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Reconstructing Economic and Social Organization at the Early Neolithic Site of ʻAyn Abū Nukhayla

The high-resolution recovery and fine-grained spatial analysis of behavioral residuals (architecture; features; artifacts; ecofacts) allowed for an unusual reconstruction of the economic and social organization of the inhabitants of ʻAyn Abū Nukhayla at household and community scales. The research protocol is described and analytic results from various data-sets presented. The results are then discussed in light of a series of issues related to Early Neolithic economic and social organization. These include: (1) household composition and control of resources, (2) social differentiation, (3) craft specialization, (4) intra-community social interaction, (5) household layout and activity areas, and (6) gender-linked household task areas.

While the high-resolution spatial analysis of archaeological sites is common to Palaeolithic occupations, the approach is rarely employed in the excavation and analysis of materials recovered in Neolithic contexts. This typically has to do with the greater size of Neolithic excavations, which are largely devoted to tracing architectural features, and the immense quantity of recovered materials that, in combination, act to overwhelm efforts to record behavioral residues at fine spatial scales and analyze such evidence in great detail. Although larger than most Palaeolithic sites, ʻAyn Abū Nukhayla is small by Early Neolithic standards. Moreover, the cultural deposit is relatively shallow, typically measuring little more than a metre in depth. These aspects of the site made it a good candidate for a high-resolution investigation. Perhaps more importantly, the extraordinary preservation of house floor assemblages within well-defined pithouse structures provided a unique opportunity to trace the economic and social organization of the residents at intramural and intrasite scales.

Background

ʻAyn Abū Nukhayla was discovered in 1946 by A. S. Kirkbride and Lankester Harding (1947) in their survey of the Wādī Ḥisma and briefly discussed in the report by Moshe Stekelis (1947). Diana Kirkbride (1960, 1978) dug a stratigraphic trench and partially excavated one of the structures (her House IV [Locus 1 in this report]) during a brief investigation in the late 1950s. The site remained unstudied until research was initiated in 1999 by a team from the University of Tulsa, with continuing field seasons in 2000, 2001 and 2005, and geological investigations lasting into 2006 (Henry and Beaver 2014; Henry *et al*. 2014; Henry *et al*. 2010; Henry 2005; Henry *et al* 2003; Cordova *et al*. 2014). A radiocarbon chronometry of the site shows the successive occupations to have

stretched over about two centuries centered at 9,550 years ago (Henry and Nowell 2007), placing the occupations late in the Middle Pre-Pottery Neolithic B (PPNB) interval of the Early Neolithic of the Levant (Simmons 2007).

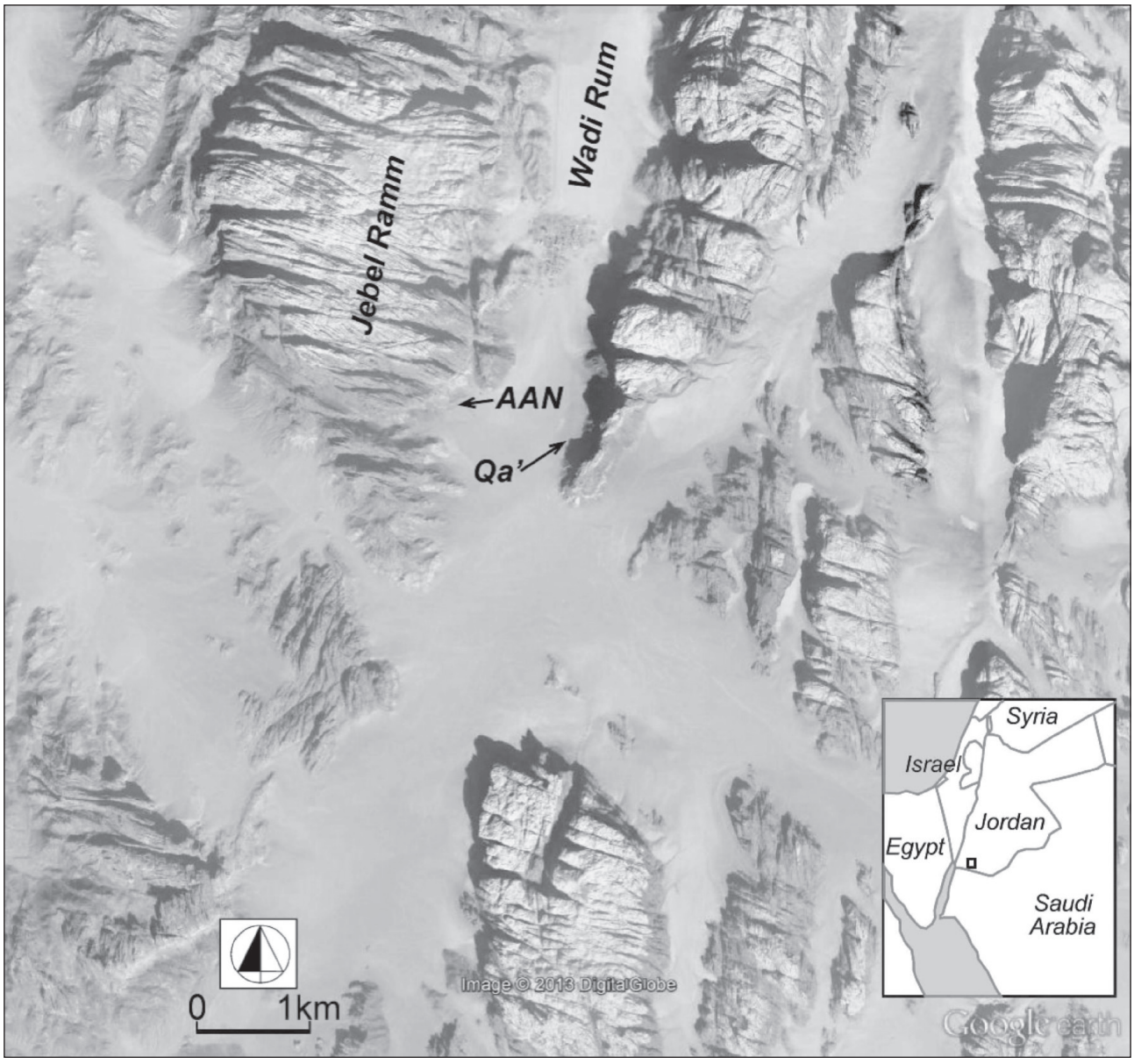
The sites of the so-called Desert Neolithic display considerable variation in size and permanency with the largest communities, such as ‘Ayn Abū Nukhayla, displaying extensive architectural features and holding evidence for a mixed economic package. Herding of sheep and goats, cultivation of wheat and barley, and foraging provided a broad economic base that reduced risk in the harsh, variable environment. Recent research on the Desert Neolithic also challenges the traditional notion that the Levantine arid-zone was limited to occupations consisting of small, highly mobile groups of foragers (Jobling and Tangri 1991:147). Moreover, these studies show that herding and cereal cultivation occurred much earlier in the arid-zone than previously suspected (Garrard *et al*. 1999: 74, *cf.* Fujii 2010 and Henry 2014).

Another common feature of the desert communities was the practice of transhumance, that is the seasonally scheduled abandonment of sites during the driest part of the year, accompanied by movement to better watered settings typically at higher elevations. Even by following these strategies of economic diversification and transhumance, settlement of the desert during the Middle PPNB was precarious and appears to have fluoresced for only about two centuries during a brief moist pulse. The research at ‘Ayn Abū Nukhayla from on-site and off-site investigations produced a wide array of palaeoenvironmental evidence from pollen, phytolith, faunal, diatom and geological studies. While these point to significantly greater available moisture during the occupational interval, moisture levels (<300mm) were nevertheless inadequate to support cereal cultivation from direct rainfall. The groups occupying the site were however able to cultivate cereals through run-off farming of a small, nearby basin or *qa’* in which water collected seasonally. During this period, the occupants of other desert settlements at Wādī Abū Ṭulayḥa (Fujii 2010) and nearby sites developed elaborate water management systems involving the construction of stone lined barages dug adjacent to drainages for collection of seasonal run-off.

Site-Setting and Layout

‘Ayn Abū Nukhayla rests on the toe of an alluvial fan that extends from the eastern foot-slope of Jibāl Ramm, which forms part of the western flank of the narrow, steep-walled valley of Wādī Rum (FIGS. 1 and 2). The site draws its name, *Spring of the Father of the Young Palm*, from a small spring located on the rock cliff just above the site. The deposit of the site, a nascent *tall*, was formed by the accumulation of aeolian sediments from an encroaching sand ramp interlaced with the anthropogenic sedimentation of successive occupations. The eroded surface of the lobe has exposed the upper courses of about 150 stone-walled, mostly oval structures that are interconnected in a honeycomb pattern. The walls are associated with a rich scatter of chert artifacts, groundstone, bones and ash distributed over an area of approximately 1,200m^2. With <50mm mean annual precipitation, the modern hyper-arid setting of the area is one of the driest on earth and associated with a Sudano-Deccian biome. The sparse desert vegetation is accompanied by occasional pockets of more verdant growth situated around springs and seeps.

Research at the site began in 1999, with the initial season devoted to clearing the surface of loose rocks, digitally photographing and mapping the exposed wall stones, and placing sediment cores in the deposit of the site and immediate area. The following seasons (2000; 2001; 2005) focused on two block excavations that exposed 13 structures in conjunction with the excavation of a large (2 × 3m) stratigraphic pit into the deposit of the Qā‘ Nukhayla (FIG. 3).

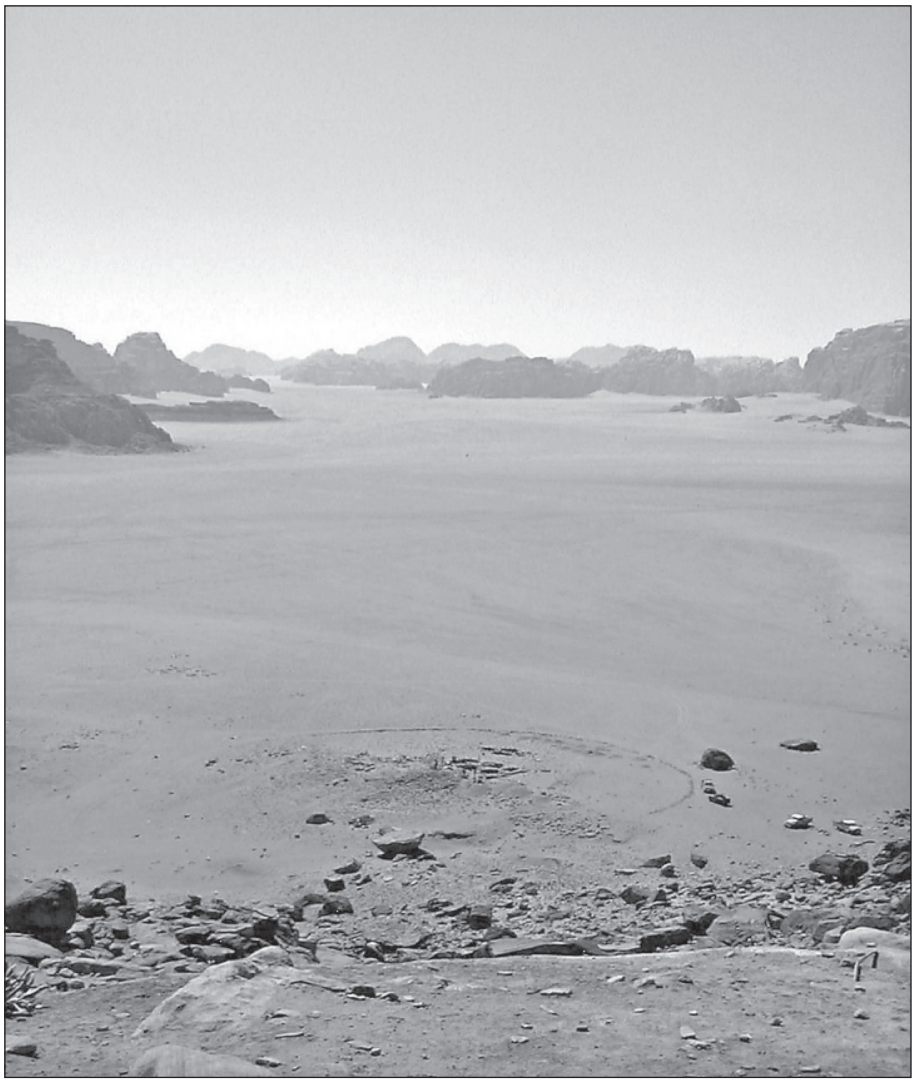


1. *Google Earth* image of the area around ‘Ayn Abū Nukhayla showing the location of the site (AAN) and prominent natural features mentioned in the text. Note the *qā‘* east of the site and the nexus of canyons to the south-east.

Stratigraphy and Chronometry

Each of the semi-subterranean structures displayed a discrete sedimentary deposit, but a general similarity in the depositional succession across structures was recognized that consisted of: (1) a basal fine red aeolian sand with few to no artifacts, (2) a thick layer of black-gray fine sand and ash with moderate to high frequencies of artifacts that was associated with the bottom course of wall stones and sometimes associated with a stone-paved or packed floor and features (FIG. 4), (3) an inter-stratified deposit composed of relatively thin layers of dark gray and ashy, artifact-rich layers separated by layers of reddish tan sand with few artifacts, and (4) a layer of rock slabs and fragments thought to represent wall-collapse that formed the upper 10-30cm and capped the deposit.

Charcoal samples, collected from different loci and excavation levels across the site, yielded twelve conventional radiocarbon assays (ranging from 9,103±221 calBP to 9,897±206 calBP), with a best common date of 9504±32 calBP and an estimated



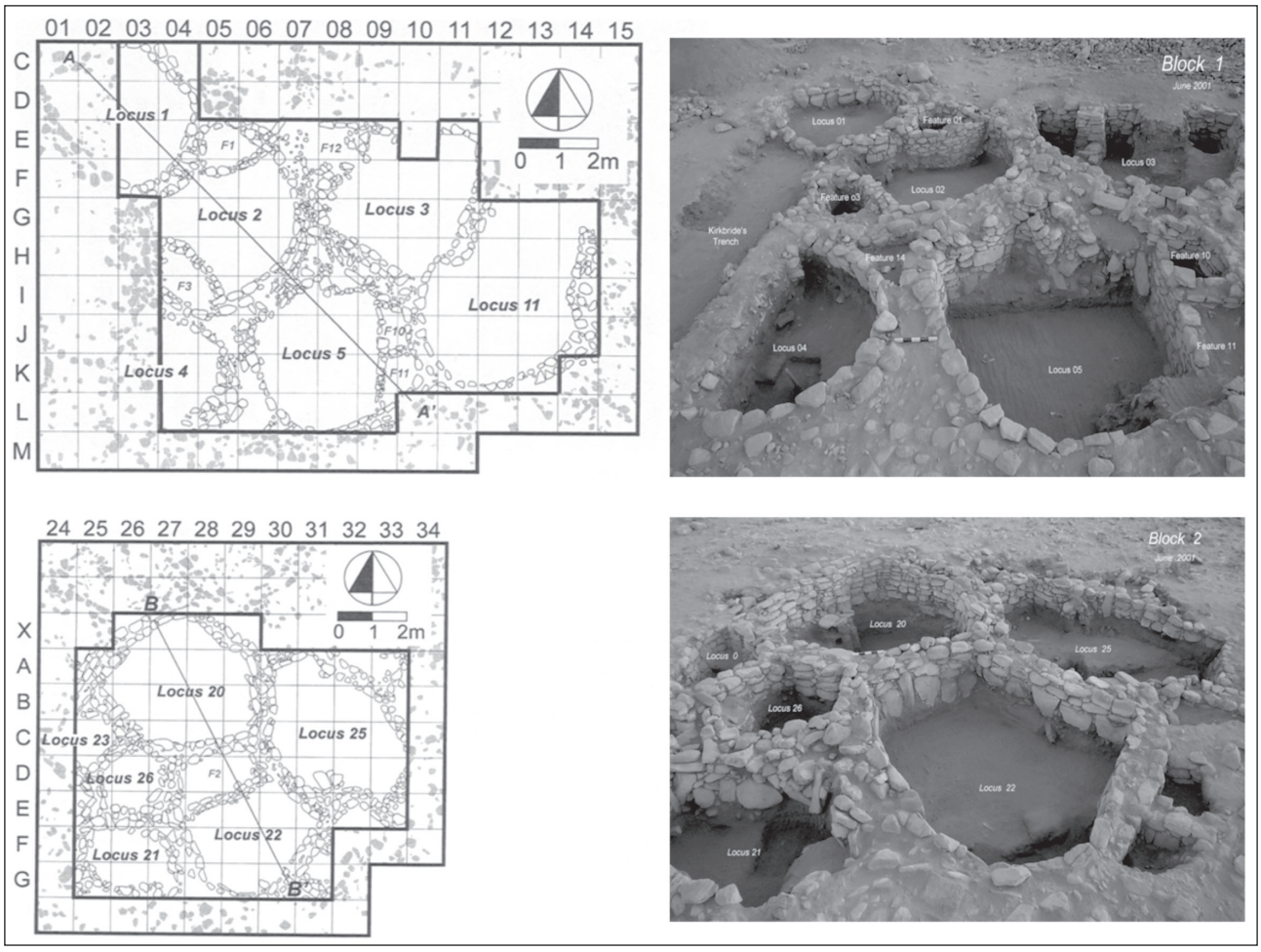
2. View of the site looking down from the spring to the south-east. Vehicles provide a scale (Image by Marie Balasse).

duration of 180-260 years. Calibrations were established through *CalPal07Hulu*, provided in the Cologne Radiocarbon and Palaeoclimate Research Package (Weninger *et al*. 2007), and the best common date and estimated duration were calculated using Hietala's (1989: 284-85) method for determining the degree of contemporaneity and temporal duration from multiple C14 dates.

Excavation and Sampling Strategies

The excavation followed provenience controls consisting of a grid of 1m^2 units, each subdivided into 0.25m^2 quadrants, that were superimposed on loci defined by the perimeter walls of structures. The excavation preceded in 10cm spits that were broken at the contacts of natural sedimentary layers or layers defined by stone-paved or compacted house floors. All artifacts and ecofacts were recovered, recorded and analyzed within the fine-grained provenience controls. Intramural features (hearths; storage installations; stone platforms; caches; large basin querns) were recorded by point plots established within each locus through use of the Sokkia Total Station and laser theodolite, or through measurements from the grid. The point-plotting of artifacts / ecofacts was impractical because of the very large sample sizes (*i.e.* >26,000 lithic artifacts and >6,000 NISP [faunal]), but all of the recovered materials were recorded and analyzed within the fine-grained excavation spits of 0.25m^2 quadrants, no more than 10cm thick.

All of the excavated matrix was dry-screened through 3mm mesh and sediment samples were



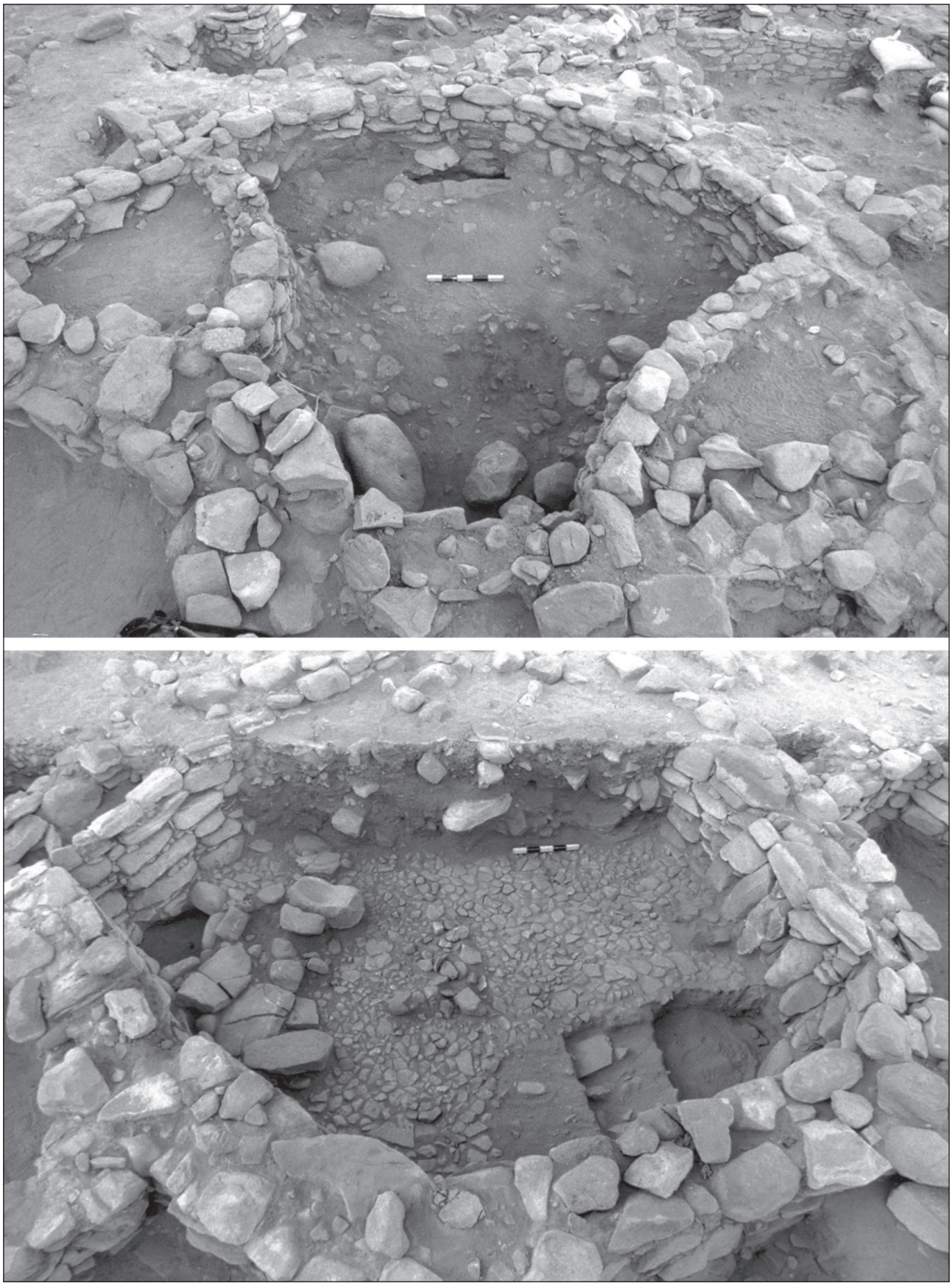
3. Architectural plans and images (looking north) of Blocks I and II showing loci, grid system and features. Note Kirkbride’s old trench along left edge of Block I.

collected randomly from house floors, and purposefully from hearths and storage facilities, for floatation. Other sediment samples were gathered across house floors and taken from stratigraphic columns for pollen, phytolith, fecal spherulite and starch analyses.

Stratigraphic Analyses and Data-Sets

An initial step in the study involved the identification of the stratigraphic positions and thicknesses of house floors. Within several of the loci, house floors were unambiguously defined during excavation by stone pavements, packed earth, hearths and dark, ashy, artifact-rich layers, but in others house floors were less apparent.

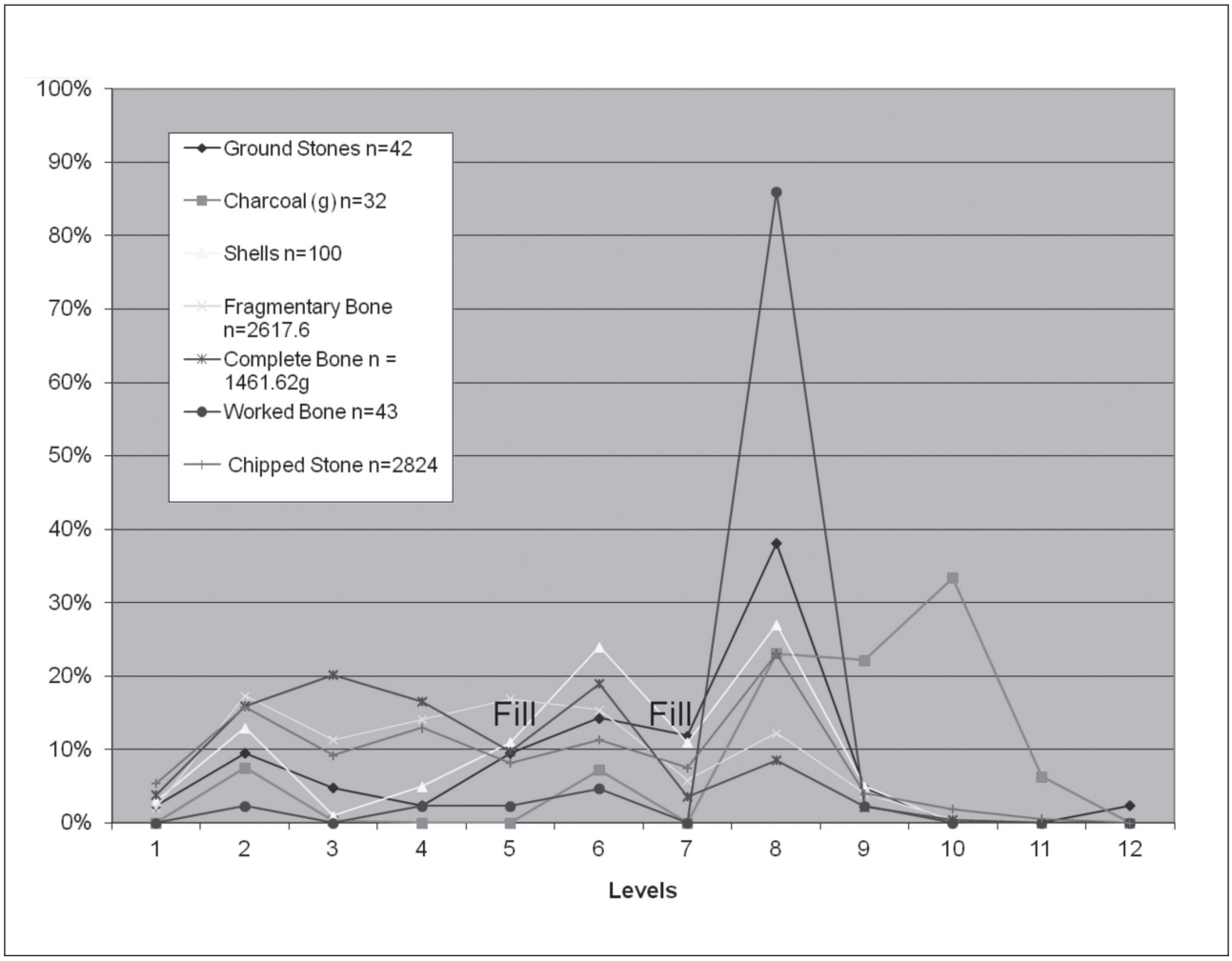
In an effort to distinguish house floors from intervening fills within each structure’s stratigraphic sequence, the frequencies and weights of artifacts and ecofacts, the presence of features and sediment varieties were compared by excavation level using an *MSExcel* spreadsheet and line graph function to organize and compare the data-sets (TABLE 1; FIG. 5). Floors were distinguished by peaks in artifact density and diversity (*i.e.* a greater representation of the number of general artifact categories, such as ground stone, chipped stone, worked bone, shell, identifiable and fragmentary bone), features (hearths) and large basin querns. Although the cultural residues and sedimentary evidence defined occupational surfaces or floors within the stratigraphic sequences of the structures, there remained a crucial question as to what processes were responsible for their formation. Schiffer (1987: 89-97) and others (LaMotta and Schiffer 1999; Diehl 1998; Brooks 1993) have observed that



4. Views of house floors exposed in Locus 2 (top) and Locus 20. Note the inverted querns in Locus 2 and the cobbled floor in Locus 20 (Images by Joseph E. Beaver).

Table 1. Example of the distributions of the various data-sets by layer and level for each locus organized on a *MS Excel* spreadsheet. Also note the stratigraphic extension of wall stones and floor / fill designations.

BLOCK 1: LOCUS 2														
	Floor/Fill	Fill	Floor 4	Fill	Floor 3	Fill	Floor 2	Fill	Floor 1	Fill	Fill	Fill	Fill	
	Layer	A	A	B	C	D	D	E	F	F	F	F	F	
	Level	1	2	3	4	5	6	7	8	9	10	11	12	Total
	Wall													
No. of complete querns		0	0	0	0	1	1	0	4	0	0	0	0	6
Ground Stones	n=42	2.4%	9.5%	4.8%	2.4%	9.5%	14.3%	11.9%	38.1%	4.8%	0.0%	0.0%	2.4%	100.1%
Charcoal (g)	n=32g	0.0%	7.5%	0.3%	0.0%	0.0%	7.2%	0.0%	23.1%	22.2%	33.4%	6.3%	0.0%	100.0%
Shells	n=100	3.0%	13.0%	1.0%	5.0%	11.0%	24.0%	11.0%	27.0%	5.0%	0.0%	0.0%	0.0%	100.0%
Fragmentary Bone (g)	n=2617.6g	2.1%	17.3%	11.4%	14.2%	16.9%	15.4%	5.8%	12.3%	4.0%	0.4%	0.1%	0.1%	100.0%
NISP	n =1461.6g	3.8%	15.9%	20.2%	16.5%	9.7%	19.0%	3.6%	8.6%	2.2%	0.5%	0.0%	0.0%	100.0%
Worked Bone	n=43	0.0%	2.3%	0.0%	2.3%	2.3%	4.7%	0.0%	86.0%	2.3%	0.0%	0.0%	0.0%	100.0%
Chipped Stone	n=2824	5.4%	15.8%	9.2%	13.0%	8.2%	11.3%	7.5%	23.1%	4.0%	1.9%	0.5%	0.0%	100.0%
Tools	n=470	3.8%	9.6%	10.0%	15.3%	11.9%	8.3%	8.1%	28.9%	2.8%	0.4%	0.9%	0.0%	100.0%
Debitage	n=1594	5.2%	16.1%	7.7%	10.4%	7.1%	13.7%	8.2%	26.6%	3.2%	1.1%	0.6%	0.0%	100.0%
Debris	n=760	6.8%	19.1%	11.8%	17.0%	8.2%	8.2%	5.8%	12.1%	6.4%	4.5%	0.1%	0.0%	100.0%



5. Example of the distributions of the various data-sets by layer and level for each locus, shown on a line-graph generated from a *MS Excel* spreadsheet (see TABLE 1).

de facto or primary refuse on such floors is actually uncommon and that *secondary refuse* from rubbish disposal may well be a more likely formation process associated with house floor assemblages.

There are several lines of evidence, however, that indicate that the house floors at ‘Ayn Abū Nukhayla are associated with primary as opposed to secondary refuse. These include both the composition and the spatial context of artifacts and features. If the floor assemblages were a consequence of rubbish disposal, one

would not expect to see the presence of so many useable, unbroken artifacts across a wide-range of categories (large basin querns; hand-stones; chipped stone points and blades; worked bone; shell), in addition to caches of points, blades and shells. Although the floor assemblages include some broken groundstone objects, such as hand-stones and perforated querns, these are often flat-lying and located at the edges of the rooms, indicating that the broken tools are not the result of refuse-dumping during the post-abandonment stage but instead represent provisional refuse that inhabitants of the structures kept for later re-use. Moreover, had the floor assemblages been derived from secondary refuse, the spatial contexts of the residues would be expected to be largely random and not spatially and technically connected to other artifacts and features as activity complexes seen on many of the house floors (FIG. 4). The spatial patterns of artifacts and features are described later, in a section concerned with site-structure.

In contrast to floors, fills were defined in our analysis by low artifact densities and diversity, an absence of features and a paucity or absence of basin querns. Additionally, the excavation levels encompassing fills were principally composed of red to tan aeolian sands with little evidence of ashy, anthropogenic sediments. This stratigraphy is thought to trace intervals of deposition associated with the occupation of the structures (floors), in which anthropogenic deposition from hearths and other organic materials (bedding; food-stuffs) was dominant and natural, mostly aeolian, sedimentation was limited by enclosures. The sedimentation associated with fills, on the other hand, is thought to have occurred during intervals of abandonment when the structures would have been open to the natural influx of wind-borne sands and when they would have received little to no anthropogenic deposition except from refuse disposal.

Spatial Analyses and Data-Sets

Having identified house floors stratigraphically, based upon composition and content, we moved to an intramural spatial examination of floors and fills in an effort to further evaluate our floor / fill definitions and to refine our understanding of the specific behaviors responsible for their formation. The analysis involved a contextual examination of the spatial distributions of artifacts, ecofacts, features and architectural elements associated with the excavated loci.

Using a mapping software (*Surfer*, version 6.04, 1997)[1], spatial plots expressed in contour intervals indicative of densities were generated for each artifact- / ecofact-class for each house floor and these were, in turn, overlain on the architectural plans of the loci and their intramural features (*e.g.* hearths, caches, storage installations etc.) that had been developed using a graphics software (Macromedia *Freehand MX*, 2002)[2]. The architectural plans and feature locations were initially captured as digital images within 2 × 2m tiles made for each floor. This process was conducted for each of the 31 occupational floors identified within the 12 loci. For each floor, ground stone, shell, NISP (faunal), worked bone, projectile points, chips, tools, secondary blades, tertiary blades, cores, ridge blades, core-trimming elements and the total frequency of chipped stone were plotted in order to examine their spatially defined contextual relationships. This resulted in a total of 12 spatial plots per floor. In the case of low artifact quantities, as was often the case for projectile points, shells and cores, point plots were utilized instead of contour plots. This process led to the creation of over 400 spatial plots.

The general findings of the spatial analyses were consistent with the inferences for the activities and depositional processes that were drawn from the stratigraphic analyses.

1. Scientific Software Group (1997) *Surfer* version 6.04: http://www.ssg-surfer.com/.

2. Macromedia (2002) *Freehand MX*.

Levels attributed to house floors showed spatial distributions in which specific artifact- / ecofact-classes were concentrated in certain areas. Moreover, the artifact- / ecofact-classes forming the concentrations were consistent with their functions and human behavior. For example, the various lithic classes defining a reduction stream (*i.e.* core, ridge blades, secondary blades etc.) were clustered together; handstones and querns were located together, chipped stone and NISP (faunal) clustered near hearths, and so forth. In contrast to the spatial structure of house floors, fills lacked the distinct clustering and artifact / ecofact spatial differentiation, and instead display a general mixing of classes within a random distribution.

At a more refined level, the intramural spatial analyses enabled us to identify patterns of activity differentiation across the house floors that allowed for a better understanding of the functional use of the structures (*i.e.* sun-lit areas; entry areas), their architectural designs and gender-associated activity areas. These are discussed in following sections.

Discussion and Interpretation

The results of the high-resolution spatial analyses allowed various issues related to Early Neolithic economic and social organization to be addressed. These include: (1) household composition and the control of resources, (2) social differentiation, (3) craft specialization, (4) intra-community social interaction, (5) household layout and activity areas, and (6) gender-linked household activity areas.

Household Composition and Control of Resources

The excavated loci at ‘Ayn Abū Nukhayla contained remarkably similar floor assemblages, composed of artifacts and ecofacts associated with a variety of domestic tasks involving extractive, primary production and maintenance activities. These were connected to cereal processing, storage and cooking, weaving and threadwork, fabrication of ornaments of shell, bone and stone, flint knapping and butchery. With the exception of a single structure that most likely served as a storage facility or animal pen (Locus 26), all of the other loci held floor assemblages that were very similar in their range of contents. The house floor assemblages in each of these structures contained evidence of diverse varieties of behavioral residuals, including chipped stone, ground stone, shell, fragmentary bone and identifiable bone. Three loci lacked worked bone tools and ornaments, but this class of artifacts was also rare in the other loci. The similarities between house floors was also evident in the consistent presence of large querns and microbotanic evidence (*i.e.* phytoliths, pollen and starches) associated with milling and storage of cereals (Emery-Barbier 2014; Portillo and Albert 2014; Portillo *et al*. 2009; Albert and Henry 2004). Relative to lithic technology, evidence of full reduction streams involving core-shaping, blank delivery, tool fabrication, use and recycling was recovered from each house floor.

This pattern of redundancy in house floor assemblages across the excavated loci consisting of different classes of artifacts and ecofacts reflective of quotidian activities is in agreement with Byrd’s (2000: 87) predictions for the residuals left by domestic units of nuclear families, but inconsistent with the expected inter-household variability associated with occupations composed of extended family compounds (Flannery 1972: 42, 1993: 114). Additionally, the presence of intramural storage facilities in six of the nine fully excavated, residential structures, points to private, household-held rather than communally held resources. The identification of caches in three of the structures also suggests a control of different items of value (marine shells; large flint blades and points) at a household-specific, family level.

Social Differentiation

In addressing the question of the degree to which social differentiation was present in PPNB communities, researchers (Byrd 1994; Kuijt 2000; Rollefson 2000) suspect that some limited form of the recognition of status or prestige was present but, as pointed out by Kuijt and Goring-Morris (2002: 420) "almost no archaeological research has directly addressed the topic". The one line of evidence that has received attention is the standardization of house size. Within the PPNB, the sizes of residential structures varied considerably through time and between environmental zones (Simmons 2007: 160-161), but within communities floor areas were remarkably standardized (Hole 2000: 205). This intra-community uniformity in the size and form of dwellings has been interpreted as a mechanism that promoted egalitarianism (Byrd 2000: 85-86; Simmons 2007: 162). At 'Ayn Abū Nukhayla, the habitation structures display a mean area of 9.7 m^2 and, even though they are much smaller than the residential structures in the PPNB communities of the Levantine corridor, they also display little intra-community variability in size.

From a different perspective, intrasite distributions of items likely to have been tied to prestige or status were examined at 'Ayn Abū Nukhayla. Sea shells, found in abundance in PPNB sites, have been viewed by several researchers as being expressive of status differentiation, with particular emphasis accorded to distances from either the Mediterranean or Red Sea sources and the associated rarity of the shells (Bar-Yosef Mayer 1997). At 'Ayn Abū Nukhayla, ornaments fashioned from Mediterranean sea shells obtained through distant, down-the-line exchange were relatively rare and as such were viewed as prestige or status items. When the distribution of the Mediterranean shells was plotted between house floors across the excavation no statistically significant difference in frequencies was found (Spatz 2008: 113). And even though stone ornaments were rare, with the recovery of only 16 specimens, they showed a relatively even distribution across the excavated house floors with stone ornaments present in a majority (75 %) of the loci. This relatively even distribution of status items between households again points to a principally egalitarian community.

Craft Specialization

Within the PPNB, researchers have largely focused on analysis of the lithic technology tied to the Naviform Core Technique in an effort to evaluate the degree to which craft specialists may have played a role in the economy (Quintero *et al*. 1997; Nishiaki 2000; Quintero 2010; Barzilai 2010). This unique approach to producing long, slender blades from bi-directional cores and the use of specially targeted chert sources has prompted notions that craft specialists supplied the lithic industry of PPNB communities (Quintero 2010). Recently, Quintero (2010: 32) and Barzilai (2010: 151-153) examined the modes of lithic production in the PPNB and found that the organization, production and distribution of blades ranged from generalized, autonomous household production for commensal consumption to nucleated workshops in which full-time specialists produced materials distributed through inter-community networks. Moreover, these diverse patterns of blade production and distribution systems appear to have been associated with differences in the ecological settings, subsistence economies, demographic parameters and social organization of the communities. Craft specialization involving full-time artisans in specific workshops, greater standardization, enhanced production efficiency and more complex distribution networks, often accompanied by the exploitation of specific raw material sources, was present on the largest sites located in the verdant Levantine Corridor. In contrast, non-specialized household production for commensal consumption was common at

the smallest sites, those occupied by mobile groups that exploited the arid-zone.

ʻAyn Abū Nukhayla provides additional support for the findings of Quintero and Barzilai in that autonomous household production of blades was confirmed by evidence for complete reduction streams in each residential locus. The absence of nucleated or even dispersed workshops argues against craft specialists having contributed to the lithic industry. Although recovered in low frequencies, cores, primary blades (those with 100 % cortex) and core-trimming elements (crested blades) trace the initial steps in core-shaping and blank delivery within each household. Comparison of the frequency and volume of artifacts associated with initial reduction with those produced further down the reduction stream (blade blanks and tools) also suggests that some cores were trimmed and initially shaped near chert outcrops on the Maʻān plateau and that even some blade blanks were probably imported to the site as well.

In contrast to the lithic industry, production of ornaments (beads and pendants) of shell, bone and stone at ʻAyn Abū Nukhayla suggests the presence of a kind of cottage industry in their fabrication. Whereas manufacturing steps or stages were in evidence for each of the materials, only shell ornaments were present in sufficient quantities to indicate large-scale production, most likely for distribution beyond individual households and the community. Each of the excavated residential structures yielded remnants of ornamental shell-production, including unmodified shells, partially worked and finished ornaments, and shell waste (Spatz 2008). The site is likely to have served as an initial point from which shells were collected from the nearby shores of the Gulf of ʻAqaba, processed and then traded to Maʻān plateau groups in a down-the-line distribution network. This part-time craftwork undertaken within individual households is consistent with the other findings at ʻAyn Abū Nukhayla that indicate a social and economic organization which was largely formed around autonomous households composed of nuclear families.

Intra-Community Social Interaction

Researchers have noted that the growth of non-residential, public spaces within PPNB communities through time may have been an expression of greater multi-household social interaction and enhanced group solidarity (Byrd 2005: 128-129). This may also have been linked to the emergence of social differentiation derived from the authority of ritual practitioners, civic leaders, or perhaps community or household elders (Kuijt and Goring-Morris 2002). In turning to ʻAyn Abū Nukhayla, the excavation failed to reveal any evidence of public space. This, however, is not uncommon in PPNB sites, given that few excavations expose large proportions of the sites (Bar-Yosef 1998: 198). While this factor may, in part, account for the absence of a public area at ʻAyn Abū Nukhayla (as only about 12 % of the site was excavated), the digital recording and mapping of exposed wall stones on the surface of the entire site also failed to show any evidence of a large open or walled area indicative of a public space.

Another avenue used in reconstructing PPNB social organization and intra-community interaction has to do with the positions of ground stone implements and hearths within households (Simmons 2007: 162-163). In pioneering this approach, Wright (2000) found locations of food preparation and storage in many PPNB sites to rest in transitional areas (entries; porches; extra-mural positions) that invited social contacts *between* households, in contrast to locations for food consumption (hearths) that were in private settings *within* households. She interpreted this pattern as reflecting and promoting inter-household, community-wide social interaction while, at the same time, socially delineating membership in individual households. In suggesting that the nuclear family and lineages were central

to PPNB social organization, she pointed to meals as a primary means of acculturating and bonding a family and lineage. From a cross-cultural perspective, others have interpreted communal milling areas as indicative of extended family structure (Jacobs 1979; Kramer 1979) and matrilocality (James 1994). Unlike this pattern, however, the site-structure at ʻAyn Abū Nukhayla shows large milling stones, storage facilities and hearths to have intramural placement. Whilst it is possible that extra-mural placement of milling stones and storage facilities was present outside the two excavated blocks, this seems unlikely.

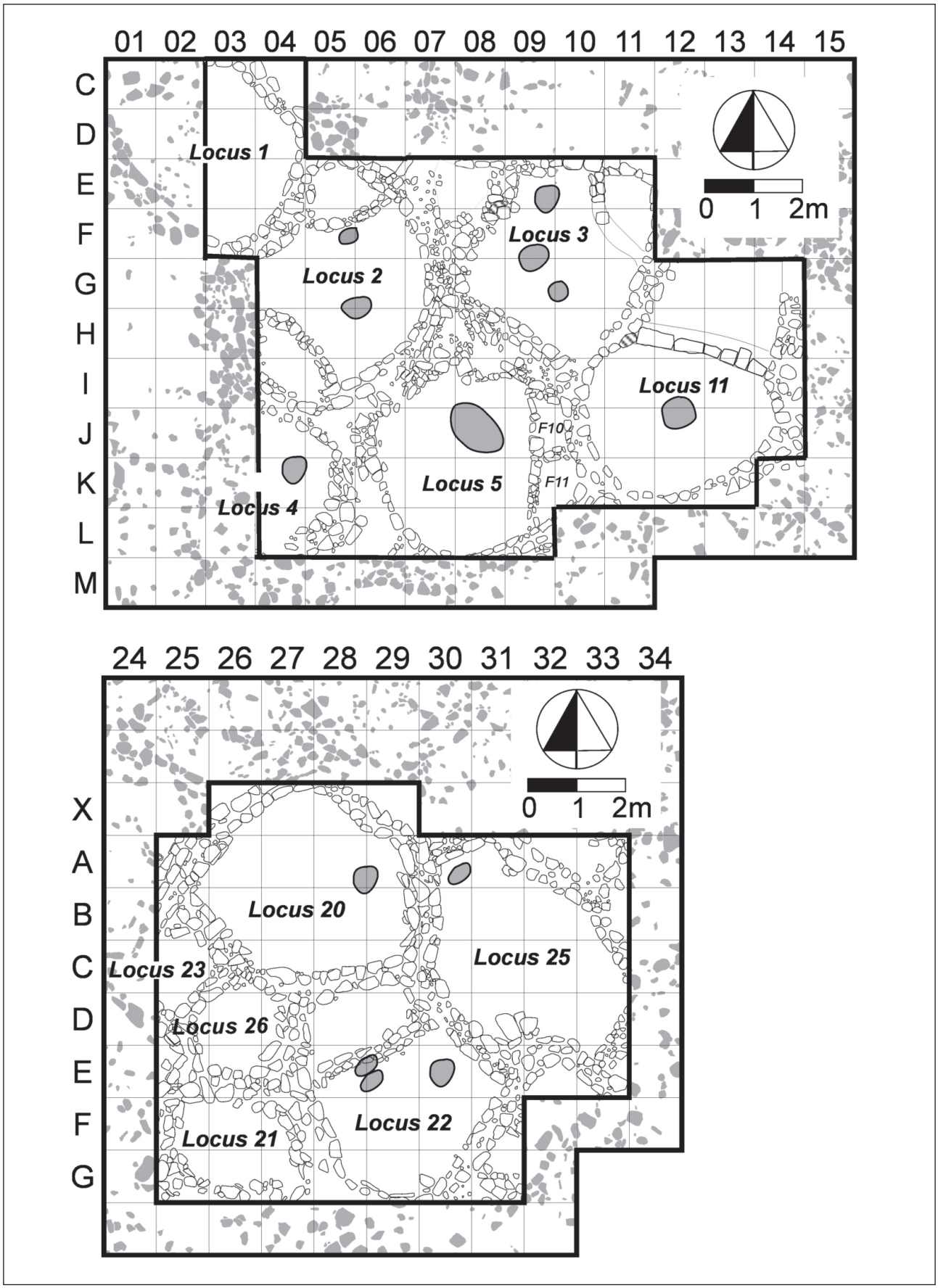
An alternative explanation for the apparent absence of clearly demarked public spaces or extra-mural placement of milling stones may be that the sizes of the groups occupying ʻAyn Abū Nukhayla were not large enough to trigger the emergence of such social mechanisms for the maintenance of community solidarity. Byrd (2005; 1994) and others have argued that growth in the sizes of PPNB communities within the Mediterranean zone was accompanied by a greater presence of public spaces. Perhaps, within the arid zone of the Levant, group population parameters were too low to prompt the creation of institutions and formal places for communal interaction.

Household Layout and Activity Areas

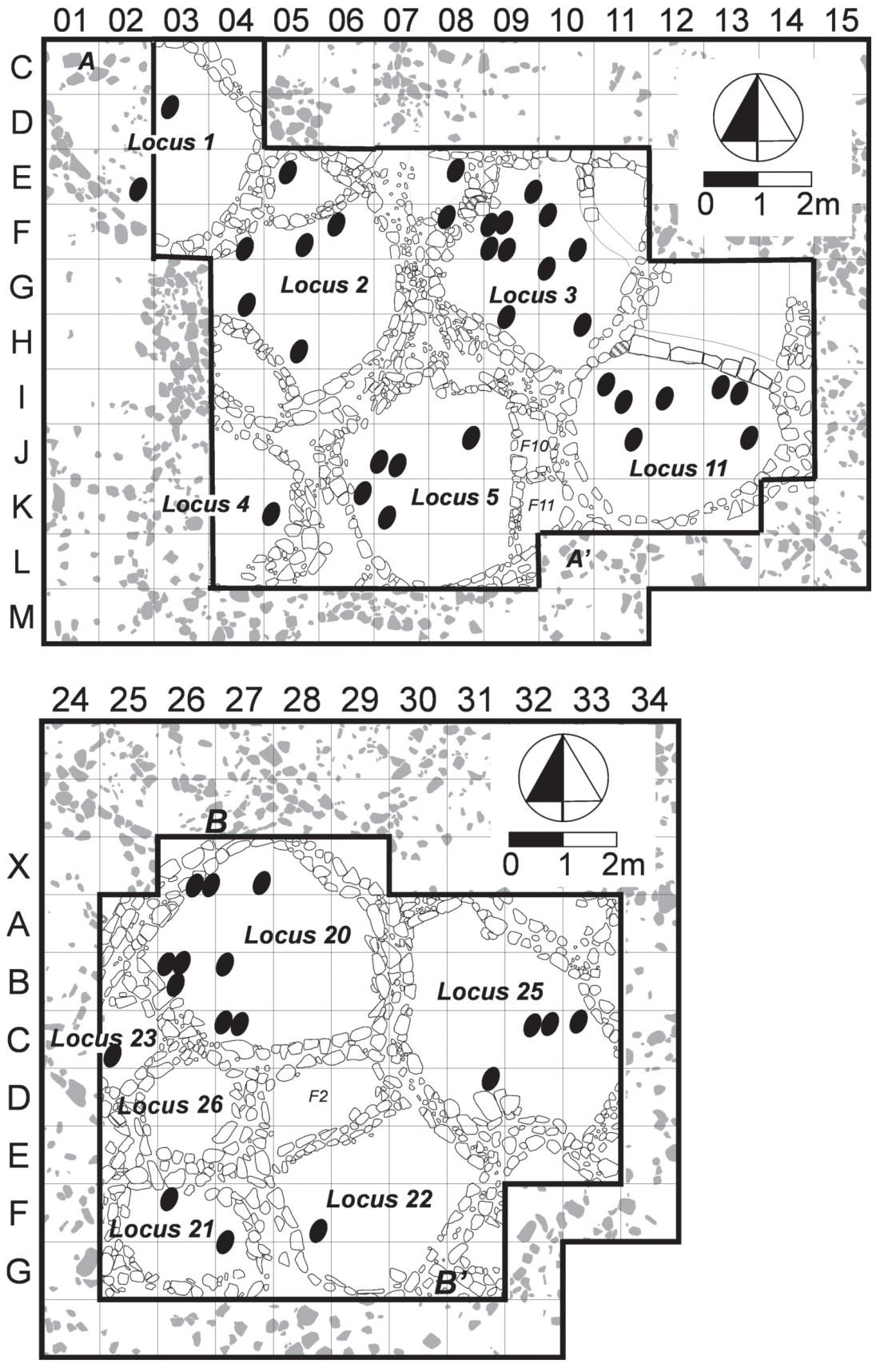
The positions of hearths and large querns on house floors have also been used by researchers to trace the locations of certain activities. Hearth-centered activities are commonly recognized in archaeology (Gamble 1991; Binford 1996; Galanidou 2000; Henry 2010), as are those related to milling (Goldstein 2008; Simmons 2007: 162-63; Wright 2000; Jacobs 1979; Kramer 1979). At ʻAyn Abū Nukhayla, each of these features was examined for contextual spatial patterns.

Hearths were identified in most (73 %) of the residential structures, but only on about 30 % of the house floors (FIG. 6). The reason that so few hearths were found may be attributed to the dark ashy, anthropogenic deposits of the house floors, coupled with informal construction that typically amounted to little more than a shallow oval depression scooped out of a sandy floor. These factors would have masked the locations of many hearths. Interestingly, the hearth patterns of the house floors in Block I appear to differ from those of Block II. In the structures of Block I, at least one hearth is centrally located and two house floors (Loci 2 and 3) have a second hearth located adjacent to the north wall. In Block II, none of the hearths show a central placement, but hearths situated along the north wall are present in two of structures. The centrally located hearths would have spread the distribution of heat and light evenly within the structure and, at the same time, offered the occupants unencumbered access from various surrounding positions for conducting hearth-side tasks. The spatial distributions of the hearths also suggest that the framework of the dwellings did not have a central support post, but most likely followed a tipi-like design with a super-structure of poles extending from the perimeter of the walls and coming together near the center of the structure.

In exploring the spatial distributions of the querns we recognized that, unlike hearths, their recovery locations may have differed from their locations of use, especially for those placed along walls in inverted positions. The spatial co-variation between querns and cereal phytolith concentrations as discussed earlier, however, implies that the querns were typically situated quite close to their areas of use. An examination of the distributions of querns in house floors reveals a distinctive spatial pattern (FIG. 7). If house floors are divided into quadrants oriented on the cardinal points, the south-east quadrant contains a markedly lower proportion of querns, accounting for only 4 % of querns (TABLE 2). In contrast, the north-west quadrant of house floors contained ~40 % of querns. This distribution may be an



6. The distributions of hearths within loci shown on the architectural plans of excavation Blocks I and II.



7. The distributions of querns within loci shown on the architectural plans of excavation Blocks I and II.

Table 2. The frequency-distribution and proportionate representation of querns by the quadrants of completely excavated loci. Given an expected proportionate representation of 25 %, note that querns are underrepresented in the south-east quadrant and over-represented in the north-west quadrant.

Quern Locations by Quadrant					
Locus	Ne	Se	Sw	Nw	
1	1		1		
2	1		2	3	
3	3	1	1	7	
4		1			
5	1		2	2	
11	3			4	
20			5	3	
21	1				
22			1		
23			1		
25	3		1		
Number	13	2	14	19	48
Percent	27.1%	4.2%	29.2%	39.6%	100.0%

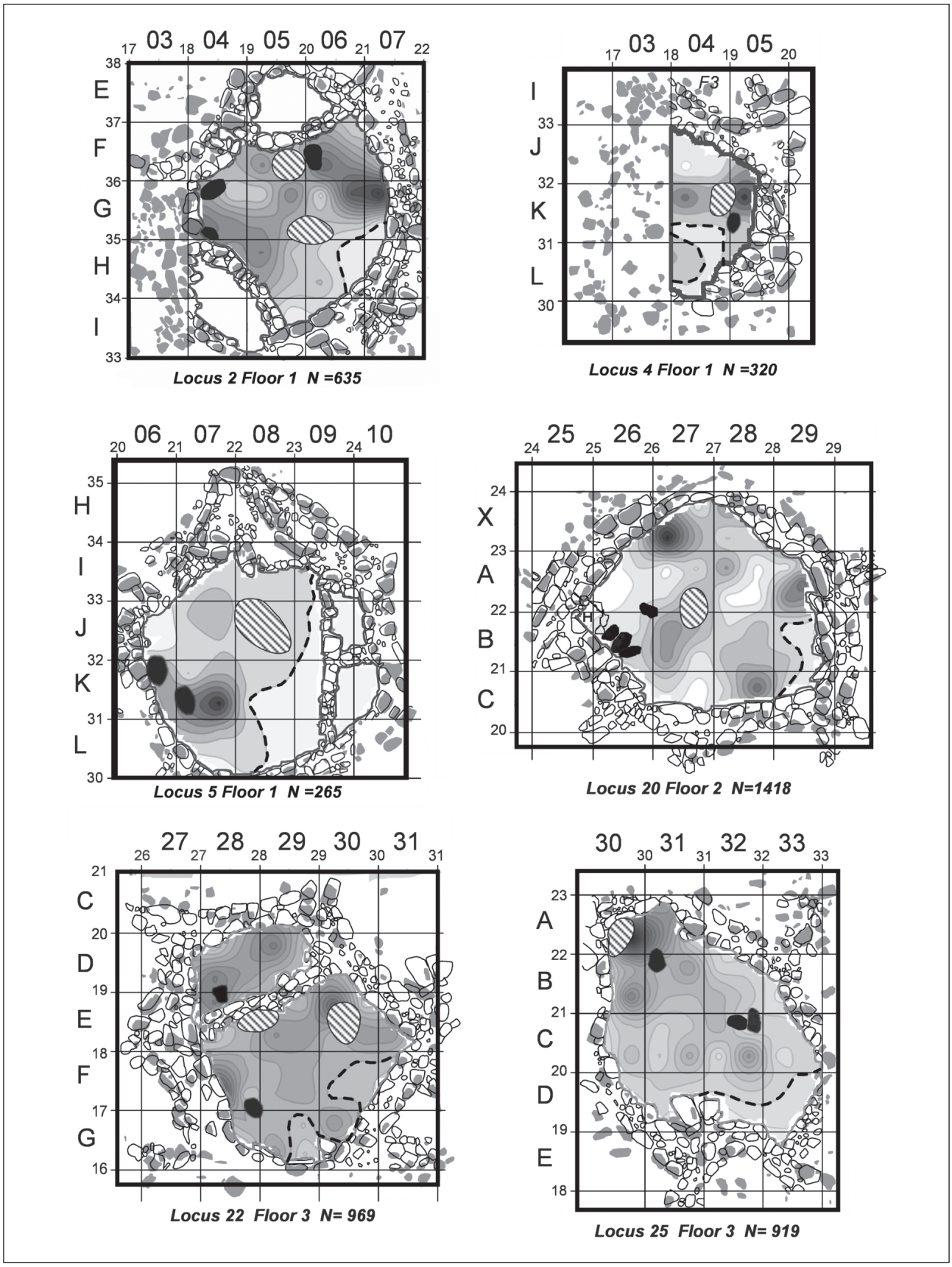
expression of a preference for undertaking milling activities within those parts of a house floor that received direct sunlight. During most of the winter / spring seasonal occupation of ‘Ayn Abū Nukhayla, the sun would have risen in the south-east and traveled in a low arc across the southern horizon, bathing the western and northern portions of the floors of the semi-subterranean structures in sunlight. The south-eastern portions of house floors, however, would have been within the shadow of the eastern walls of the structures and, in the later part of the day, the shadow cast over the site from the west by Jibāl Ramm.

If there had been a preference for undertaking milling activities on sunlit areas of house floors, we should also expect to see a similar distribution of artifacts connected with other activities. The most abundant floor assemblages for an evaluation of this proposal are chipped stone assemblages inclusive of all the artifact categories. The distribution of all chipped stone artifacts should trace areas of lithic production, as well as use and discard. When the house floor assemblages for loci in which hearths were present are inspected for total chipped stone artifact densities, the south-eastern parts of each locus consistently show low densities, resembling the distributional pattern observed for hearths and querns (FIG. 8). Some of the house floors show low artifact densities in other areas as well, but the south-eastern part of the dwellings always displays an area of very low artifact density. This area, which would have been in shadow throughout the day, may also have served as the location for basing a ladder for roof-entry into the semi-subterranean structures. An opening in the roof at this point would have admitted maximum morning sunlight and, if a flexible cover of hide or woven material was used, it could have been peeled back during the course of the day to admit additional sunlight depending on wind and weather conditions.

Gender-Linked Activities

The degree to which gender roles may have changed with the emergence of agriculture in the Early Neolithic has also been of concern to researchers, particularly in relation to issues involving descent, inheritance, marriage patterns, post-marital residence and labor roles (Peterson 2002; Nishiaki 2000; Bar-Yosef 1995; Bar-Yosef and Belfer-Cohen 1992; Flannery 1972). Specific to labor roles in the PPNB, notions that women undertook weaving and milling tasks and men conducted most of the hunting have been criticized for lack of supportive evidence (Peterson 2002; Crabtree 1991). In light of this, Peterson (2002: 129) has suggested that excavation strategies incorporate intrasite spatial analyses focused on the generation of *sexual maps* of domestic spaces. Spatial studies concerned with tracing gender-specific activity areas, however, are confronted with the fundamental challenge of identifying gender-linked artifacts or features.

The identification of gender-linked artifacts has relied principally on two approaches: (1) ethnographic analogues and (2) human osteological features. A large sample of



8. The distributions of hearths, querns and chipped stone concentrations shown for loci in which hearths were present. Note the absence of hearths and querns, and paucity of chipped stone artifacts in south-east portion of the loci. Excavation units = 1 m^2.

cross-cultural ethnographic data for gender associations with those activities for which we have archaeological evidence at ‘Ayn Abū Nukhayla and other PPNB sites clearly shows a gender-based division of labor (Murdock and Provost 1973: Table 3). The artifacts and features present in frequencies sufficient for spatial analysis at ‘Ayn Abū Nukhayla that also show strong gender-linkages are arrowheads and chipped stone elements (male) and hearths and querns (female). In the ethnographic sample, males are exclusively or strongly associated with hunting large land animals and stone-working, whereas females are more strongly connected to tasks involving preparation of vegetal foods and cooking.

Relative to human osteological evidence, a study of an Early Neolithic population from Abū Hurayra (Molleson 2000: 309-316, 1994: 74) and a large study (150 individuals) of Natufian and Neolithic populations from eight sites in northern Israel (Eshed *et al*. 2004: 312-314) found that Neolithic women took on greater workloads and that two-handed, reciprocal milling and fine hand movements linked to basketry, spinning and weaving were habitual tasks. Despite an apparently greater work-load for Neolithic females, Eshed *et al*. (2004: 314) also traced a continuity in substantial sexual dimorphism from Natufian to Neolithic populations as inferred from musculoskeletal stress markers (MSM), a pattern consistent with the broad cross-cultural findings reported by Frayer and Wolpoff (1985: 445). In another MSM study of PPNB and earlier Natufian populations involving a much smaller sample, Peterson (2002) found that PPNB skeletons showed fewer differences between sexes and less lateralization in males. She interpreted her findings to indicate that, with the emergence of an agricultural lifestyle in the PPNB, males and females both worked harder and male activity patterns changed more profoundly (Peterson 2002: 144-145).

In an effort to understand gender in space at ‘Ayn Abū Nukhayla, the distributions of large querns, hearths, arrowheads and chip concentrations were traced within and between structures. Their distributions within individual households and across the community suggests a combination of female-linked tasks that included milling and cooking and male-related tasks associated with the fabrication and curation of arrowheads. In fact, aside from the anomalous Locus 26, each of the excavated structures yielded floor assemblages indicative of both female and male activities.

A more detailed intramural spatial analysis of gender-linked artifacts and features suggests that these activities were undertaken in certain areas of the dwellings. As noted earlier, large querns are principally located along the western

Table 3. Gender-associations for activities in a cross-cultural sample of 185 societies (Murdock and Provost 1973: 107, Table 1).

Activity	Male Only	Mostly Male	Mixed	Mostly Female	Female Only	N
5. Hunting large land auna	96.50%	3.50%	0.00%	0.00%	0.00%	144
11. Stone working	91.80%	0.00%	8.20%	0.00%	0.00%	73
12. Work in bone, horn, and shell	86.60%	8.50%	2.40%	0.00%	2.40%	82
15. Butchering	85.30%	6.30%	2.80%	2.80%	2.80%	143
20. Housebuilding	59.00%	16.90%	7.90%	5.10%	11.20%	178
21. Soil preparation	49.30%	20.10%	10.40%	12.70%	7.50%	134
24. Generation of fire	46.50%	7.00%	18.60%	4.70%	23.30%	86
27. Gathering small land fauna	40.30%	4.50%	13.40%	19.40%	22.40%	67
33. Basketmaking	28.50%	6.90%	11.50%	13.80%	39.20%	130
35. Matmaking	29.10%	3.90%	8.70%	4.90%	53.40%	103
38. Loom Weaving	27.30%	0.00%	6.80%	9.10%	56.80%	88
46. Spinning	7.70%	3.30%	4.40%	5.50%	79.10%	91
49. Cooking	0.00%	1.10%	1.10%	34.20%	63.60%	184
50. Preparation of vegetal foods	1.70%	0.60%	2.30%	12.10%	83.30%	174

walls of the structures, with some 70 % situated in the western half and 40 % in the north-west quadrant of house floors. As suggested, this may be an expression of milling activities that were carried out in the sunlit portions of structures. When the areas that were used in the processing of cereals are compared to the locations of hearths, presumably used for cooking in addition to other functions, a strong spatial covariance is shown. When the central hearth locations are excluded, the predominant pattern of hearth locations parallels that of querns, with 60 % located in the western half and 50 % in the north-west quadrant. If arrowheads were fabricated and stocked by males, their locations indicate a greater emphasis on male activities in the south-western and north-eastern quadrants of the house floors and the greatest gender differentiation in the north-western quadrant where female activities were dominant. The concentrations of chips, a likely signature of locations where lithic-processing took place, tend to co-vary spatially with points, especially in quadrants where lithic artifacts were abundant (north-east) or scarce (north-west).

Summary

The high-resolution recovery and fine grained spatial analysis of behavioral residuals (architecture, features, artifacts and ecofacts) at ‘Ayn Abū Nukhayla allowed for the reconstruction of Early Neolithic economic and social organization at household and community scales. Despite certain obstacles (*e.g.* size of site and quantity of recovered materials) to undertaking this level of research in the context of Neolithic sites, the approach is clearly feasible and productive.

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