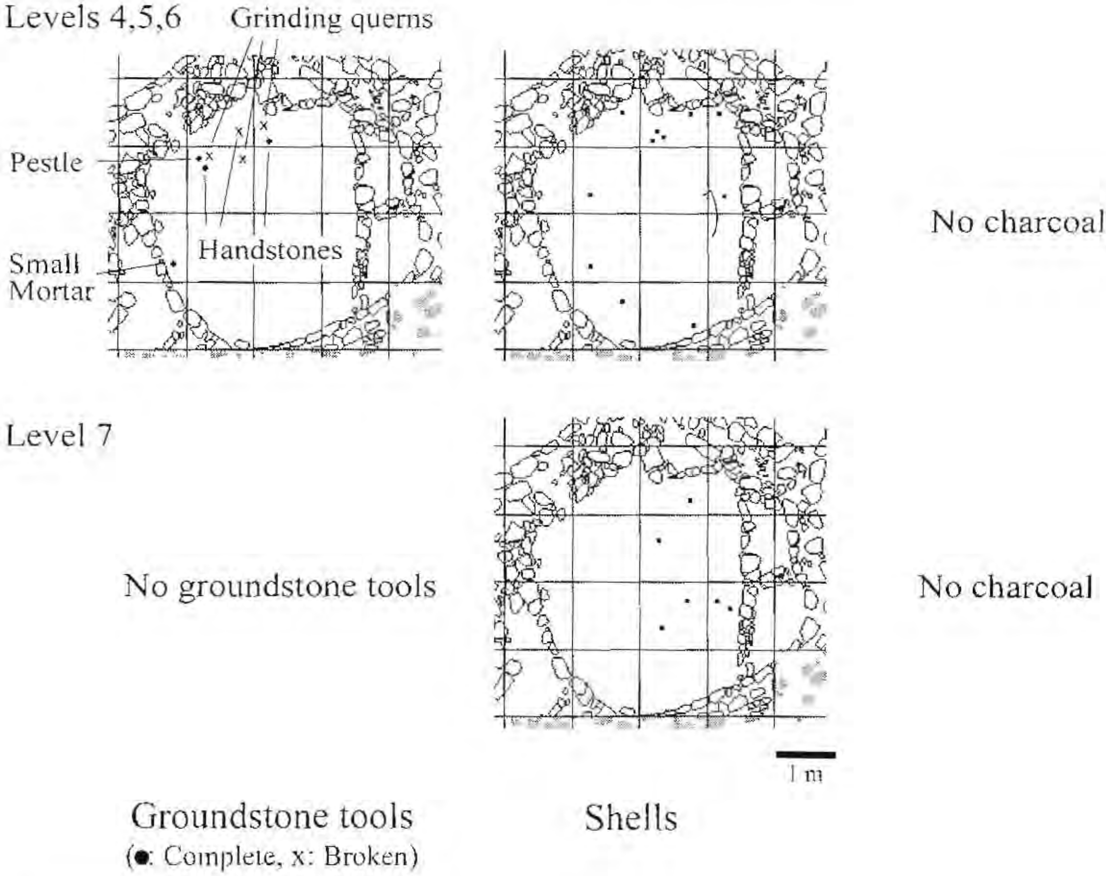

Figure 15.7 Horizontal distribution of refuse at Locus 5 in Ayn Abū Nukhayla (continued).

Locus 20. As shown in Figure 15.4, the building floor is located at levels 7 and 8, which are associated with a cobbled floor, a stone-lined hearth and the high density of ground stone tools, shells and charcoal. The densities of ground stone tools and shells decline at level 7, indicating that the main occupational surface is located at level 8. The ground stone tools predominantly consist of food processing implements with one cutmarked slab, and many are complete (ca. 70%). As Figure 15.8 shows, all ground stone tools, whether complete or broken, are located at the west side of the room, most along the building walls at both sides of the hearth. It also appears that complete and broken tools are located separately. This spatial pattern and the functional concordance of ground stone tools (i.e. milling toolkits) indicate a good preservation of their systemic integrity. Moreover, the wide distributions of shells and charcoal fragments as opposed to ground stone tools strongly indicate the occurrence of activity-area maintenance (Fig. 15.8).

Levels 5 and 6 contain moderate quantities of ground stone tools, shells, and charcoal as shown in Figure 15.4. Although these levels are located close to the floor level, they are likely to represent a reoccupation of Locus 20 because a new hearth was established at level 6, and the horizontal distribution of ground stone tools at levels 5 and 6 do not overlap with that at the floor level (Fig. 15.8). The small number of ground stone tools with the high proportion of broken specimens indicates that they are depleted *de facto* refuse (Brooks 1993; LaMotta and Schiffer 1999; Tani 1995) or the secondary refuse that was put aside to clean the area for activities around the hearth. In

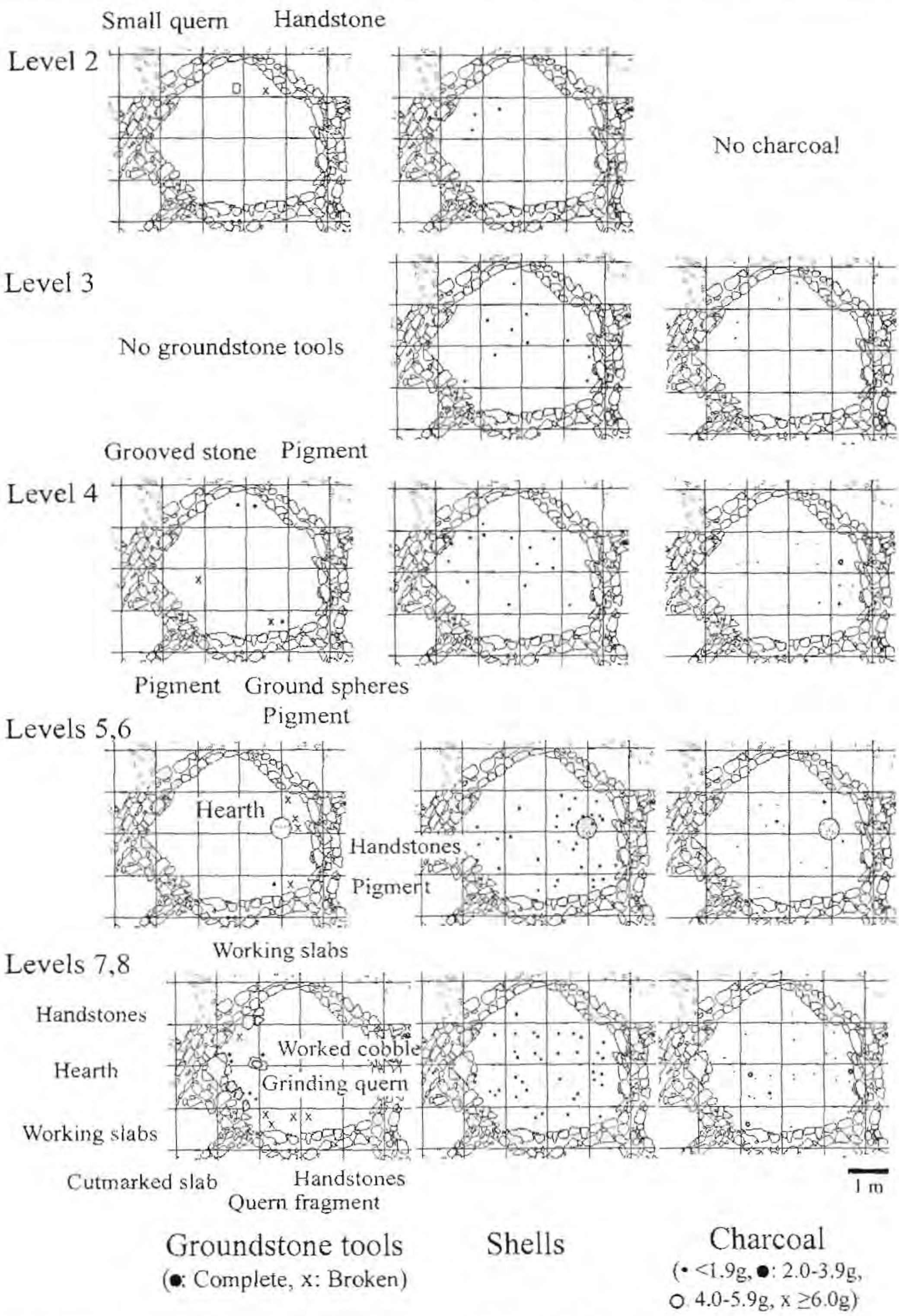

Figure 15.8 Horizontal distribution of refuse at Locus 20 in Ayn Abū Nukhayla.

either case, however, a size-sorted horizontal distribution of ground stone tools, shells, and charcoal indicates cleaning activities at these levels.

Level 4 is similar to levels 5 and 6 in terms of the densities of ground stone tool, shell, and charcoal (Fig. 15.4). All ground stone tools are located near the walls, while shells and charcoal are more widely distributed (Fig. 15.8). This size-sorted distribution may indicate activity-area maintenance although the small quantity of ground stone tools and the absence of a hearth render evidence for reoccupation less obvious. However, the sparse distributions of ground stone tools, shells, and charcoal at the southwest corner of the room, where collapsed wall-stones are strewn, supports reoccupation (Fig. 15.12; units B26, B27, and C27). This avoidance of rubble-strewn areas may indicate that clean space was selectively used for some activities.

Levels 3 and 2 contain very little refuse (Fig. 15.4), and it is difficult to point out a meaningful spatial pattern of refuse (Fig. 15.8).

Locus 22 and Feature 2 of Locus 22. As shown in Figure 15.4, the densities of ground stone tools and shells are continuously high from levels 12 to 9, but several lines of evidence indicate the presence of two different floors. The upper floor at level 9 corresponds to the bottom level of a partition wall and contains a grinding quern and a blade cache. The lower floor is associated with a hearth and a stone-built platform that stands on level 12. The collapsed wall-stones found in level 10 and 11 indicate an occupation hiatus after the abandonment of the lower floor.

At level 12, most ground stone tools are located close to the building walls whether they are complete or broken, while shells and charcoal are distributed in the middle of the room (Fig. 15.9). At level 11, several ground stone tools are distributed in the middle of the room, but half of them are small worked cobbles (3–5 cm), and the other two are broken, probably representing dumped refuse. At level 10, most ground stone tools are distributed near the east wall although a small cutmarked slab and a handstone are located near the hearth in the middle of the room. It is, however, likely that they are intrusions from the upper floor at level 9 since their positions exactly follow the southern side of the partition wall at level 9. Collectively, the horizontal distribution of ground stone tools at levels 10, 11, and 12 indicates that most ground stone tools are located at the periphery of the room in contrast to shells and charcoal, suggesting a result of activity-area maintenance. Although several ground stone tools appear to be located in the center of the room at levels 10 and 11, they are either the intrusions from the upper floor, small in size, or broken.

Levels 8 and 9 show a clear size-sorted distributional pattern between ground stone tools and shells (Fig. 15.10). Both complete and broken tools are located near the building walls, indicating the occurrence of activity-area maintenance. In addition to this, the high proportion of complete tools (80%) and the functional concordance of tool types, i.e., handstones and a grinding quern, suggest that they represent *de facto* refuse.

Levels 6 and 7 are partially preserved at Locus 22 (Fig. 15.10), and a large volume of rubble is distributed at the two levels (Fig. 15.12). In contrast, levels 6 and 7 at Feature 2 are almost devoid of rubble and contain two complete handstones and one working slab, which are located close to the walls (Fig. 15.10). Although it is not clear that the working slab functioned as a lower grinding tool, its association with handstones indicates that they were used together as a toolkit at these levels.

Locus 25. As shown in Figure 15.4, levels 6, 7, and 8 correspond to the bottom level of walls and are characterized by the high densities of ground stone tools and shells. The density of charcoal is high at level 8. Figure 15.11 shows that ground stone tools at levels 7 and 8 are distributed at the periphery of the room except for one broken worked pebble at level 7 and a broken preform of handstone at level 8, both of which are likely secondary refuse tossed into the abandoned room. In contrast, shells appear to be more widely distributed, indicating cleaning activities at the floor.

In contrast, level 6 is characterized by the concentration of food processing implements at the center of the room (Fig. 15.11). The functional concordance of complete ground stone tools (i.e. a

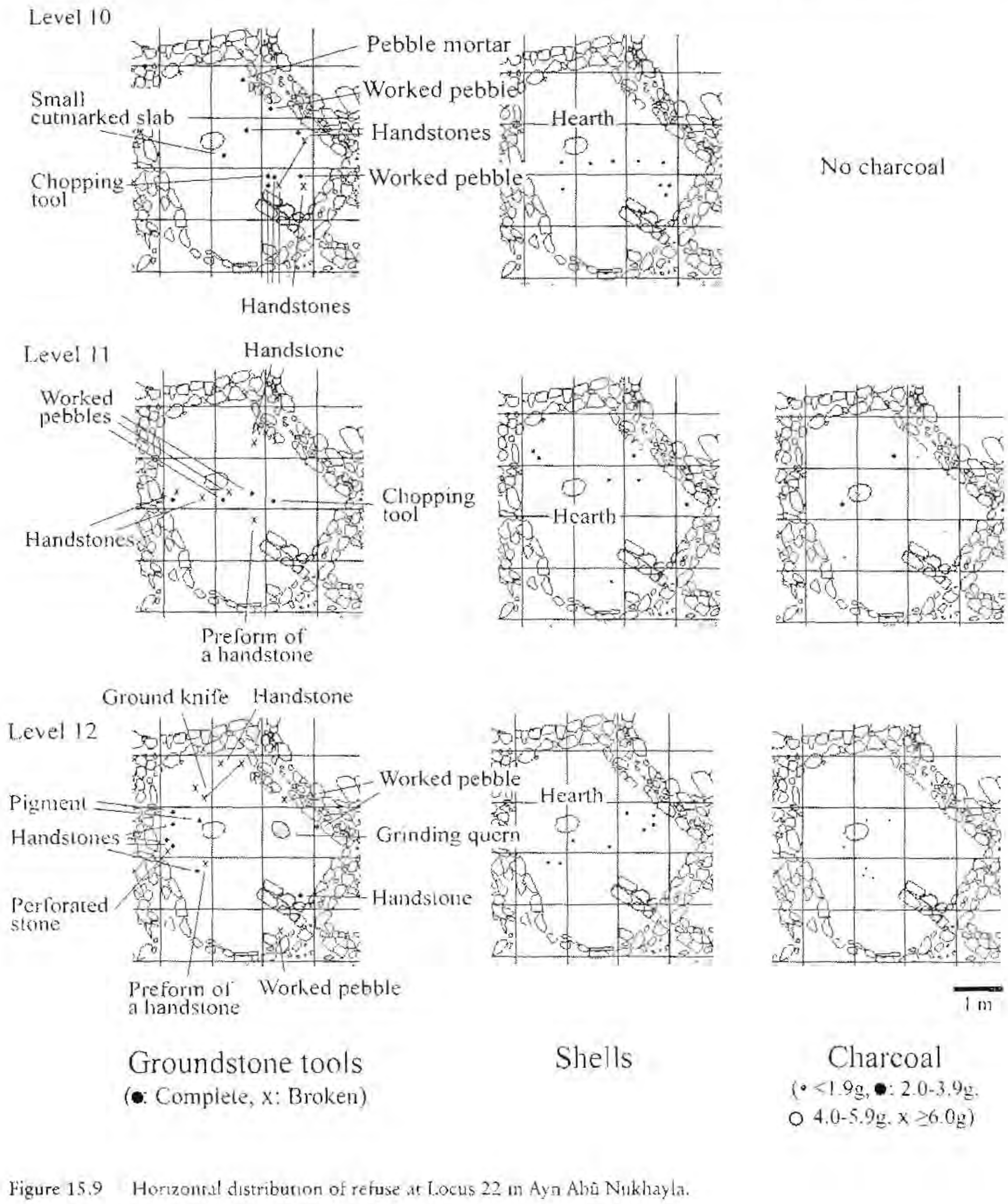

Figure 15.9 Horizontal distribution of refuse at Locus 22 in Ayn Abū Nukhayla.

milling toolkit) and their spatial concentration may indicate that they represent *de facto* refuse. The apparent absence of activity-area maintenance at this level may be explained as a result of relaxed practices of activity-area maintenance before the planned abandonment of the building (Brooks 1993; Tani 1995).

The upper fill is partially preserved as shown in Figure 15.11, and the fill contains a large amount of rubble (Fig. 15.12). Very little refuse was recovered from these levels (Fig. 15.4).

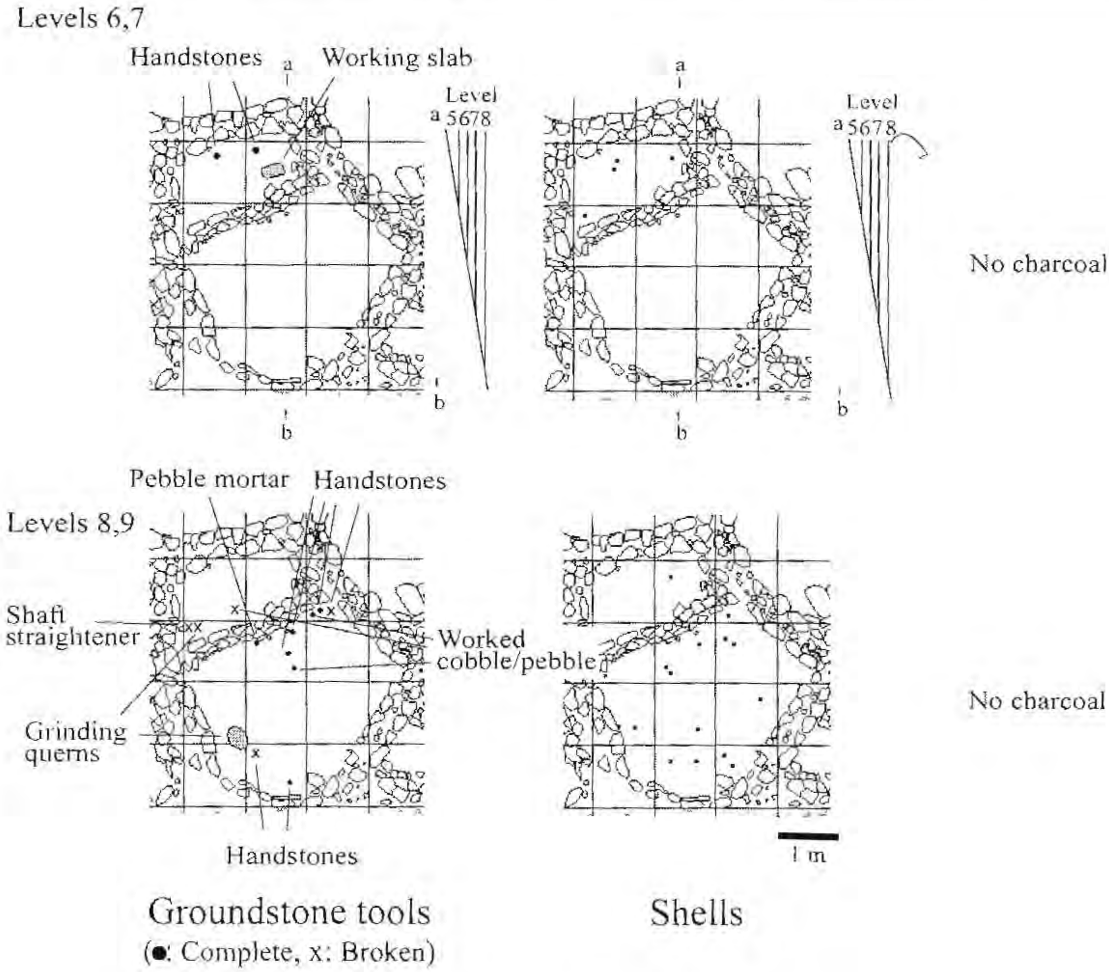

Figure 15.10 Horizontal distribution of refuse at Locus 22 in Ayn Abū Nukhayla (continued).

Summary

The results of the above exploration of the refuse structure are summarized in Table 15.2. Each row in the table represents one depositional phase, which is characterized by the refuse structure and the presence or absence of hearths. Some contiguous levels were grouped together to compose one depositional phase when they were similar in the characteristics of refuse structure.

Floor occupations are defined by architectural features, such as paved floors, hearths, or the bottom level of walls, as well as the refuse structure. The refuse structure at most floor levels is characterized by several common points, including the high density of refuse, the size-sorted distributional pattern, the high proportion of complete ground stone tools, and the functional concordance of ground stone tools (e.g. milling toolkits or pigment-processing toolkits). Some of these characteristics are sometimes distorted by several factors, such as subsequent scavenging (Locus 5), relaxed cleaning activities before the anticipated abandonment of the building (Loci 5 and 25), or the dumping of refuse into abandoned rooms (Loci 5, lower 22, and 25). However, the close examination of the refuse structure allows us to identify these depositional events and to assess their influence on the nature of remaining tool assemblages.

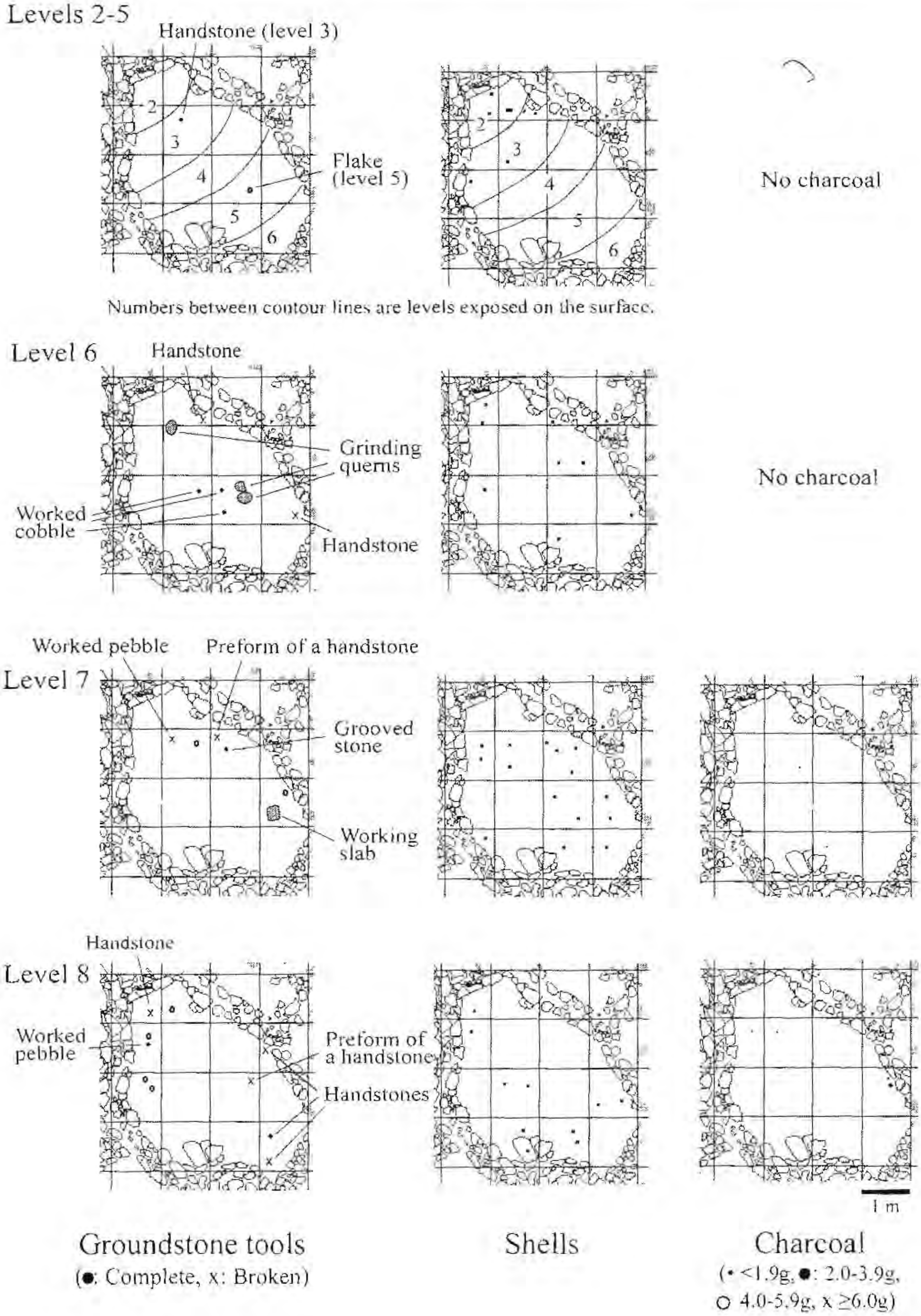

Figure 15.11 Horizontal distribution of refuse at Locus 25 in Ayn Abū Nukhayla.

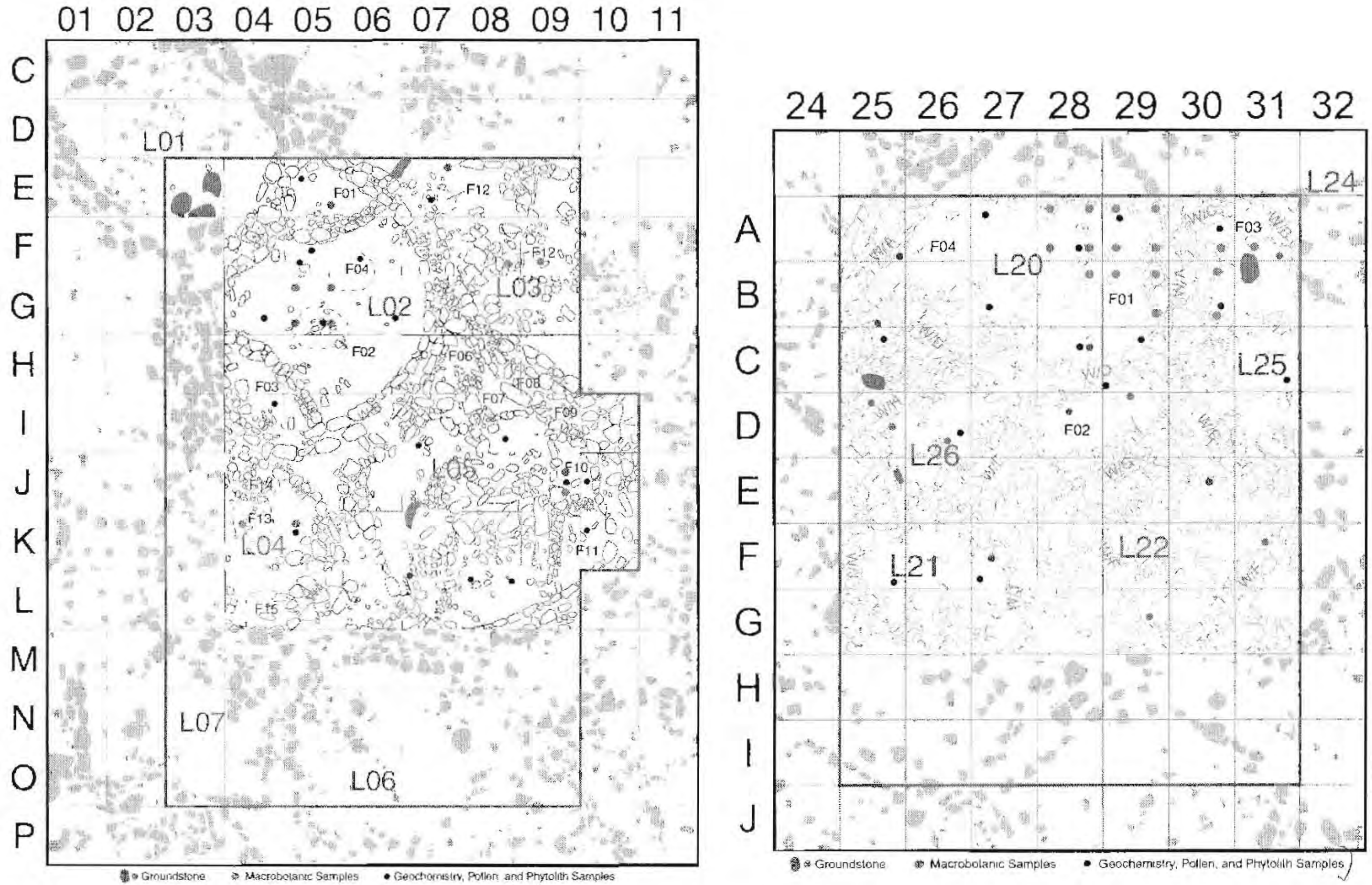

Figure 15.12 Horizontal distribution of rubble in Block I (left) and Block II (right) at Ayn Abū Nukhayla (after Henry *et al.* 2001).

Table 15.2 Life histories of residential buildings as indicated by the sequences of depositional phases in house-deposits at Ayn Abū Nukhayla.

Depositional phase	*Locus/ Feature*	*Level*	*Hearth*	*Distribution of refuse*	*% of complete tools*	*Functional concordance*
Reoccupation (type 3)	2	2, 3, 4	X	Size-sorted	0%(n=5)	Low
Reoccupation (type 1)	2	5, 6	O	Size-sorted	100%(n=4)	High(Handstone & quern)
Floor occupation	2	7, 8	O	Size-sorted	84%(n=19)	Higb(Handstone & quern)
Fill	2/F1	1, 2	X	-	0%(n=2)	Low
Fill	2/F1	3, 4	X	-	n=0	-
Floor occupation	2/F1	5, 6, 7	X	Cluster	75%(n=8)	(Cache of handstones)
Fill	4	4	X	-	0%(n=1)	-
Floor occupation	4	5, 6, 7	?	Size-sorted	83%(n=6)	High(Handstone & quern)
Reoccupation (type 3)	5	4, 5, 6	X	Size-sorted	50%(n=8)	High (Pestle & Mortar)
Fill	5	7	X	-	n=0	-
Reoccupation (type 2)	5	8, 9, 10	X	Size-sorted	57%(n=7)	High(Handstone & quern)
Fill	5	11	X	-	0%(n=1)	-
Floor occupation	5	12	X	Random	55%(n=11)	High(Handstone & quern; Pigment & processor)
Fill	20	2	X	-	67%(n=3)	?
Fill	20	3	X	-	n=0	-
Reoccupation (type 3)	20	4	X	Size-sorted	60%(n=5)	Low
Reoccupation (type 1)	20	5, 6	O	Size-sorted	20%(n=5)	Low
Floor occupation	20	7, 8	O	Size-sorted	69%(n=16)	High(Handstone & quern)
Fill	21	8, 9	X	Random	0%(n=3)	Low
Floor occupation	21	10, 11, 12	X	Size-sorted	67%(n=6)	Low
Reoccupation (type 2)	22/F2	6, 7	X	Size-sorted	100%(n=3)	Higb(Handstone & slab)
Floor occupation	22/F2	8, 9	X	Size-sorted	33%(n=3)	Low
Fill	22	6, 7	X	-	n=0	-
Floor occupation	22	8, 9	O	Size-sorted	80%(n=10)	High(Handstone & quern)
Floor occupation	22	10, 11, 12	O	Size-sorted	61%(n=36)	High(Handstone & quern)
Fill	23	2, 3, 4	X	-	n=0	-
Floor occupation	23	5, 6, 7	X	Size-sorted	71%(n=7)	High(Handstone & quern)
Fill	25	2, 3, 4, 5	X	-	50%(n=2)	Low
Floor occupation	25	6	O	Cluster	63%(n=8)	High(Worked cobble & Quern)
Floor occupation	25	7, 8	O	Size-sorted	50%(n=16)	High(Handstone & quern)
Fill	26	5, 6, 7	X	-	100%(n=1)	-
Floor occupation	26	8	X	-	n=0	-

House-fills contain little refuse and large or small amounts of rubble. The rubble-strewn fill represents an occupation hiatus, while the fill with little rubble is more ambiguous in its depositional processes. A small amount of rubble may have been caused by activity-area maintenance, or it is simply a result of the fact that walls did not collapse into the areas. However, this ambiguity can be partly compensated by ground stone tools' distributional and breakage patterns; broken tools strewn in the middle of the room indicate dumping of refuse and the absence of activity-area maintenance.

A size-sorted distributional pattern of refuse is observable at some levels in house-deposits besides building floors. The levels containing size-sorted refuse are differentiated into three types of depositional phases. The first type of depositional phases is associated with hearths, and these phases most likely represent the reuse of abandoned buildings for some activities. This type of depositional phase has a variety of the proportion of complete ground stone tools and their functional concordance. The second type of depositional phases does not contain hearths, but is characterized by the high proportion of complete ground stone tools and their high functional concordance. For example, at levels 8, 9, 10 of Locus 5, most tools consist of food processing implements, which are distributed in the area devoid of rubble (Fig. 15.6). At levels 6 and 7 of Feature 2 of Locus 22, two complete handstones are associated with a working slab (Fig. 15.10). These depositional phases also appear to indicate the reuse of abandoned buildings as activity areas. The third type of depositional phases is more ambiguous in their formation processes than the former two types because ground stone tools are characterized by medium or low proportions of complete tools and the low functional concordance. However, a small amount of rubble at Locus 2 (levels 2, 3, and 4) and the concentration of tools and shells towards rubble-free areas at Locus 5 (levels 4, 5, and 6) and 20 (level 4) may indicate activity-area maintenance or a selective use of clear space for some activities.

Implications to the Built Environment and the Use of Space

What Activities Were Performed at the Reoccupational Phases?

The results of the above examination indicate that some abandoned buildings were reused. These reused buildings include Locus 2, 5, 20, 22, and 22/F2 (Table 15.2). The reoccupation of Locus 22 is distinct from the others and designated here as a 'floor' instead of 'reoccupation' because its reuse involves substantial construction activities, such as an erection of a partition wall and probably reroofing. On the other hand, the other reoccupations do not appear to involve any construction activities except for the hearths at Locus 2 and 20. Because these reoccupational events occurred after the collapse of roofs or walls, they are not likely to be the continuation of initial floor occupations.

What kinds of activities were performed at the reoccupational phases? Generally, the density and the variety of ground stone tools at the reoccupational phases are smaller and more limited than those from floor phases (Table 15.3). The results of t-test and Mann-Whitney test show that both density and diversity of tools are significantly higher at the floor phases than the reoccupational phases (density: $t=2.59$, $df=12$, 2–tailed $p=0.02$; Mann-Whitney $U=5.0$, 2–tailed $p=0.01$; diversity: $t=3.67$, $df=12$, 2–tailed $p=0.003$; Mann-Whitney $U=2.5$, 2–tailed $p=0.002$), indicating that the intensity and the diversity of activities are more limited at the reoccupational phases. Four out of the seven reoccupational phases are characterized by the high proportion of complete tools. Two of them (levels 5, 6 of Locus 2, and levels 8, 9, 10 of Locus 5) are dominated by food processing tools, such as handstones and grinding querns (Table 15.4). The reoccupational phase at levels 6 and 7 of Feature 2 of Locus 22 contains two handstones and a working slab (Table 15.4). Although clear use-wear was not detected on the surface of the working slab, its spatial association with handstones indicates its function as a lower grinding tool. The tool types from level 4 at Locus 20 include ground spheres, pigments, and a grooved stone (Table 15.4). It is difficult to specify activities on the basis of these tool types.

Table 15.3 Comparison of the density and diversity of ground stone tools between activity areas at floor phases and reoccupational phases.

	Density (per m²)	*Diversity*[1]
Activity areas at floor levels[2]	Mean: 1.46, S.D.: 0.58	Mean: 0.42, S.D.: 0.15
Re-occupational phases[3]	Mean: 0.77, S.D.: 0.39	Mean: 0.20, S.D.: 0.06

1: # of recovered tool types divided by the total number of tool types
2: Loci 2, 5, 20, 21, lower 22, upper 22 and 25
3: Locus 2 (levels 2, 3, 4 and 5, 6), Locus 5 (levels, 4, 5, 6 and 8, 9, 10), Locus 20 (level 4 and 5, 6), and Locus 22/F2 (levels 6, 7)

Table 15.4 Ground stone tool types recovered from reoccupational phases.

Locus	*Level*	*Tool types*	*Completeness*
2	2, 3, 4	3 handstones, 1 mortar, and 1 pigment	0%
2	5, 6	3(3) handstones and 1(1) grinding quern	100%
5	4, 5, 6	3(2) handstones, 3(0) grinding querns, 1(1) pestle, and 1(1) small mortar	50%
5	8, 9, 10	4(2) handstones and 3(2) grinding querns	57%
20	4	2(1) ground spheres, 2(1) pigments, and 1(1) grooved stone	60%
20	5,6	3(1) handstones and 2(0) pigments	20%
22/F2	6,7	2(2) handstones and 1(1) working slab	100%

The numbers of complete pieces are shown in parentheses in the column of tool types.

In this way, the low density and diversity of ground stone tools at reoccupational phases precludes us from reconstructing a full range of activities performed during these phases. However, the presence of milling tool kits indicates that food processing activities were practiced at several reoccupational loci.

Roofed or Unroofed?

Another question about the reoccupational phases is whether they were accompanied by the roof reconstruction. Given the low intensity and the limited range of activities performed at the reoccupational loci, the roof reconstruction is considered an unlikely investment. The absence of a roof is also indicated by a small amount of rubble lying over the reoccupied areas. As shown in Figure 15.12, the reused buildings, such as Locus, 2, 20, and 22/F02, contain smaller quantities of rubble than other loci. Even at Locus 5, where rubble appears to be widely strewn, the reused west side of the room is relatively clear of rubble. If these observations are correct, the reoccupations of abandoned buildings at Ayn Abū Nukhayla suggest the use of abandoned buildings as outdoor activity areas.

Who Used the Abandoned Buildings?

The last question is: 'who used the abandoned buildings as activity areas?' Ayn Abū Nukhayla is a single component site of the PPNB period and contains no earlier or later occupations. A series of C14 dates indicate that the site was occupied during a tight chronological span (180 to 260 years) around 8509 ± 64 uncalibrated BP (Henry *et al.* 2003). Tool typologies of chipped and ground stone tools from house-deposits also confirm this idea. Therefore, the abandoned buildings were reused by people who were culturally and chronologically very close to the initial occupants of the houses.

As we have seen, the examination of the ground stone tools from reoccupational phases indicates that the abandoned buildings were used for a limited range of activities during a short period of time. There are two possible scenarios about the people who reused the abandoned buildings. The first is that the site function changed from a relatively sedentary settlement to an ephemeral camp after the abandonment of the settlement. This means that occnpants of another settlement reused the abandoned bnildings at Ayn Abñ Nukhayla during their short stay. The second scenario is the reuse of abandoned buildings by the inhabitants of Ayn Abū Nukhayla. In this case, the abandoned buildings were reused during the occupation of the settlement.

Several lines of evidence appear to favor the second explanation. First, the sequences of depositional phases of house-deposits indicate that several abandoned buildings were reused shortly after their roof or wall collapse (Table 15.2). If the abandoned bnildings were reused after the abandonment of the entire settlement, more deposits wonld accumulate between floor levels and reoccupational levels. Second, if Ayn Abū Nukhayla functioned as an ephemeral camp after its abandonment, there should he roughly contemporary similar settlements atound Ayn Abū Nukhayla. However, no such sites have been discovered (Henry 1995; Jobling and Tangri 1991; Kirkbride 1978). It is also possible that the people became more nomadic after the abandonment of the site and left no substantive settlements, only ephemeral camps. Although the archaeological remains from the reoccupational phases need to be closely examined from this perspective, the techno-morphological characteristics of chipped and ground stone tools do not appear to indicate such a drastic change in lifestyle.

Patchy Distribution of Contemporary Houses, and the Performance of Some Domestic Activities in Open, More Visible, Settings

Based on the above discussions about the reoccupational phases, I suggest that some abandoned bnildings at Ayn Abū Nukhayla were reused as outside activity areas by the site inhabitants. If this interpretation is correct, it has implications for (1) the built environment and (2) the use of space at Ayn Abū Nukhayla.

First, the proposed presence of outdoor activity areas implies the patchy distribution of contemporary houses in the settlement. This suggestion is particularly significant at Ayn Ahū Nukhayla hecause of its peculiar settlement layout called 'beehive structure' (Goring-Morris 1993), where curvilinear buildings are densely distributed with no space between them (Fig. 15.2 and 15.3). On the contrary, I suggest that the prehistoric built environment at Ayn Abū Nukhayla is characterized by the patchy distribution of houses with outdoor areas, which facilitated the movement and interaction among inhabitants.

Second, the proposed presence of outdoor activity areas necessitates some changes in the spatial organization of domestic activities at Ayn Abū Nukhayla. As shown in Figure 15.13, the examination of floor assemblages indicates that large interior spaces were used for main activity areas, while small rooms adjacent to the large spaces were used for storage or task specific areas hy household members (Kadowaki 2002 and 2006). This hypothesis suggests that most daily practices of households were conducted in intimate, less visible settings (Joyce and Hendon 2000:155). However, this picture needs to be reconsidered because all the buildings may not have been synchronically standing. The evidence for the use of abandoned buildings as outdoor activity areas indicates that standing buildings were accompanied with abandoned buildings, where some domestic activities were also performed in open, more visible settings (Fig. 15.13). Although the low intensity and diversity of activities in abandoned buildings impede us from reconstructing a full range of activities (Table 15.3), they seem to include food processing activities (Table 15.4).

Combining the above discussions regarding the built environment (patchy occupations) and the use of space (the practice of some activities in outdoors), I propose that the prehistoric on-site landscape at Ayn Abū Nukhayla may have been more open than previously envisioned. This in turn means some degree of difference of Ayn Abū Nukhayla from other mid to late PPNB villages in the built environment and the use of space. As I described in the iutroduction, other sites are characterized by the highly compartmentalized built environment and the habitual use of indoor

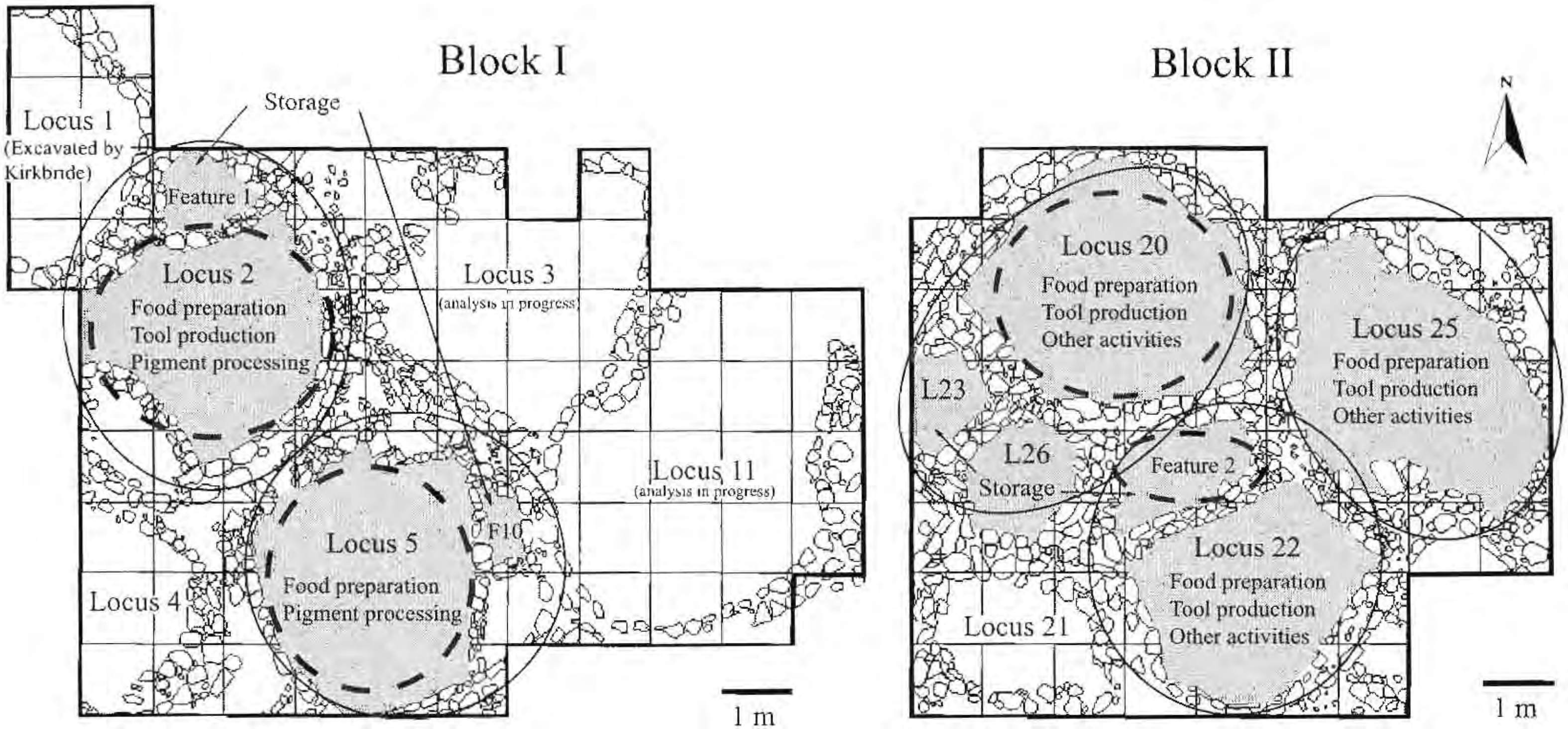

Figure 15.13 Household units and the use of internal spaces inferred from floor assemblages. (Spaces marked by dotted lines were reused as outdoor activity areas during their post-abandonment periods.)

areas for daily domestic activities (Banning 1996; Kuijt 2000; Kuijt and Goring-Morris 2002; Rollefson 1997; Wright 2000). On the other hand, the relatively open built environmenr and the use of outdoor space for some activities at Ayn Abū Nukhayla imply some degree of similarity to PPNA or early-middle PPNB sites, such as Netiv Hagdud and Phase A of Beidha, where food processing activities appear to have been performed in building interiors as well as in outdoor areas (Wright 2000). I do not, however, suggest that the results of this study entirely change the nature of the built environment and the use of space at Ayn Abū Nukhayla because we can still see a greater degree of spatial and behavioral segmentation at this site than at Netiv Hagdud or Phase A of Beidha. For example, the absence of house-entrances at ground level still indicates the restricted access to private residences (Figs. 15.2 and 15.3), and the intensity and diversity of activities are significantly higher in indoor spaces than outdoor settings at Ayn Abū Nukhayla (Table 15.3).

Conclusions

This paper examined the life histories of residential buildings at Ayn Abū Nukhayla in order to clarify the built environment and the use of space in the settlement. Specifically, I presented the sequences of depositional phases in house-deposits based on the analyses of three datasets, which are 1) breakage patterns of ground stone tools, 2) vertical and horizontal spatial distributions of ground stone tools, shells, and charcoal fragments, and 3) architectural contexts, such as the location of hearths, cobbled floors, and the bottom level of walls. The close examination of depositional events allowed us to assess the integrity of 'floor assemblages', and the proposed sequences of depositional phases in house-deposits clearly showed the reoccupations of buildings in their post-abandonment periods. The low density and diversity of ground stone tools from these reoccupational phases indicate the low intensity and the limited range of activities although food processing was probably part of outdoor activities. This ephemeral use of abandoned buildings and the relatively small amount of rubble suggests that the reused areas were unroofed. Several lines of evidence also suggest that the abandoned buildings functioned as ourdoor activity ateas while other houses were still occupied.

The proposed presence of outdoor activity areas implies (1) the patchy distribution of contemporarily occupied houses and (2) the performance of domestic activities in both indoor and outdoor contexts in a 'beehive' settlement at Ayn Abū Nukhayla. Such an on-site landscape at Ayn Abū Nukhayla indicates 'more open' social environments than other mid to late PPNB settlements, such as 'Ain Jammam, Ba'ja, Basta, Beidha, al-Ghwair, and 'Ain Ghazal (Banning 1996; Kuijt 2000; Kuijt and Goring-Morris 2002; Simmons and Najjar 1998; Rollefson 1997; Wright 2000), thus adding to a variety of the PPNB settlement organizations in the southern Levant. It is particularly interesting that the relative 'openness' of the built environment and the use of space at Ayn Abū Nukhayla is also found at earlier sites, such as Netiv Hagdud (PPNA) or Phase A of Beidha (early-middle PPNB), in a more enhanced manner. This unique nature of Ayn Abū Nukhayla may be understood in terms of its geographical location in the arid environmental zone, which also seemingly affects other dimensions, such as subsisteuce activities, architecture, and settlement systems (Henry *et al.* 2003). Fnrther investigations are necessary in order to provide explanations bridging these different dimensions.

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