Isaac I. T. Ullah
School of Human Evolution
and Social Change
Arizona State University
Tempe, Arizona, 85287-2402
Isaac.Ullah@asu.edu
USA

Isaac I. T. Ullah

Within-Room Spatial Analysis of Activity Areas at Late Neolithic Ṭabaqat al-Būma, Wādī Ziqlāp, al-Kūra, Jordan

Introduction

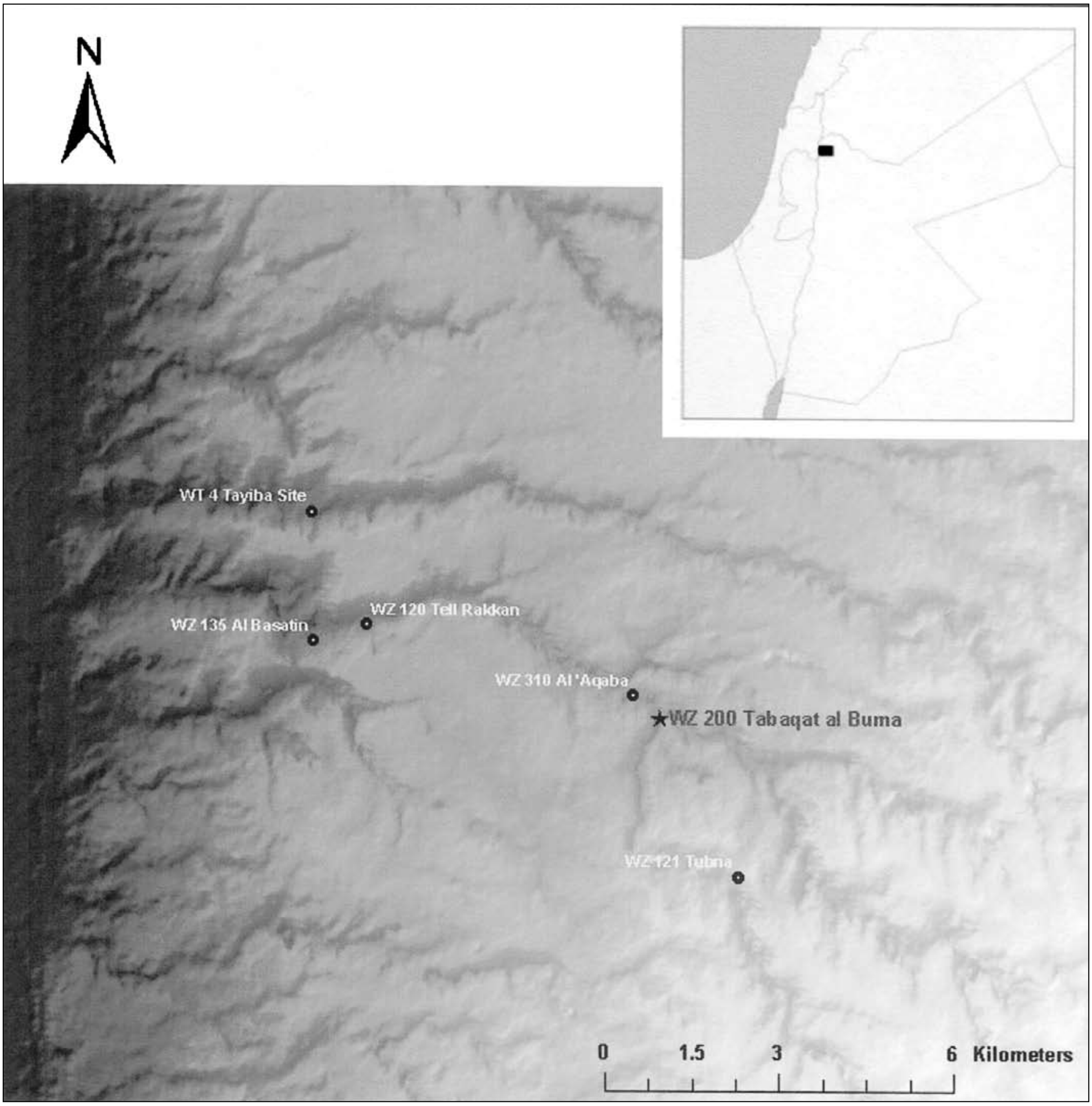
The organization of domestic space in the ancient Levant has become a topic of great interest to Near Eastern archaeologists, and much excellent recent work has been focused on intra-site architectural and artifactual spatial patterning (Banning and Chazan 2006; Gibbs *et al.* 2002). However, relatively little attention has been given to the organization of space within individual living areas, especially for individual living surfaces at prehistoric sites. Typically, the only data readily available for such studies are the placements of major architectural features such as walls, doors, hearths, grinding querns and slabs, and windows. The assignation of function to architectural features is a bias-laden process, however, and arguments about the internal designation of within-room spaces are rarely made without some other contextual data. In general, researchers support such architecturally based hypotheses with the spatial patterning of larger artifact types, such as handstones, flaked lithic artifacts and debitage, animal bone and pottery, but these data are themselves problematic. The spatial patterning of these larger-sized artifacts is more likely to be affected by site formation processes (Brooks and Yellen 1987). Therefore, their location as recorded during archaeological recovery may be very different from where they were initially deposited (LaMotta and Schiffer 1997).

The spatial patterning of micro-artifacts, commonly defined as any human-produced debris smaller than about half a centimeter, may more directly reflect ancient activity areas (Hodder and Cessford 2004). Formation processes may have less impact on their spatial patterning, and they may remain closer to where they were deposited than larger artifacts (Baker 1978; Fladmark 1982; Hayden and Cannon 1983; LaMotta and Schiffer 1997; Rosen 1993). Micro-artifacts are also more likely to be deposited close to where the activities that produced them were located. Therefore, significant quantities of micro-artifacts with differing proportions of micro-artifact types should accrue where certain activities or suites of activities were routinely performed. Finally, although micro-archaeology was once considered to be tedious and time-consuming, new sampling strategies and study methodologies make these types of small sized artifacts quite easy to analyze (For more detail see Ullah and Banning n.d.).

Case Study

This paper describes the results of new sampling and spatial analysis methods applied to micro-archaeological deposits recovered from a single living floor from the Late Neolithic site of Ṭabaqat al-Būma, excavated from 1987-1992 by the University of Toronto's Wādī Ziqlāp Project (Banning 1995, 1996; Banning *et al.* 1994; Banning and Siggers 1997; Blackham 1997; Kadowaki 2007). The location of Wādī Ziqlāp in northern Jordan, the location of Ṭabaqat al-Būma within the project area and the locations of some of the other major nearby Neolithic and Chalcolithic sites are shown in Figure 1.

The Late Neolithic in northern Jordan is characterized by a major shift in settlement patterns and technology. In Wādī Ziqlāp, settlement changed dramatically between the Pre-Pottery Neolithic (PPN), when people lived in villages in which houses were tightly clustered, and the Pottery Neolithic (PN) where people lived in dispersed small farmsteads, each with few houses (Banning *et al.* 1994). In the Late Neolithic coarse-ware pottery becomes common. Although most often these are plain-wares, incised, painted and burnished deco-



1. The location of Ṭabaqat al-Būma in northern Jordan, and other important nearby Pre-Pottery Neolithic, Late Neolithic, and Chalcolithic sites.

rations are also found (Banning *et al*. 2004). Flint cores from the period are mainly amorphous; the bulk of debitage comprises flakes and angular shatter. Non-formal retouched flakes make up the majority of lithic tools recovered from Late Neolithic sites in Wādī Ziqlāp (Banning and Siggers 1997). Sickle elements, the main formalized tool class, are made on both flakes and blades and are denticulated and highly retouched (Kadowaki 2005).

Ṭabaqat al-Būma was occupied in four distinct architectural phases from ca. 7700 to 6200 cal BP. It probably never housed more than three households, or around 20 people. Although some architecture from previous phases was visible during the later phases, and although the buildings may have been reused for other purposes, each building was probably only occupied as a living space during the phase in which it was built. Although much of the site was intact, some parts had been obviously disturbed.

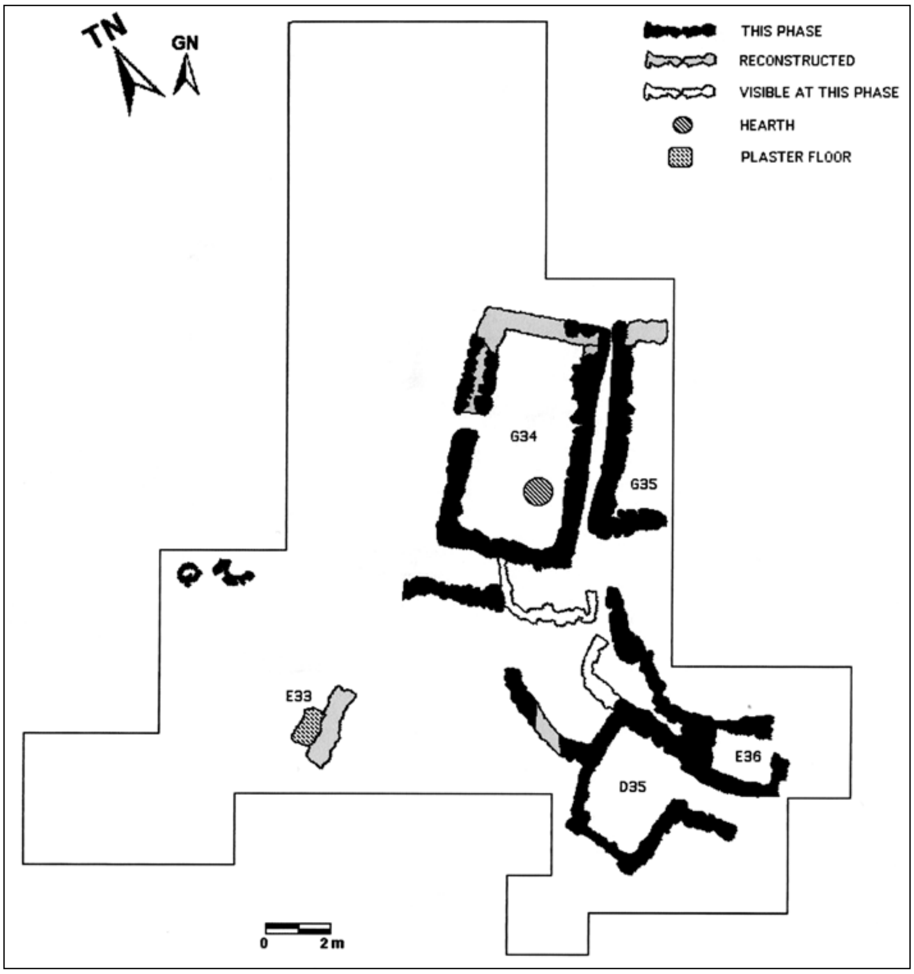
Sampling and Labwork

Many of the intact parts of living surfaces identified in houses at the site were sampled for micro-refuse. Structure G34 was chosen for this first analysis because it is a comparatively large room with a large section of intact floor that had been (fairly) securely sealed by layers of clay and fill. The structure belongs to the LN3 phase (originally designated Phase 2, (Blackham 1997)), which means it dates roughly to the interval between 5700 and 5330 cal. BP (Banning 2007) (see FIG. 2). The G34 floor was sampled for micro-artifacts using a grid of 50 by 50 centimeter square. All sediment from 2-3cm. above the floor and from in between cobbles of the floor was collected from each grid square. The heavy fraction of each sample was removed by flotation and size-sorted through a series of nested sieves.

The 1.4-2 mm. size-class was chosen as our micro-refuse sample; many analysts counted artifacts from 3cm^2 sub-samples from each grid square. We tracked the analysis history of each analyst and removed data collected by analysts who were consistently marking counts very different from the mean. The mean density per grid square of each micro-artifact type was then calculated as a cluster sample. Macro-artifacts, defined as any artifact larger than half a centimeter, from each grid square were also sorted, counted, and described. In addition, several attributes were recorded for the macro-sized lithic artifacts. Density per grid square of each macro-artifact type was then calculated from these raw counts.

Density Surface Interpolation

These density data were inputted into a database and, using GRASS GIS (GRASS Development Team 2007), were spatially associated with the center of each grid cell. Using regularized spline-tension interpolation (Mitasova and Mitas 1993),



2. Plan of architecture extant during phase LN3 at Ṭabaqat al-Būma, showing the room G34 in its context with contemporary structures (after Blackham 1997).

a series of 'density probability surfaces' were created from the grid square density data. Essentially, this process uses the data from each known point and 'fills the gaps' between them on the basis of an adjustable mathematical curve, which also accounts for the values of squares in the neighborhood of each point. The resulting maps are visually pleasing and much easier to interpret than a coarse-grained grid of density numbers.

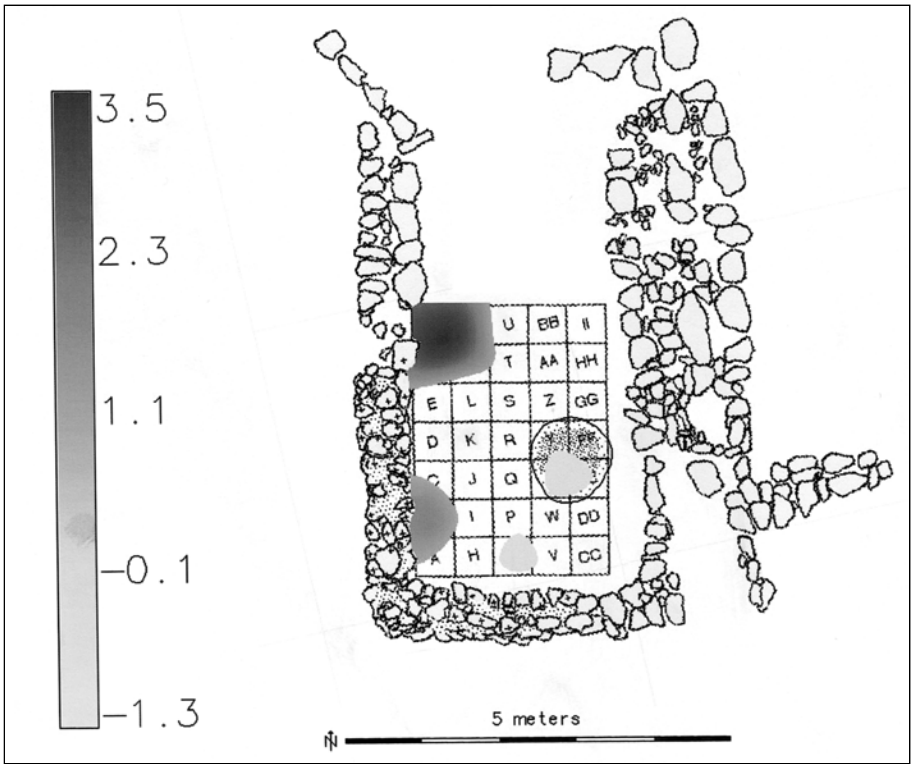
These maps, however, only show the raw density of the different micro- and macro-artifact classes, which are not standardized and therefore difficult to compare. Therefore, each map was converted, using map algebra, into Z-score units away from the mean, thereby facilitating inter-map comparison. These Z-score maps are then re-colored to highlight densities that are more than one standard deviation away from the mean. This distinguishes areas that have artifact densities that are *significantly* dense or *significantly* sparse from areas with average densities of artifacts. The artifact deposits in significantly dense patches likely result from de-facto refuse left very near to where they were originally deposited, whereas artifacts deposited in areas with average density values are more likely to have been secondarily deposited and are therefore more likely to constitute background 'noise' associated with formation processes (see FIG. 3).

Cluster Analysis

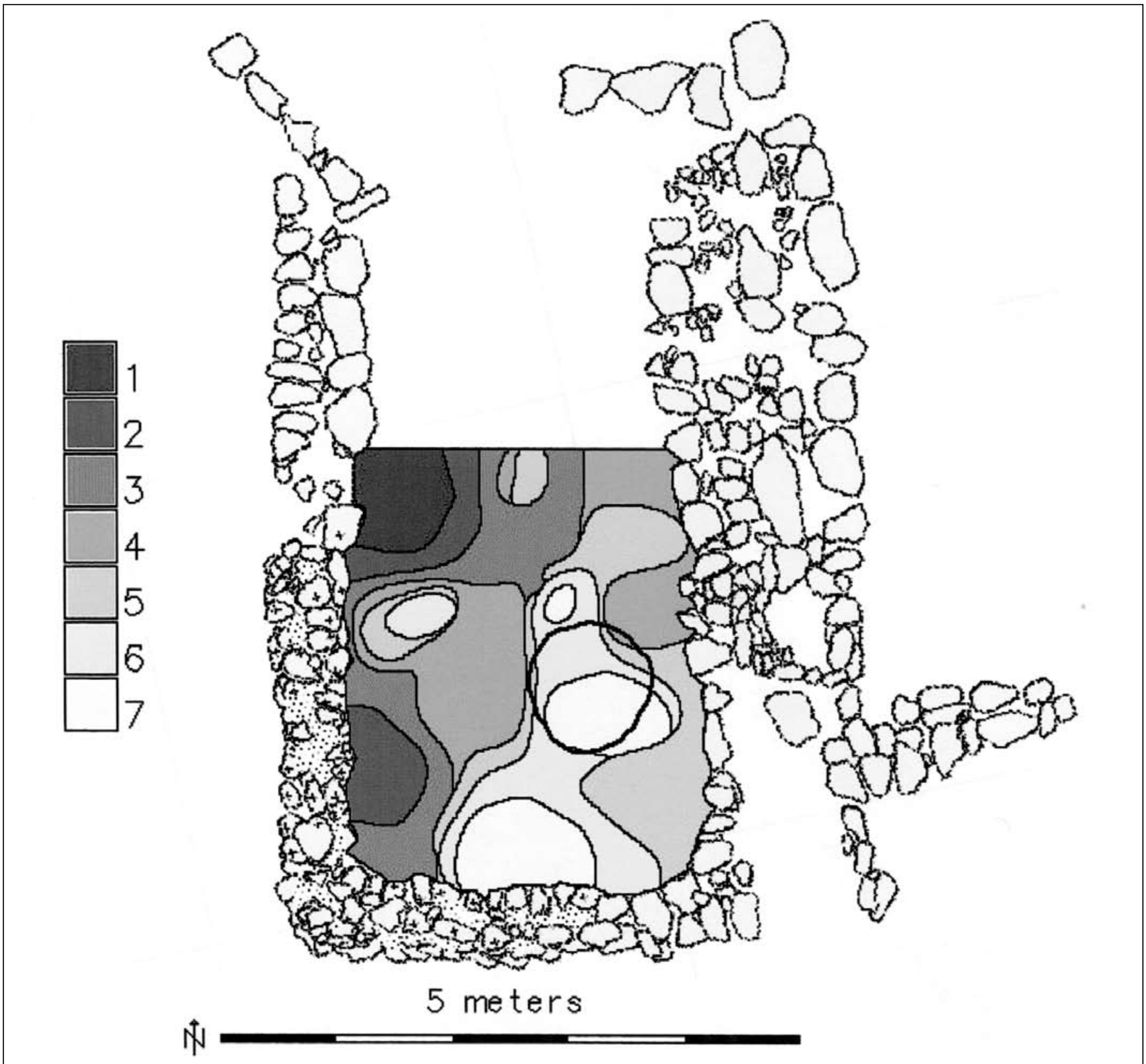
Although the Z-score standardized maps make it easier to compare the density distributions of the different macro- and micro-artifact classes, the sheer number of dimensions that could be compared makes it functionally impossible to compare all of them visually. Fortunately, this procedure can be automated with cluster classification routines developed for use with multiband satellite imagery (Lillesand *et al.* 2004).

This process entails three stages. First, a series of artifact density maps are 'stacked' like layers of transparencies to make a multiband image. Then software — Multispec (Purdue Research Foundation 2006) — is used to perform an unsupervised classification of the stack of maps, which compares the spectral 'signatures' from each band at each pixel of the image and classifies all pixels with similar signatures into clusters (FIG. 4). The artifact composition of each resulting cluster indicates the relative importance of specific artifact classes in the areas defined by the cluster's boundaries (FIG. 5).

In order to ensure that this type of cluster analysis produces the meaningful results, it is important to constrain the number of layers used in each classification process. In this study, micro-artifact density maps are analyzed separately from macro-artifact density maps. In addition, several other lithic



3. Example of a Z-score transformed density map, showing the density distribution of flint micro-debris. The map has been clipped at one standard deviation away from the mean to reflect areas of significantly high or low density.



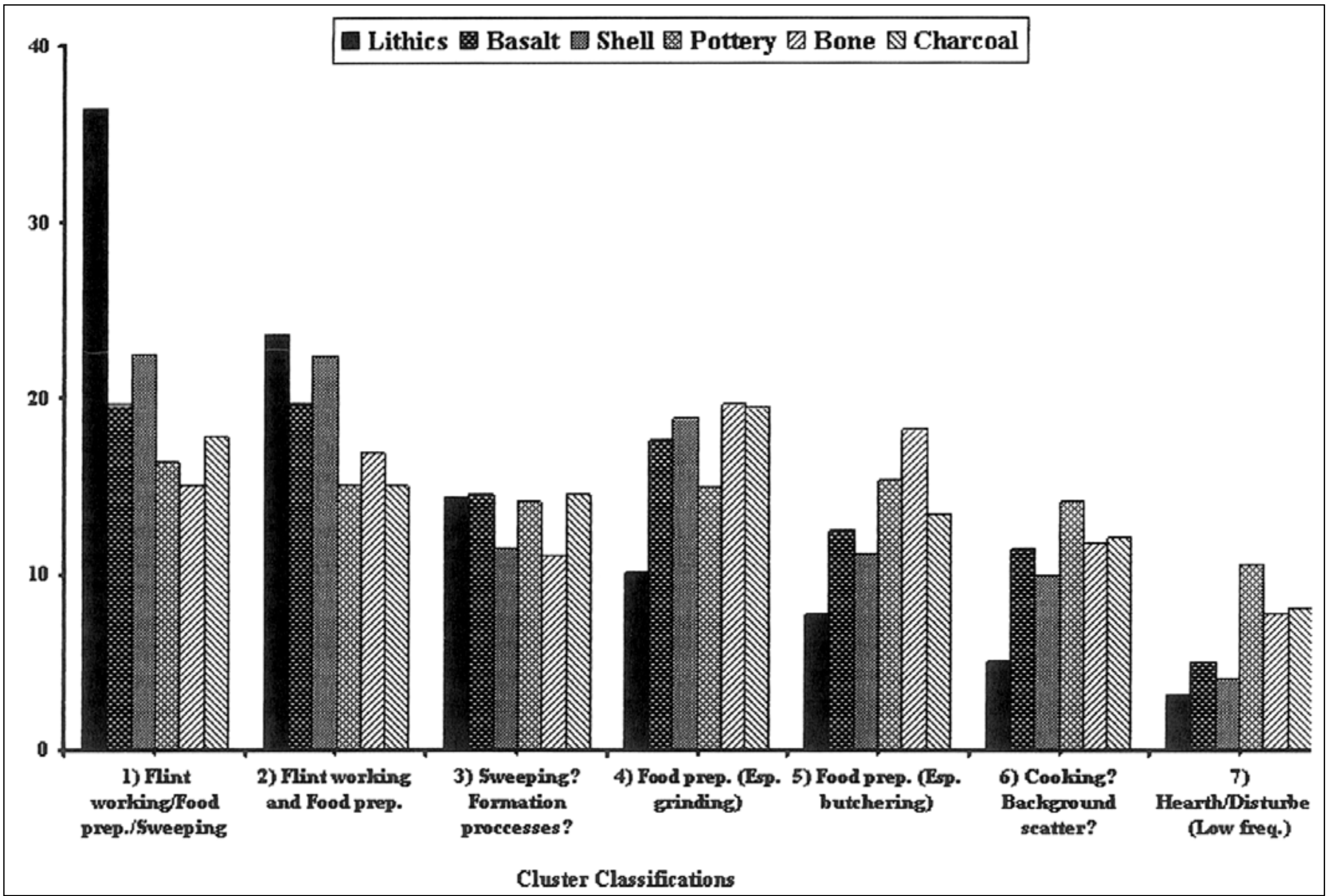
4. Example of the results of cluster classification, showing a spatial representation of the seven cluster solution for micro-refuse artifact types. The artifact types are: lithics, basalt, shell, pottery, bone and charcoal. The cluster classes are: (1) flint working / food prep. / sweeping, (2) flint working and food prep., (3) sweeping (?) and formation proccesses (?), (4) food prep. (esp. grinding), (5) food prep. (esp. butchering), (6) cooking (?) and background scatter (?), and (7) hearth / disturbed (low freq.).

attributes were also analyzed independently.

Results

Architectural study revealed three features: a plastered hearth, the threshold of what was most probably the house's main doorway, and small anomaly on one wall that may indicate the presence of a window. Some initial hypotheses can be generated from these data. Food preparation probably took place near the hearth, refuse was probably swept out of the door, and activities needing natural light probably took place near the door and window. These hypotheses are extremely tentative and generalized, however, and no further conclusions can be drawn based on these architectural analyses alone.

Summary visual analysis of the Z-score transformed artifact density maps yields some further

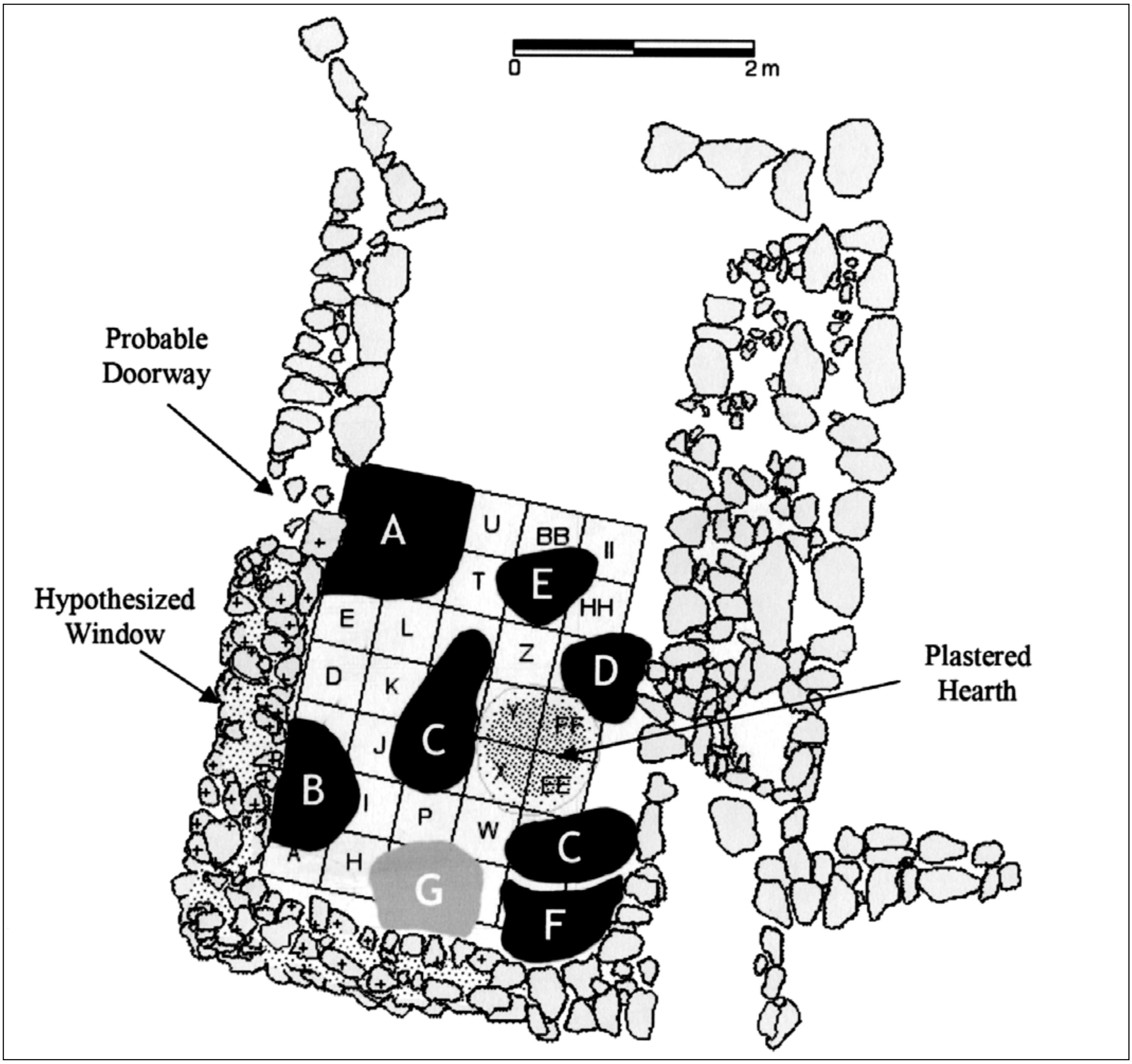


5. Example of a cluster composition graph, displaying the cluster compositions for the seven cluster solution for the micro-refuse cluster solution mapped in figure 4.

trends. There are discrepancies between the distribution of similar artifact types between size classes, especially chipped stone debitage and pottery. Importantly, this indicates that the presence of high amounts of micro-debitage and micro-pottery are not the result of *in situ* fragmentation of the larger sized artifacts. Many of the significantly dense areas surround the hearth and concentrate under the hypothesized window and near the door. Interestingly, there also seems to be a major concentration of burned artifacts just to the north of the hearth and an interesting spot along the south wall with very low amount of chipped stone chunks, but a high concentration of complete flakes of very similar length.

These trends are further quantified by the results of the cluster analysis. Seven distinct clusters of micro-artifact, eight clusters of macro-artifact and five clusters of lithic artifact were identified. The probable depositional characteristics of each cluster type can then be hypothesized based on the spatial distribution, artifact composition and proximity to the identified architectural features of each cluster.

The final hypotheses about the organization of internal space in room G34 at Ṭabaqat al-Būma are mapped in Figure. 6. These hypotheses take the results of the architectural analysis, the Z-score mapping analyses and the cluster analyses into account. The first area identified (A) seems to be where people manufactured and / or used flint tools. They may also have cached those tools in this area, and probably used or manufactured groundstone implements here as well. Additionally, it seems that rubbish from the rest of the floor was swept towards and out of what was most likely a doorway. Therefore, this seems to be an area where several different types of activities occurred, probably because of the abundance of natural light and the ease of access to both outdoor and indoor spaces. The second area (B) seems to be a place where people also manufactured and / or used flint tools and ground-



6. Map of final hypotheses of activity areas and architectural features: (A) flint tool manufacture / use, tool caching, groundstone manufacture / use and sweeping, (B) flint tool manufacture / use, groundstone manufacture / use and shellfish processing, (C) processing of animal remains, grinding and cooking, (D) shellfish processing, grinding and cooking, (E) provisional discard of hearth debris, (F) flint flake storage / provisional discard, and (G) highly disturbed area.

stone. In addition, people also seemed to be processing shellfish in this area. That these activities would also have benefited from extra natural light adds some support to the hypothesis that the anomaly in the portion of the wall at this location is the remains of a window. The third area (C) is a disjointed cluster to the west and south of the hearth, where people seemed to have preferentially processed animal remains, and where they processed — perhaps by grinding or pounding with basalt implements — and then cooked various foodstuffs. The fourth area (D) is to the north-east of the hearth, and seems also to have been where people not only also ground / processed and cooked foodstuffs, but additionally was another location where they processed shellfish. Both of these areas are located near to the plaster hearth, lending some credence to the initial hypothesis that the hearth was the center of food processing and cooking. Next is an area (E), just adjacent to area D to the north of the hearth. This seems to have been used for provisional discard of hearth debris. An abundance of large burnt lithic debris in this location indicates that the central hearth may have also been used to heat treat flints. Additionally, significant quantities of burned macro-sized bone and pottery were found here. These artifact types are probably detritus related to cooking that were secondarily deposited in this area, which is between the hearth and the doorway — thereby making it easier to finally dispose of cooled hearth debris. The final identified activity area (F) is in the south-east corner of the house, and seems to have been used for flint flake storage or provisional discard. A highly disturbed location (G) was also identified and is characterized by low densities of artifacts, but high densities of intrusive eco-facts such as freshwater snail shell and uncarbonized botanics. The artifact deposition in all other areas was most probably the result of cultural or natural formation processes. These can be considered areas where activities that left no significant residues were performed, where large furnishings may have been placed, or where everyday cleaning significantly decreased the quantities of even the small-sized artifacts.

Conclusions

This study provides evidence that the people of Late Neolithic Ṭabaqat al-Būma performed many activities inside their houses. Unsurprisingly, they organized these activities with respect to the architecture of the building and with a regard for the practicality of performing activities in appropriate locations. Specifically, they performed food preparation near the hearth, and even seemed to prefer particular areas around the hearth for these activities. They preferred to manufacture or use stone tools in areas with abundant natural light and where they had easy access to outdoor spaces. People cleaned out their hearth periodically, provisionally discarding hearth refuse in the house, perhaps to sort through the ashes for reusable items such as heat-treated flints or burned bones, before discarding the ashes outside. People also swept the house, probably on a regular basis, and directed the debris out of what was most probably the main doorway.

Architectural analysis alone cannot yield such detailed interpretations about the use of internal space with any sort of confidence. The spatial distribution of larger-sized artifacts can help to increase the complexity and accuracy of these types of hypotheses, but is itself plagued by errors due to the predisposition of macro-artifacts towards post-depositional disturbance by site formation processes. The addition of a spatial analysis of micro-artifacts, which are much less likely to have been significantly displaced since deposition, helps greatly to identify and characterize ancient activity areas and yield hypotheses about within-room use of space that are otherwise unattainable. Indeed, these conclusions were only made possible by detailed study of the distribution of artifacts of different size classes through proper sampling procedures and a new, efficient, analysis with GIS.

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