Cultural Logic and Practical Reason: the Structure of Discard in Ancient Maya Houselots

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Since the 1980s, archaeologists have challenged the idea that prehistoric actions were guided primarily by practicality and expedience. Rubbish disposal, a superficially mundane activity, provides a critical case for exploring the depth to which cultural logics penetrate. Ethnoarchaeological research on discard behaviour in Mesoamerican houselots has modelled rubbish disposal as a matter of expedience predictable by factors such as density of settlement and length of occupation. At the Classic period site of Chunchucmil, Yucatan, such models based on practical reason succeed only partly in predicting the distribution of rubbish. Ethnographic and ethnohistorical accounts of rubbish in Mesoamerica suggest that fully understanding its distribution requires attention to cultural logics. At Chunchucmil, ancient Maya cosmology explains the location of dumps within households. Thus, both practical and cultural logics structured discard. The case of Maya subsistence farming suggests that practical logic is subsumed by cultural logic, rather than the two logics conflicting. These findings show how broadly-held beliefs and predispositions are instantiated and reproduced in daily life.

This article uses patterns of ancient trash disposal to address the tension between what Marshall Sahlins has called cultural and practical logics (see also Wilk 1996, 3–13). In practical logic, culture 'is precipitated from the rational activity of individuals pursuing their own basic interests' (Sahlins 1976, vii), seeking to maximize efficiency with regard to time, energy, and resources. Practical logic is an economizing logic in which utility determines custom and convention. On the contrary, in a cultural logic, utility depends on custom and convention. The usefulness of an item or activity depends not on cross-cultural, universal assessments of value in terms of energy or time but on how it is understood and valued from a socially and historically contingent system of symbols. Rationality is culturally relative and economy is embedded in such symbol systems.

The perspective of practical logic dominates most interpretations of the disposal of day-to-day rubbish. This appears clearly in literature on formation processes. For example, in the essay that laid the foundation for this sub-discipline, Schiffer (1972, 161–2) argued that people living in densely occupied sites will remove rubbish from activity areas because rubbish gets in the way of continued activities. Practical logic governs this example because in crowded sites with less space for activity areas it is more convenient — more practical — to move the rubbish as opposed to moving the activity areas. Of course, Schiffer did not intend to take a stand on cultural versus practical logic, but rather to get archaeologists to stop assuming a one-to-one spatial correspondence between the archaeological context of rubbish and the places where it was produced. Subsequent contributions to behavioural archaeology also presume a practical logic (Schiffer 1976; Hodder 1983). Thus, as an unintended consequence of an otherwise invaluable contribution, interpretations unreflectingly steeped in practical logic pervade most studies of everyday discard behaviour.

Yet Deetz's treatment of trash disposal in colonial North America clearly demonstrates the influence of

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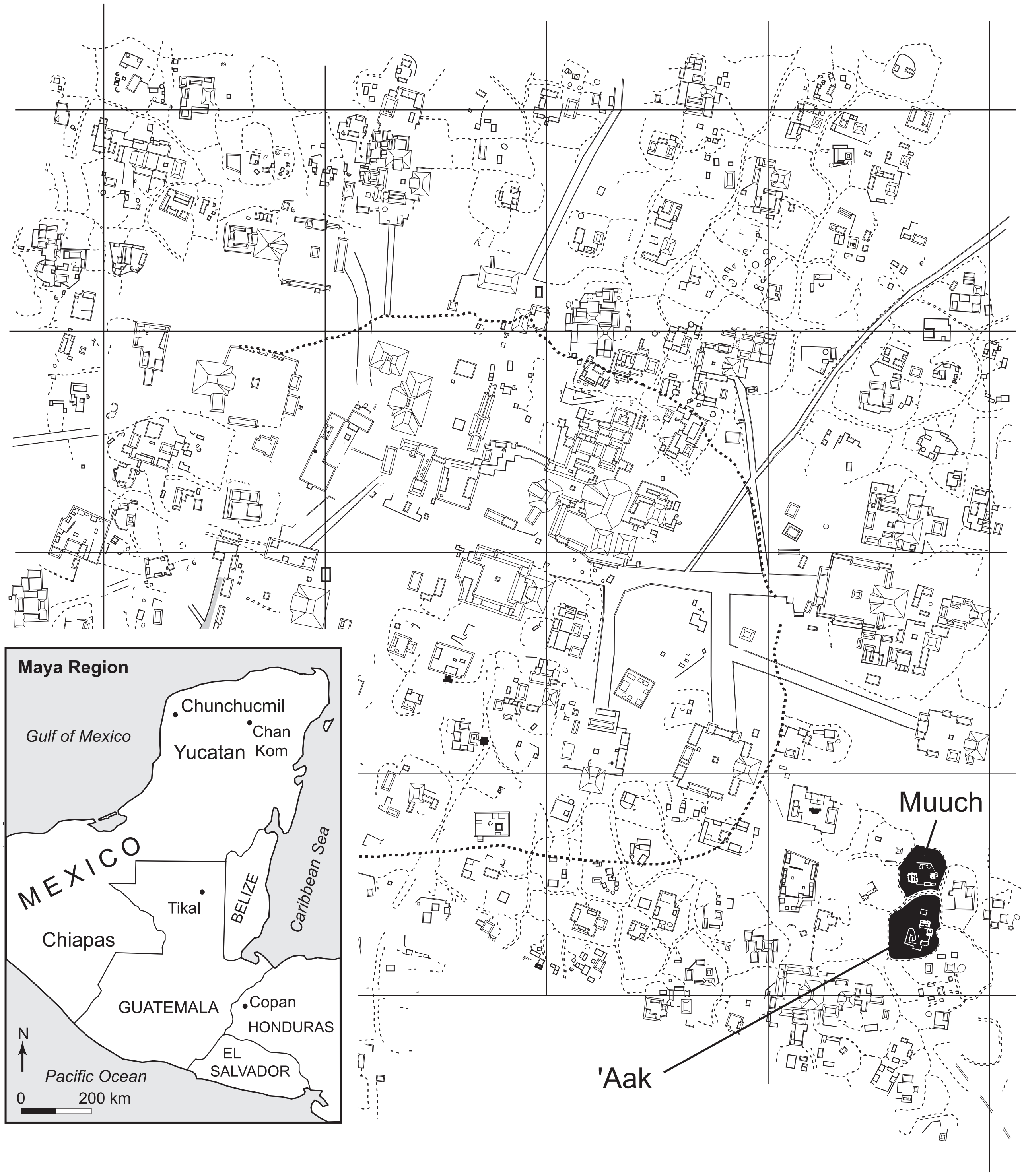

Figure 1. *Map of Chunchucmil site centre, identifying 'Aak and Muuch houselots. Inset map represents Maya region with contemporary political boundaries.*

cultural logic on discard behaviour. In the latter half of the eighteenth century, New Englanders ceased throwing refuse out their doors indiscriminately, creating broad, scattered sheets of debris, and began tidily dumping it into pits often dug for that purpose. Deetz (1977, 126) noted that population increase and

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concentration do not account for the timing of this change in behaviour. He therefore attributed this change as well as many other transformations in early American material culture to 'a newly emergent world view characterized by order, control, and balance' (Deetz 1977, 60). In this case, cultural logic does not oppose practicality. Rather, actions that are not maximally efficient in terms of energy expenditure can be practical and sensible from within a particular world view.

Deetz's example shows that the lack of attention to the embeddedness of practicality within cultural logic can represent a shortcoming in studies of discard behaviour and site structure (see also Hodder 1983, 62–5). Unfortunately, this shortcoming is grave because much of archaeology, particularly household archaeology, builds from basic assumptions about rubbish and how it is patterned. Additional examples of the nuanced interplay between cultural and practical logic are therefore pertinent not only to specialists in formation processes but also to archaeologists interested in the structures of meaning that condition daily practices in any part of the world. In this article, we use data from the Classic period Maya site of Chunchucmil (Fig. 1) to show that cultural and practical logics can be identified from even the most mundane of archaeological contexts: domestic refuse. The conclusions we reach imply an understanding of cultural and practical logics that contributes to general understandings of the relation between ritual and rationality (see Brück 1999).

We begin by exploring the theoretical foundations of cultural and practical logic because we find that the tension between the two clarifies the roots of social archaeology. We then discuss ethnoarchaeological models of waste management in Mesoamerica. These models are based in practical logic yet have not been thoroughly evaluated with Prehispanic data. After demonstrating that Chunchucmil's site structure makes it an ideal test case, we use data from three houselots at Chunchucmil to evaluate the ethnoarchaeological models' ability to predict ancient patterns of rubbish disposal. Since the results show that practical logic does not account for all of the patterning in these houselots, we then use traditional Maya farming as an example of how both practical and cultural logics may operate within a seemingly utilitarian activity. We then present Mesoamerican ethnohistorical precedents for cultural logics that structure behaviour toward broken pottery. Finally, we present patterns of broken pottery disposal from several contexts at Chunchucmil that foreground the presence of cultural logic.

Cultural and practical logic

In providing a background for cultural and practical logic, we use Marx because, in his early work, he framed the debate in a way that eloquently exposes the differing visions of human nature that underlie the two logics. Cultural logic can be seen to originate from the belief that humans are inherently social: 'just as society itself produces man as man, so is society produced by him' (Marx 1961, 103). Marx argued that society shapes people's tastes, talents and dispositions to such a degree that no person stands alone: a person is always accompanied by the accumulated cultural perspectives of previous generations (Marx 1961, 105; see also Giddens 1971, 13–14). Always inhabited by these perspectives, people never experience the world as is: social life moulds the senses to the point that even the most basic observation is at once an interpretation. 'The *senses* have therefore become directly in their practice *theoreticians*' (Marx 1961, 107). These points show that, in his early writings, Marx held that a person's sensibilities can only be understood in relation to social and historical context. 'The forming of the five senses is a labor of the entire history of the world down to the present' (Marx 1961, 108). The way historic context mediates people's relation with the world sets humans apart from animals (see also Ingold 1988). 'What distinguishes the worst architect from the best of the bees is this, that the architect raises his structure in imagination before he erects it in reality' (Marx 1976, 178). Marx's understanding of the historical malleability of the senses prefigured Boas's (and Benedict's: Sahlins 1999, 413) understanding that 'the seeing eye is the organ of tradition'. The position that symbolic behaviour is the defining characteristic of humanity established the basic condition for a forceful array of twentieth-century anthropologies: structural (Levi-Strauss 1963), interpretive (Geertz 1973), symbolic (Dolgin *et al*. 1977; Douglas 1970).

Marx argued that the capitalist view of economy reduces people to the status of animals. In the capitalist view, rife with practical logic, human needs are equivalent to the minimal conditions for survival and humans do what is most practical to satisfy these needs. Trans-historical and trans-cultural, these needs are non-historical and non-cultural, given not by society but by biology. In this view, humans are severed from the social relations into which they are born and robbed of the social and historical sensibilities that mediate their experience of the world. This severance represents alienation. Alienation underlies the logic of rational maximization, which itself forms the foundation of various approaches in anthropol-

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ogy, such as cultural materialism, formalist economics (Burling 1962; Cook 1966), optimal foraging theory (Winterhalder 1981) and complexity theory (Kohler & Gumerman 2000). Evolutionary approaches to agency, such as Boone's, highlight the alienation at the core of practical logic (Boone 1992). In Boone's analysis, individuals pursuing their interests precede social groups, and, if social groups do form, they form only if the benefits of joining a society outweigh the costs.

The way we have framed the distinction between cultural and practical logics lends itself to two misreadings. In the first misreading, the tension between culture and practical logic appears as a gloss on the dichotomy of idealism and materialism. Both cultural and practical logics appreciate the limits imposed by humanity's biological existence in a material world. Cultural logic is not simple idealism because it recognizes biological needs (while noting that most 'needs' are culturally constructed). Yet cultural logic departs from practical logic by noting that there are always many ways to satisfy basic biological needs and the particular way that one society satisfies these needs is not necessarily the best from an economizing standpoint. A classic case is dietary taboos, which have been examined from the standpoint of both practical and cultural logics (Douglas 1966; Harris 1987; Sahlins 1976).

The second misreading is to see the difference between cultural and practical logic as a dichotomy in itself. The alienation that, according to Marx, underlies utilitarian approaches is a historical product of capitalism (Giddens 1971). Rational maximization can be seen as a product of history. This line of argument parallels the position that rationalization is culturally relative, a position which sets a trap for archaeological inquiries into the logics of the ancient mind (Stanton 2004). Neoclassical economics presents a position that subsumes cultural and practical logics in a somewhat different way: behaviours that do not maximize economic utility, that appear to follow a cultural logic, nevertheless fit within a practical logic insofar as they serve to maximize other aspects of human well-being, such as love or security (Wilk 1996, 9). Thus, though history and culture may determine what is considered valuable (and that which is considered valuable may in fact be impractical or wasteful in terms of time, energy and resources), actors attempt to maximize these values through rational, practical strategies.

In archaeology, tension between cultural and practical logic peaked in the 1980s when ecological and processual approaches were challenged by textual and symbolic approaches. These new approaches emphasized cultural logics in their insistence that material culture was meaningfully constituted (Hodder 1986). Everyday rubbish was recognized as an important category of material culture and ethnographic examples were marshalled to show that what rubbish means, and therefore how it is discarded, depends on historically and culturally particular contexts as opposed to 'universal' principles such as efficiency. Henrietta Moore (1986) presents an excellent case study in which the Marakwet, in Kenya, separate ash, chaff, and dung and, because of the symbolism that these materials gain through association with male or female activities, dispose of them in discrete locations according to the differently gendered spaces within the houselot. In his study of the nearby Ilchamus on the south side of Lake Baringo, Ian Hodder recorded a similar set of gendered associations regarding ash and dung. Ash, which is almost always kept separate from other trash, has multivalent and powerful symbolic associations that condition who can handle it and where it can go. How ash is handled 'is not functionally expedient except in relation to values which the Ilchamus have themselves historically constructed' (Hodder 1987, 442; for additional case studies, see Hodder 1983, 62–5; Lightfoot *et al*. 1997; Okely 1975).

Nevertheless, as Brück (1999, 325) has noted, prehistoric case studies that challenged functional expedience relied on exceptional archaeological remains, such as burials, iconography, monuments, caches, and structured deposition. Though archaeologies of daily life were also burgeoning in the 1980s, the mundane activities studied by archaeologists of households did not play a large part in this debate. One of the best known archaeological studies of houses from within symbolic archaeology (Hodder 1984) focused on the relation between house form and ritual space but did not delve into the logic of daily practices in and around the house. Articles by Brück (1999) and Walker (2002) represent productive steps forward. Brück's paper is particularly germane to our discussion because it builds on a contribution by Barrett (1991) that is grounded in Marx's point, highlighted above, that humans do not perceive the world 'as is' but interpret it through historically and metaphorically moulded faculties. This point eliminates the dichotomy between the ideal and the real and, in doing so, eliminates the dichotomy between symbolic and practical action. In other words, 'practical' action is at the same time symbolic and cultural because it is performed in and on a world understood through historically malleable cosmologies and systems of values. At the same time, these systems of value — such as the one characterized by order, balance, and control in late eighteenth-century North America — are not abstract

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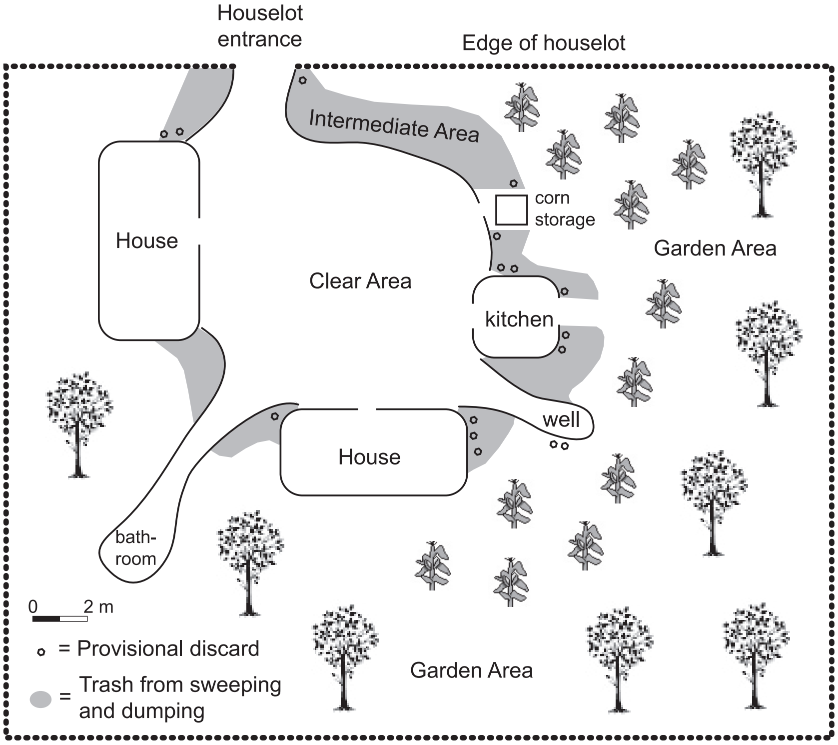

Figure 2. *Idealized representation of a Maya houselot (after Hayden & Cannon 1983).*

and ideal because 'they enable people to understand the world and to get on in it by providing a logic for action and an explanation of the universe' (Brück 1999, 326).

While Walker's test case focuses explicitly on ritual and Brück's on 'odd' deposits, we focus on the generally unremarkable residues that result from managing day-to-day waste. The seemingly mundane activity of discarding rubbish is implicitly cosmological. Hill (1995, 96), for example, has affirmed that 'daily refuse maintenance strategies will be structured through deep-rooted cultural norms' (see also Needham & Spence 1997, 86–7). We acknowledge the large body of Mesoamericanist literature focusing on debris that results from artefacts destroyed as part of termination rituals in domestic contexts (Freidel *et al*. 1998; 2003; Garber *et al*. 1998; Mock 1998; Stanton *et al*. n.d.; Walker 1998). Ours differs from these studies because we examine daily practice as opposed to irregularly performed rituals.

Domestic trash and the archaeology of Chunchucmil

In Mesoamerica, the prevailing approach to discard management comes from Hayden & Cannon's 1983 paper, 'Where the garbage goes'. This publication and others (Deal 1985; 1998) resulted from the Coxoh ethnoarchaeological project, centred in the highland Maya villages of Aguacatenango and Chanal (Chiapas, Mexico) and San Mateo (Guatemala). In their paper, Hayden & Cannon view discard as a matter of expedience and they use the perspective of rational maximization to make sense of rubbish disposal. For example, the three major principles they infer from discard management — economy of effort, hindrance minimization, and temporary retention of potentially reusable material (Hayden & Cannon 1983, 154) — all arise from a practical concern for saving time and energy. Later ethnoarchaeological projects conducted in the Matacapan region of Veracruz, Mexico, also treated refuse disposal as a matter of practicality and expedience (Arnold 1990; Killion 1992).

One of the most exciting aspects of these models and additional postulates from behavioural archaeology is that they entail many testable expectations. The expectations we will evaluate are: that the amount of space available should correlate negatively with the degree to which rubbish clusters in dense piles; that the length of occupation should correlate positively with the degree to which rubbish clusters in dense piles; that more effort should be spent disposing rubbish with high hindrance potential; and that more rubbish should be found in areas that are lower. In so far as these expectations exemplify practical logic, evaluating them using data from an ancient site helps to determine the degree to which ancient discard behaviour followed practical logic. Results that do not conform to these expectations would suggest that other cultural logics were at work.

Chunchucmil is an ideal site for evaluating these expectations because its residential spatial organization closely resembles that of the contemporary villages from which these expectations arose. Located in the dry northwest of Yucatan, Chunchucmil has evidence of occupation from the Middle Preclassic (700–300 BC) to the Late Postclassic (AD 1300–1519). The primary period of occupation dates from the Early Classic to the beginning of the Late Classic (AD 400–650/700). All of the contexts studied in this article were occupied in this period and most were occupied exclusively in

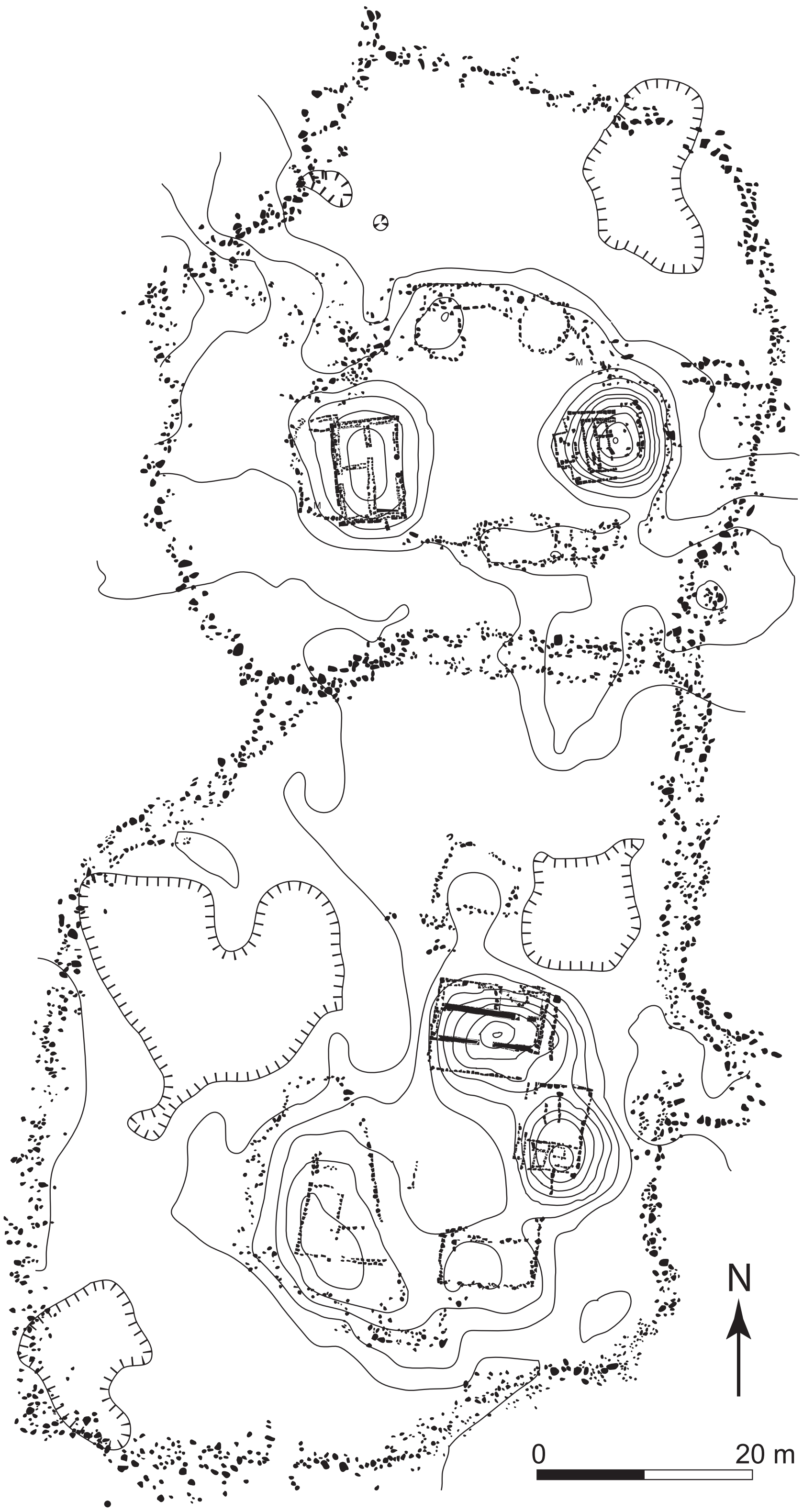

Figure 3. *Topographic map of the 'Aak (lower) and Muuch (upper) groups. Topographic lines represent 20 cm.*

this period. At its peak, Chunchucmil extended over more than 20 km^2 and its population most likely surpassed 30,000, making it one of the largest cities on the Yucatan peninsula. The apparent contradiction posed by the existence of a large site in a dry, agriculturally marginal region drew the attention of archaeologists surveying the peninsula in the 1970s (Vlcek *et al*. 1978). A multifaceted project begun in 1993 by Bruce Dahlin has clarified this contradiction through systematic mapping, regional survey, test-pitting, broad-scale household excavations, pedological and hydrological investigations and other lines of research.

Chunchucmil's vast residential zone comprises houselots encircled and separated from each other by low stone walls. Houselots in Mesoamerica and other areas of the world have three general spatial zones: a central patio; houses and auxiliary structures (kitchen, shrine, storage bin, etc.) which face onto the patio; and open space surrounding the patio and its associated structures (Killion 1992). Figure 2 shows an idealization of contemporary Maya houselots, while Figure 3 shows two ancient houselots from Chunchucmil. Elsewhere, we have argued that Chunchucmil's houselots, which usually contain two to four residences, were occupied by corporate groups with distinct social identities and long histories of attachment to their houselots (Hutson 2004; Hutson *et al*. 2004). Perhaps the most important similarity between the contemporary and ancient houselots is the walls that delimit the houselot boundaries. These walls, which are rare in ancient Maya sites, allow researchers to determine the amount of space available to a social group and to determine which garbage pertains to which group. Deal (1998) rightly warns that formation processes such as dumping into abandoned houselots disturb the ability to connect garbage dumps in a houselot with the original occupants of the houselot

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but, in the ancient lots examined in this article, several lines of evidence suggest that very little post-abandonment dumping occurred (Hutson *et al*. n.d.). Nevertheless, just as in contemporary houselots and most other ancient Maya domestic contexts (Johnston & Gonlin 1998), the vast majority of the debris in Chunchucmil's houselots is not in primary context.

During the period when the houselots under study were occupied, Chunchucmil was unquestionably larger and more urbanized than the contemporary towns and villages whose houselots furnished the observations that generated the practical models of discard discussed above (Chanal and Aguacatenango, for example, have populations of 3900 and 1900, respectively). Nevertheless, the houselots in contemporary settlements and houselots from the middle of the Classic period at Chunchucmil are approximately the same size, and the major productive activities that took place in them, a combination of gardening and small-scale craft production, are roughly alike. Finally, discard patterns in contemporary houselots and Chunchucmil's houselots are broadly similar (Hutson *et al*. n.d.). In sum, these similarities justify the use of Chunchucmil as a test case.

Practical logic in garbage at Chunchucmil: evaluating expectations

In this section, we evaluate the expectations of the ethnoarchaeological model using three systematically excavated houselots from Chunchucmil. Since many of the expectations presume that an economizing concern for efficiency governs the people who manage trash, evaluating the expectations serves to measure the degree to which practical logic pervades refuse discard.

Size of houselot and degree of concentration of trash

Hayden & Cannon noted that when less space is available to the occupants of a houselot, trash is more carefully maintained. Arnold (1990) as well as Santley & Hirth (1993, 7) speak more explicitly about the relationship between houselot size and refuse discard patterns: houselots with less space per resident will have concentrated trash dumps. This pattern results from the fact that smaller houselots have less space for activity areas. With space in high demand, the residents cannot afford to broadcast their rubbish indiscriminately. They will try to concentrate trash into specific spots. Occupants of larger houselots have more space and therefore can be less vigilant in maintaining clean areas. They will scatter their rubbish; concentrated trash dumps will be rare. The degree to which trash is concentrated into discrete dumps is also affected by the types and intensity of productive activities conducted both inside and outside of the houselot (Killion 1990; 1992, 136; Schiffer 1987, 59).

Practical reason — in the form of effort minimization — pervades this expectation. People will only expend effort in managing trash if they are forced to, if the trash gets in the way of basic household activities. Evaluating this expectation at Chunchucmil requires a comparison of the degree to which ancient occupants scattered trash across houselots of different sizes. As O'Connell (1987) and others (Johnston & Gonlin 1998) note, patterns of discard only become apparent by looking at broad spaces. In the case of Chunchucmil, the space of the entire houselot must be scrutinized. Since the non-structural space of the houselots is too large (mean = 3049 m^2, n = 75, s.d. = 1651) for complete excavation, determining the degree of scattering across houselots requires an excavation sampling programme (few artefacts at Chunchucmil are found on the surface). The sampling strategy used at Chunchucmil consisted of laying a 5 m by 5 m grid across a houselot and excavating 50 cm by 50 cm pits at the corner of each grid. This systematic strategy ensures excavation in every area of the houselot and results in a 1 per cent sample, consisting of about 100 pits per houselot. Owing to the substantial number of pits, only three houselots were selected. Two of these houselots, named 'Aak and Muuch (Fig. 3), are next-door neighbours in a dense neighbourhood close to the site centre (approximately 500 m from the site centre datum: see Fig. 1), while the third houselot, named Balam (Fig. 4a), is at the less densely settled edge of the site (2200 m from the site centre). All three houselots have roughly the same amount of architecture. 'Aak has 3200 m^2 of open space (above the site mean), while Muuch and Balam have 2000 m^2 and 2150 m^2 respectively (well below the mean).

According to the model, trash should be more evenly scattered in the 'Aak houselot than the Muuch and Balam houselots since the 'Aak houselot has more space. Since ceramics account for more than 90 per cent of the trash recovered at ancient Chunchucmil, we limit the current discussion of houselot size to this artefact class. Incidentally, the distribution of the other major class of debris, fragments of obsidian blades, closely resembles that of ceramics. Maps of sherd density in Balam (Fig. 4b) and Muuch and 'Aak (Fig. 5a) give a sense of the degree of scattering. To make a systematic comparison among the three houselots we constructed cumulative curves, ogives (Thomas 1986, 49) which express the frequency distribution of

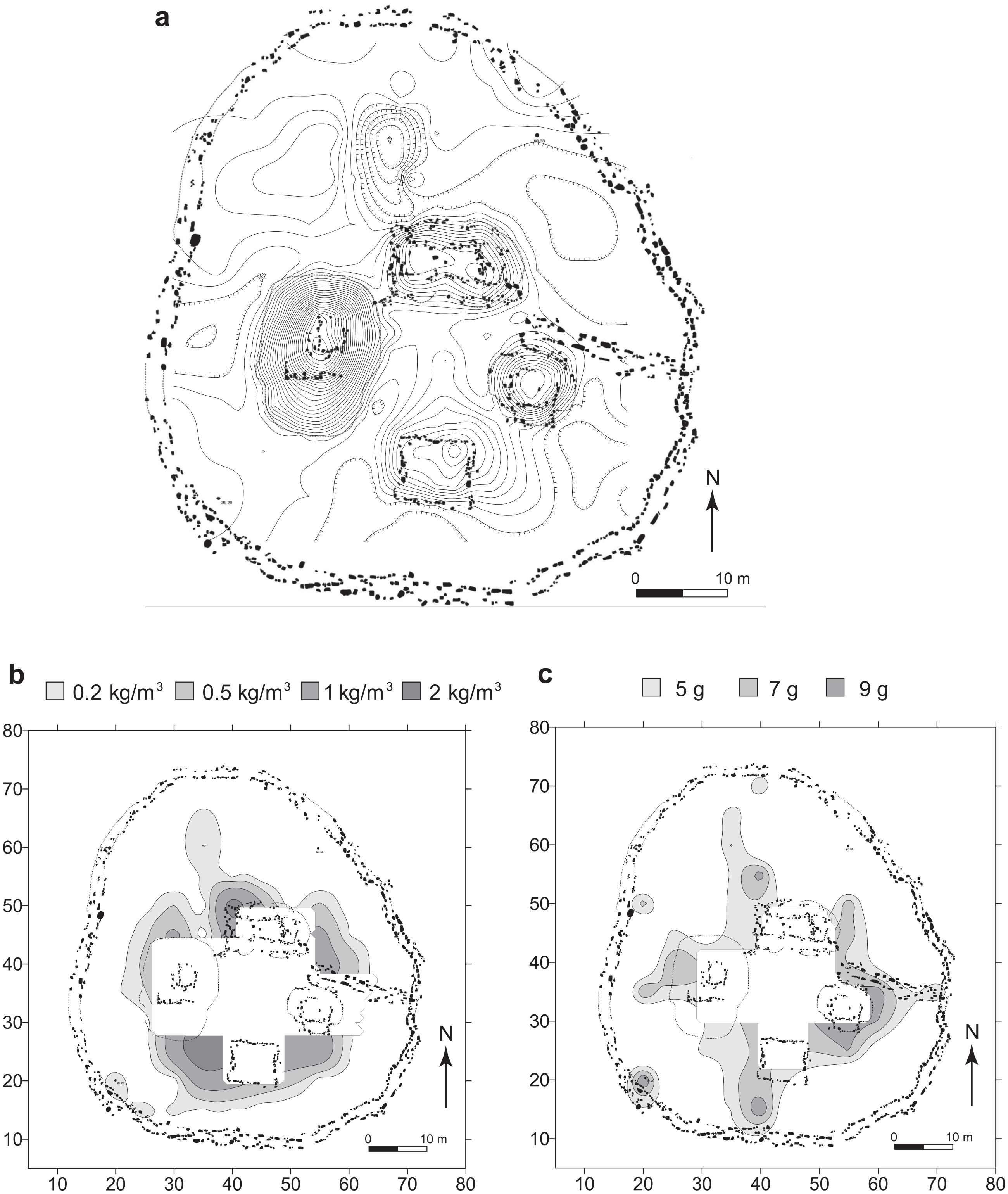

Figure 4. *a) Topographic map of Balam houselot (contour lines represent 15 cm elevation levels). b) Map of Balam ceramic density, non-architectural space. c) Map of Balam average sherd size. For b) and c) the grid is in metres and data for each excavation unit can be found in Table 1.*

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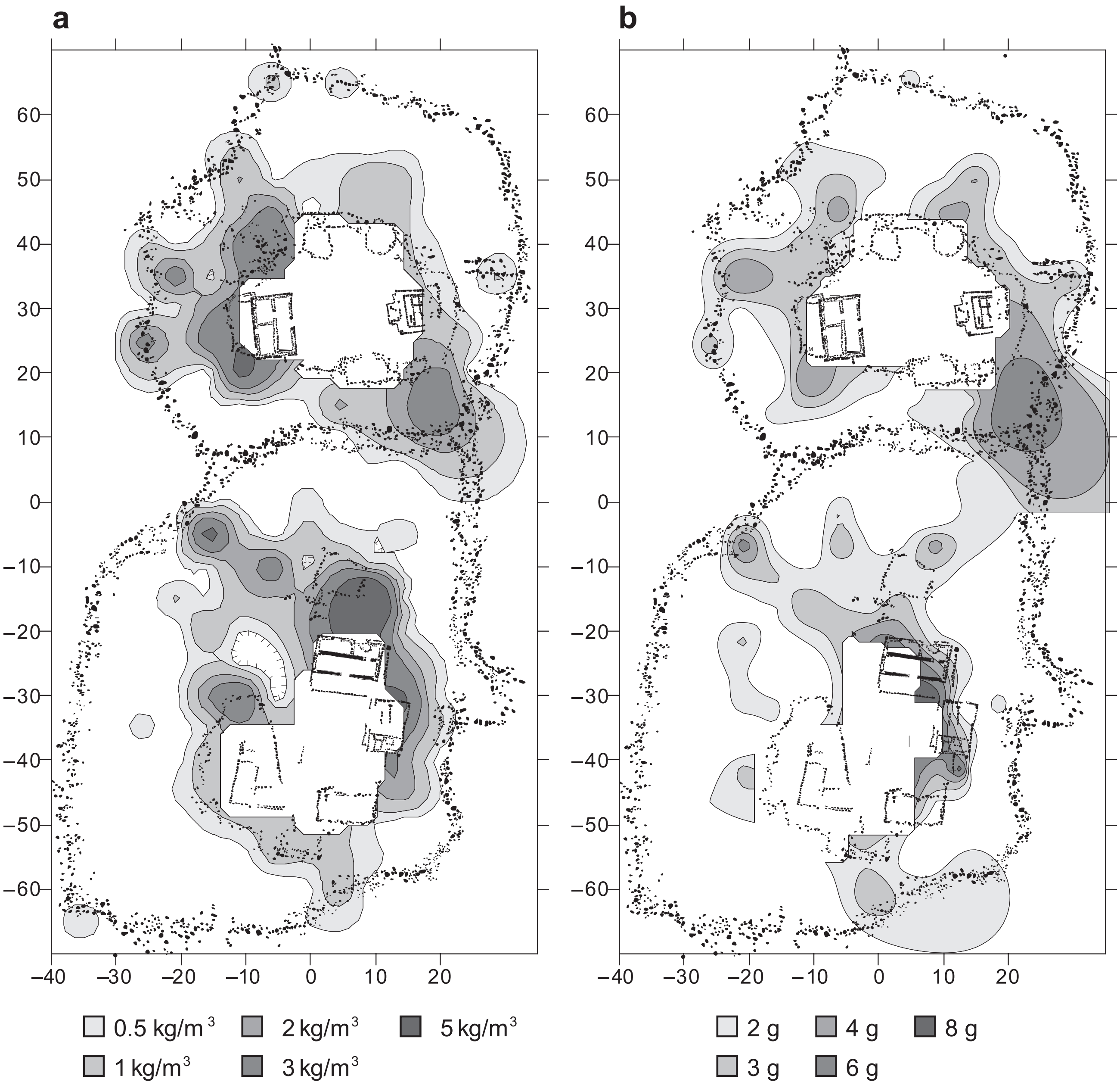

Figure 5. *a) Map of 'Aak (lower) and Muuch (upper) groups showing sherd density of non-architectural space; and b) Map of 'Aak (lower) and Muuch (upper) groups showing average sherd size. In both a) and b), the grid is set to north and the grid is in metres. Using the grid numbers, data for excavation loci can be found in Table 1.*

a variable. Ogives are commonly used by economists to document unequal distribution of wealth within societies. For example, a cumulative curve could show what proportion of wealth is controlled by the richest 10 per cent of the population. We use cumulative curves to document unequal distribution of ceramics within houselots: they show, for example, what proportion of the total of ceramics recovered in all of the 50 cm by 50 cm pits is accounted for by the 10 per cent of pits with the highest ceramic density. Table 1 lists ceramic densities, as well as other data, for all pits in the three houselots. In Figure 6, the *x* axis holds the percentage of pits in the houselot, arranged from those with the lowest ceramic density (on the left) to those with the highest (on the right). The *y* axis holds the percentage of ceramics accounted for in the houselot. The cumulative curve for a houselot in which ceramics are perfectly evenly scattered would take the shape of the straight line in Figure 6, showing that 10 per cent of the pits account for 10 per cent of the sherds, 80 per

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Table 1. *Excavation data from the 50 cm by 50 cm pits. The north and east coordinates go with the coordinate grids on Figures 4 and 5. * = Data from horizontal excavations that supplement the 50 cm by 50 cm pits.*

House-lot	North coord.	East coord.	Vol.	Sherd count	Total sherd mass (g)	Avg. sherd mass (g)	Sherd density (kg/m^3)	Obsidian quantity
Aak	–65	–35	0.005	4	6	1.50	1.200	0
Aak	–60	–35	0.023	0	0	0.00	0.000	0
Aak	–55	–35	0.057	4	25	6.25	0.439	0
Aak	–50	–35	0.081	0	0	0.00	0.000	0
Aak	–30	–35	0.008	0	0	0.00	0.000	0
Aak	–25	–35	0.023	0	0	0.00	0.000	0
Aak	–65	–30	0.035	1	6	6.00	0.171	0
Aak	–60	–30	0.028	0	0	0.00	0.000	0
Aak	–55	–30	0.059	2	0.5	0.25	0.008	0
Aak	–50	–30	0.113	2	7	3.50	0.062	0
Aak	–45	–30	0.013	0	0	0.00	0.000	0
Aak	–40	–30	0.178	0	0	0.00	0.000	0
Aak	–35	–30	0.020	4	4	1.00	0.204	0
Aak	–20	–30	0.032	0	0	0.00	0.000	0
Aak	–15	–30	0.048	2	4	2.00	0.083	0
Aak	–10	–30	0.073	0	0	0.00	0.000	0
Aak	–60	–25	0.093	2	3	1.50	0.032	0
Aak	–50	–25	0.024	0	0	0.00	0.000	0
Aak	–45	–25	0.029	0	0	0.00	0.000	0
Aak	–35	–25	0.011	2	10	5.00	0.889	0
Aak	–30	–25	0.021	1	3	3.00	0.141	0
Aak	–25	–25	0.034	0	0	0.00	0.000	0
Aak	–20	–25	0.012	1	0.5	0.50	0.042	0
Aak	–15	–25	0.042	7	12	1.71	0.289	0
Aak	–10	–25	0.056	4	8	2.00	0.143	0
Aak	–65	–20	0.051	3	11	3.67	0.216	0
Aak	–60	–20	0.021	0	0	0.00	0.000	0
Aak	–50	–20	0.028	4	2	0.50	0.073	1
Aak	–45	–20	0.073	22	46	2.09	0.634	1
Aak	–40	–20	0.041	3	8	2.67	0.197	0
Aak	–30	–20	0.024	3	7	2.33	0.287	0
Aak	–25	–20	0.028	1	2	2.00	0.071	0
Aak	–20	–20	0.033	1	5	5.00	0.151	0
Aak	–15	–20	0.028	1	32	32.00	1.164	0
Aak	–10	–20	0.029	4	6	1.50	0.211	0
Aak	–5	–20	0.021	0	0	0.00	0.000	0
Aak	–65	–15	0.019	0	0	0.00	0.000	0
Aak	–60	–15	0.040	0	0	0.00	0.000	0
Aak	–50	–15	0.095	48	70	1.46	0.741	0
Aak	–40	–15	0.051	29	98	3.38	1.936	0
Aak	–35	–15	0.020	10	16	1.60	0.800	0
Aak	–30	–15	0.080	98	262	2.67	3.275	0
Aak	–25	–15	0.069	28	60	2.14	0.865	1
Aak	–20	–15	0.066	43	143	3.33	2.158	0
Aak	–15	–15	0.081	26	32	1.23	0.395	0
Aak	–10	–15	0.027	7	11	1.57	0.409	0
Aak	–5	–15	0.062	71	421	5.93	6.790	0
Aak	0	–15	0.037	3	3	1.00	0.082	0
Aak	–65	–10	0.045	1	0.5	0.50	0.011	1
Aak	–60	–10	0.051	1	7	7.00	0.137	0
Aak	–55	–10	0.020	2	2	1.00	0.100	0
Aak	–30	–10	0.071	154	384	2.49	5.437	2
Aak	–20	–10	0.078	26	34	1.31	0.435	0
Aak	–15	–10	0.118	104	193	1.86	1.643	2
Aak	–10	–10	0.059	43	138	3.21	2.349	0
Aak	–5	–10	0.071	55	90	1.64	1.263	0
Aak	0	–10	0.033	8	7	0.88	0.215	0
Aak	5	–10	0.054	6	28	4.67	0.521	0
Aak	–65	–5	0.025	1	2	2.00	0.080	0
Aak	–55	–5	0.021	4	30	7.50	1.408	0
Aak	–20	–5	0.073	34	72	2.12	0.993	0
Aak	–15	–5	0.076	36	145	4.03	1.900	0
Aak	–10	–5	0.078	139	336	2.42	4.335	1
Aak	5	–5	0.024	5	6	1.20	0.253	0
Aak	–65	0	0.024	12	13.5	1.13	0.567	0
Aak	–60	0	0.023	2	3	1.50	0.133	3
Aak	–15	0	0.018	12	37	3.08	2.114	0
Aak	–10	0	0.038	10	20	2.00	0.533	0
Aak	–5	0	0.060	20	84	4.20	1.400	0
Aak	0	0	0.117	35	111	3.17	0.945	1
Aak	5	0	0.059	5	10	2.00	0.171	0
Aak*	–20	3	0.29		86		0.297	0
Aak	–60	5	0.052	22	89	4.05	1.705	1
Aak	–55	5	0.039	15	44	2.93	1.135	1
Aak*	–20	5	0.285		385		1.351	0
Aak	–15	5	0.045	101	258	2.55	5.733	3
Aak	–5	5	0.055	24	43	1.79	0.782	0
Aak	5	5	0.081	18	34	1.89	0.422	0
Aak*	–20	7	0.255		207		0.812	0
Aak	–60	10	0.044	5	7	1.40	0.159	0
Aak	–55	10	0.058	26	46	1.77	0.793	0
Aak	–15	10	0.086	311	1134	3.65	13.263	2
Aak	–10	10	0.035	8	29	3.63	0.829	0
Aak	–5	10	0.056	16	30	1.88	0.533	0
Aak	0	10	0.011	2	4	2.00	0.377	0
Aak	5	10	0.053	8	24	3.00	0.457	0
Aak	–49	11	0.064	14	32	2.29	0.500	0
Aak*	–49	11	0.64	137	321	2.34	0.502	3
Aak	–47	11	0.039	13	55	4.23	1.410	0
Aak	–41	11	0.095	29	197	6.79	2.074	0
Aak*	–41	11	0.95	289	1973	6.83	2.077	18
Aak*	–21	11	1.28		1354		1.058	0
Aak*	–47	11.5	0.39	133	555	4.17	1.423	9
Aak*	–45	11.5	0.19		221		1.163	0
Aak*	–43	11.5	0.29		629		2.169	0
Aak	–41	13	0.073	56	259	4.63	3.548	0
Aak*	–41	13	0.73	566	2587	4.57	3.544	15
Aak*	–27	13	1.42		3940		2.775	0
Aak*	–25	13	1.21		4244		3.507	0
Aak	–55	15	0.032	6	11	1.83	0.349	0
Aak	–45	15	0.049	74	145	1.96	2.935	3
Aak	–31	15	0.063	56	380	6.79	6.032	0
Aak*	–29	15	0.64		12,103		18.911	74
Aak	–20	15	0.043	16	38	2.38	0.894	0
Aak	–15	15	0.055	34	41	1.21	0.745	0
Aak	–10	15	0.059	5	14	2.80	0.238	0
Aak	–5	15	0.051	11	52	4.73	1.027	0
Aak*	–40	16	0.29	155	622	4.01	2.145	0
Aak*	–40	17	0.34	115	590	5.13	1.735	0
Aak*	–35	17	0.47		33		0.070	0
Aak*	–33	17	0.71		65		0.092	0
Aak*	–31	17	0.775		143		0.185	0
Aak*	–40	18	0.415	89	440	4.94	1.060	0
Aak*	–40	19	0.585	61	479	7.85	0.819	0
Aak	–55	20	0.059	10	30	3.00	0.508	2
Aak	–50	20	0.044	3	0.5	0.17	0.011	0
Aak	–45	20	0.029	9	21	2.33	0.724	0
Aak	–40	20	0.020	2	9	4.50	0.450	0
Aak*	–40	20	0.2	22	92	4.18	0.460	0
Aak	–30	20	0.046	16	31	1.94	0.670	1
Aak	–20	20	0.071	8	12	1.50	0.170	0
Aak	–15	20	0.059	20	32	1.60	0.539	0
Aak	–10	20	0.038	17	20	1.18	0.533	0
Aak	–5	20	0.056	2	8	4.00	0.144	0
Aak	0	20	0.059	11	25	2.27	0.426	2
Aak	5	20	0.065	22	68	3.09	1.046	0
Aak*	–40	22	0.19	6	42	7.00	0.221	0
Aak*	–40	23	0.070	1	3	3	0.043	0
Aak*	–40	24	0.19	5	15	3	0.079	0
Aak	–30	25	0.131	15	40	2.67	0.306	0
Balam	30	10	0.079	0	0	0.00	0.000	0
Balam	35	10	0.069	0	0	0.00	0.000	0
Balam	40	10	0.058	0	0	0.00	0.000	0
Balam	20	15	0.094	0	0	0.00	0.000	0
Balam	25	15	0.131	0	0	0.00	0.000	0
Balam	30	15	0.118	3	2	0.67	0.017	0
Balam	35	15	0.041	0	0	0.00	0.000	0
Balam	40	15	0.047	0	0	0.00	0.000	0
Balam	55	15	0.063	0	0	0.00	0.000	0
Balam	60	15	0.026	0	0	0.00	0.000	0
Balam	20	20	0.069	2	23	11.50	0.332	0
Balam	25	20	0.077	0	0	0.00	0.000	0
Balam	30	20	0.068	0	0	0.00	0.000	0
Balam	35	20	0.050	1	9	9.00	0.180	0
Balam	40	20	0.019	0	0	0.00	0.000	0
Balam	45	20	0.029	0	0	0.00	0.000	0
Balam	50	20	0.060	1	8	8.00	0.133	0
Balam	55	20	0.034	0	0	0.00	0.000	0
Balam	60	20	0.039	0	0	0.00	0.000	0
Balam	15	25	0.066	7	18	2.57	0.272	0
Balam	20	25	0.034	0	0	0.00	0.000	0
Balam	25	25	0.044	0	0	0.00	0.000	0
Balam	30	25	0.064	0	0	0.00	0.000	0
Balam	40	25	0.073	5	46	9.20	0.634	0
Balam	45	25	0.058	4	22	5.50	0.383	0
Balam	50	25	0.037	1	1	1.00	0.027	0
Balam	55	25	0.031	0	0	0.00	0.000	0
Balam	60	25	0.054	0	0	0.00	0.000	0
Balam	65	25	0.073	0	0	0.00	0.000	0
Balam	10	30	0.018	0	0	0.00	0.000	0

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Table 1. *(cont.)*

House-lot	North coord.	East coord.	Vol.	Sherd count	Total sherd mass (g)	Avg. sherd mass (g)	Sherd density (kg/m^3)	Obsidian quantity
Balam	15	30	0.120	6	31	5.17	0.258	0
Balam	20	30	0.023	0	0	0.00	0.000	0
Balam	25	30	0.117	30	180	6.00	1.540	0
Balam	45	30	0.048	18	59	3.28	1.242	0
Balam	50	30	0.030	5	16	3.20	0.533	0
Balam	55	30	0.069	0	0	0.00	0.000	0
Balam	60	30	0.056	0	0	0.00	0.000	0
Balam	65	30	0.026	0	0	0.00	0.000	1
Balam	70	30	0.048	0	0	0.00	0.000	0
Balam	75	30	0.104	0	0	0.00	0.000	0
Balam	15	35	0.035	1	5	5.00	0.143	0
Balam	20	35	0.124	29	185	6.38	1.487	0
Balam	25	35	0.081	41	249	6.07	3.065	0
Balam	55	35	0.070	3	16	5.33	0.229	0
Balam	60	35	0.053	4	29	7.25	0.552	0
Balam	65	35	0.108	5	35	7.00	0.326	0
Balam	70	35	0.069	1	1	1.00	0.015	0
Balam	75	35	0.068	0	0	0.00	0.000	0
Balam	15	40	0.070	1	11	11.00	0.157	0
Balam	50	40	0.074	30	200	6.67	2.689	0
Balam	55	40	0.074	1	10	10.00	0.136	0
Balam	60	40	0.119	0	0	0.00	0.000	0
Balam	65	40	0.020	0	0	0.00	0.000	0
Balam	70	40	0.094	1	7	7.00	0.075	0
Balam	10	45	0.073	9	14	1.56	0.193	0
Balam	15	45	0.062	1	1	1.00	0.016	0
Balam	55	45	0.063	0	0	0.00	0.000	0
Balam	60	45	0.058	0	0	0.00	0.000	0
Balam	65	45	0.063	0	0	0.00	0.000	0
Balam	70	45	0.049	0	0	0.00	0.000	0
Balam	10	50	0.116	2	9	4.50	0.078	0
Balam	15	50	0.105	0	0	0.00	0.000	0
Balam	50	50	0.084	2	2	1.00	0.024	0
Balam	55	50	0.045	0	0	0.00	0.000	0
Balam	60	50	0.055	0	0	0.00	0.000	0
Balam	65	50	0.044	0	0	0.00	0.000	0
Balam	70	50	0.056	0	0	0.00	0.000	0
Balam	15	55	0.048	1	1	1.00	0.021	0
Balam	20	55	0.027	0	0	0.00	0.000	0
Balam	25	55	0.051	10	92	9.20	1.795	0
Balam	40	55	0.123	25	170	6.80	1.381	0
Balam	45	55	0.094	15	119	7.93	1.269	0
Balam	50	55	0.071	5	42	8.40	0.595	0
Balam	55	55	0.093	0	0	0.00	0.000	0
Balam	60	55	0.035	0	0	0.00	0.000	0
Balam	20	60	0.032	0	0	0.00	0.000	0
Balam	25	60	0.024	2	5	2.50	0.205	0
Balam	30	60	0.087	1	9	9.00	0.104	0
Balam	35	60	0.088	4	40	10.00	0.454	0
Balam	40	60	0.071	16	62	3.88	0.870	0
Balam	45	60	0.089	5	16	3.20	0.179	0
Balam	50	60	0.063	0	0	0.00	0.000	0
Balam	55	60	0.061	0	0	0.00	0.000	0
Balam	15	65	0.064	0	0	0.00	0.000	0
Balam	20	65	0.030	0	0	0.00	0.000	0
Balam	25	65	0.019	0	0	0.00	0.000	0
Balam	40	65	0.046	0	0	0.00	0.000	0
Balam	45	65	0.093	1	4	4.00	0.043	0
Balam	50	65	0.073	0	0	0.00	0.000	0
Balam	30	70	0.075	0	0	0.00	0.000	0
Balam	35	70	0.053	1	7	7.00	0.132	0
Balam	40	70	0.105	0	0	0.00	0.000	0
Balam	45	70	0.064	3	10	3.33	0.155	0
Balam	50	70	0.052	0	0	0.00	0.000	0
Balam	35	75	0.121	2	4	2.00	0.033	0
Muuch	25	–25	0.091	100	377	3.77	4.143	0
Muuch	30	–25	0.080	3	12	4.00	0.150	0
Muuch	40	–25	0.008	4	8	2.00	1.067	0
Muuch	15	–20	0.093	7	4	0.57	0.043	0
Muuch	20	–20	0.035	8	27	3.38	0.771	0
Muuch	25	–20	0.030	31	50	1.61	1.667	0
Muuch	30	–20	0.034	10	14	1.40	0.407	0
Muuch	35	–20	0.181	134	812	6.06	4.480	1
Muuch	40	–20	0.030	2	6	3.00	0.200	0
Muuch	45	–20	0.052	0	0	0.00	0.000	0
Muuch	10	–15	0.102	6	18	3.00	0.177	0
Muuch	15	–15	0.096	13	34	2.62	0.356	0
Muuch	25	–15	0.061	124	257	2.07	4.196	2
Muuch	30	–15	0.054	55	153	2.78	2.847	1
Muuch	35	–15	0.037	5	15	3.00	0.407	0
Muuch	40	–15	0.049	25	63	2.52	1.292	0
Muuch	50	–15	0.050	11	22	2.00	0.440	0
Muuch	10	–10	0.024	0	0	0.00	0.000	0
Muuch	15	–10	0.089	2	13	6.50	0.146	0
Muuch	20	–10	0.070	74	449	6.07	6.414	0
Muuch	40	–10	0.056	57	225	3.95	4.000	0
Muuch	45	–10	0.015	11	25	2.27	1.667	0
Muuch	50	–10	0.037	9	82	9.11	2.224	1
Muuch	55	–10	0.060	31	68	2.19	1.133	0
Muuch	15	–5	0.010	1	0.5	0.50	0.050	0
Muuch	20	–5	0.078	67	226	3.37	2.893	0
Muuch	40	–5	0.011	24	49	2.04	4.612	0
Muuch	45	–5	0.024	17	88	5.18	3.667	0
Muuch	50	–5	0.059	5	18	3.60	0.306	0
Muuch	55	–5	0.016	1	0.5	0.50	0.032	0
Muuch	60	–5	0.047	0	0	0.00	0.000	0
Muuch	65	–5	0.034	6	49	8.17	1.425	0
Muuch	10	0	0.008	1	0.5	0.50	0.067	0
Muuch	15	0	0.070	33	32	0.97	0.457	0
Muuch	20	0	0.035	10	27	2.70	0.767	0
Muuch	45	0	0.058	0	0	0.00	0.000	0
Muuch	50	0	0.040	15	40	2.67	1.000	1
Muuch	55	0	0.022	2	5	2.50	0.229	0
Muuch	60	0	0.049	0	0	0.00	0.000	0
Muuch	15	5	0.043	50	104	2.08	2.412	1
Muuch	20	5	0.044	13	18	1.38	0.406	0
Muuch	50	5	0.016	10	14	1.40	0.896	1
Muuch	55	5	0.029	3	11	3.67	0.374	0
Muuch	60	5	0.027	1	3	3.00	0.112	0
Muuch	65	5	0.048	18	48	2.67	0.997	0
Muuch	16.5	10	0.065	41	101	2.46	1.554	0
Muuch	45	10	0.063	22	93	4.23	1.488	2
Muuch	50	10	0.030	32	61	1.91	2.033	0
Muuch	55	10	0.028	0	0	0.00	0.000	0
Muuch	60	10	0.075	2	6	3.00	0.080	0
Muuch	16.5	15	0.044	40	112	2.80	2.560	0
Muuch	45	15	0.063	21	81	3.86	1.283	0
Muuch	50	15	0.030	10	42	4.20	1.400	0
Muuch	55	15	0.059	5	25	5.00	0.421	0
Muuch	60	15	0.036	5	6	1.20	0.166	0
Muuch	14	20	0.111	50	557	11.14	5.007	0
Muuch	40	20	0.089	20	55	2.75	0.620	2
Muuch	45	20	0.033	0	0	0.00	0.000	0
Muuch	50	20	0.113	4	5	1.25	0.044	0
Muuch	55	20	0.051	3	9	3.00	0.176	0
Muuch	20	23	0.044	14	133	9.50	2.997	0
Muuch	25	25	0.052	15	75	5.00	1.440	0
Muuch	25	25	0.059	14	76	5.43	1.279	0
Muuch	30	25	0.063	9	20	2.22	0.320	0
Muuch	35	25	0.075	6	25	4.17	0.333	0
Muuch	40	25	0.051	0	0	0.00	0.000	0
Muuch	45	25	0.040	0	0	0.00	0.000	0
Muuch	50	25	0.046	1	0.5	0.50	0.011	1
Muuch	30	30	0.067	2	1	0.50	0.015	0
Muuch	35	30	0.054	18	67	3.72	1.247	0
Muuch	40	30	0.045	6	13	2.17	0.289	0
Muuch	45	30	0.059	4	23	5.75	0.392	1

cent of the pits account for 80 per cent of the sherds, etc.: every pit has the same density.

A cumulative curve bent far to the right shows inequality; the further the curve bulges to the right, the more unequal the distribution. For example, the curve for Balam shows that most pits had low ceramic densities and just a few had high densities. More specifically, 80 per cent of the pits accounted for only 10 per cent of the sherds, whereas just a few pits — 10 per cent of the total number — accounted for about 70

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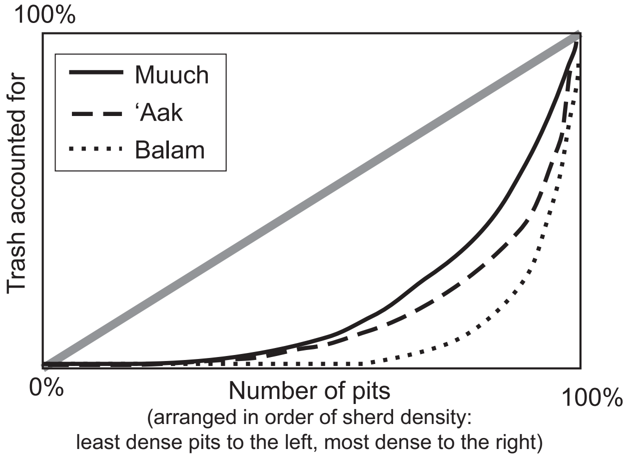

Figure 6. *Cumulative curves (ogives) that show the degree to which trash is scattered in the 'Aak, Muuch, and Balam groups. The curve for the Balam group, for example, shows that 10 per cent of the pits (the ones with the highest sherd density) contain 70 per cent of the total ceramic debris recovered from all pits. The straight, grey line represents a perfectly even scattering of trash.*

per cent of the sherds. This curve shows that the occupants kept most trash in dense piles with relatively little scattering. Practical logic predicts this result since Balam has relatively little space. Muuch also has little space, so its cumulative curve should be similar. Yet Figure 6 shows that sherds in Muuch are not only more scattered than in Balam but also more scattered than in 'Aak, the largest houselot. This result cannot be attributed to post-abandonment disturbances because the houselots underwent the same process of gradual abandonment at the same time and have had the same land use since then (Hutson *et al*. n.d.).

A potential corollary to the expectation that occupants of larger houselots will broadcast their trash more widely is that occupants in areas of low settlement density will also broadcast their trash more widely within their houselot. Balam is a perfect example: open, unclaimed space surrounds it. Unlike 'Aak or Muuch, Balam has no 'next-door' neighbours: the edge of the lot closest to Balam is about 150 m beyond Balam's boundary walls. In this situation, Balam's occupants would not be expected to concentrate their trash for saving space because they have vast expanses just outside the houselot boundary. A comparison between Balam and Muuch evaluates this expectation most cleanly because the two have approximately the same amount of space within their houselot walls, thus controlling for the effects of variation in houselot size. The results do not confirm this expectation: trash in Balam should be more scattered than in Muuch whereas Figure 6 shows the opposite. Santley & Hirth (1993, 7) suggest an additional expectation with regard to refuse discard and settlement. They reason that the occupants of a houselot like Balam would dump their garbage just over their houselot wall because, in the absence of close neighbours, there would be no peer pressure to prevent dumping into public space. A series of pits adjacent to the exterior wall of the Balam houselot, however, failed to locate any trash dumps.

Length of occupation and degree of concentration of trash

One reason why the results presented in the previous section did not support the rational expectations might be that length of occupation was not taken into account. Schiffer (1976, 163) has argued that residences occupied longer will concentrate their refuse into discrete locations, whereas residences occupied for shorter amounts of time will scatter their garbage more indiscriminately. Schiffer reasons that a longer occupation produces more trash and, as more trash is produced, it will need to be gathered into discrete dumps so that it does not become a hindrance. Though he predicts that longer occupation should lead to less scattering, it is conceivable that a longer occupation will in fact lead to more: depositional sequences are likely to be more complex and activity signatures more jumbled and palimpsest-like (Alexander 1999).

Following Schiffer's logic, a short occupation could explain why the occupants of a small houselot like Muuch scattered their trash widely. Ceramics from all three houselots at Chunchucmil exhibit the same chronological diagnostics. However, Muuch underwent fewer structural changes than 'Aak. Haviland (1988) has proposed that structural renovations accompany the passing of a generation. By this measure, Muuch had a shorter occupation than 'Aak. Though Balam dates to the same ceramic phase, we cannot include it in the comparison because we lack data on its construction sequence. Thus, Muuch's failure to follow the expected relationship between houselot size and trash management could have been caused by shorter occupation. Exploring this possibility requires data from an additional houselot in the same neighbourhood, with the same amount of space and the same length of occupation.

Hindrance potential

Perhaps the most straightforwardly practical expectation about waste management is that more effort will go into disposing of garbage with greater hindrance potential (Hayden & Cannon 1983, 156). Obsidian should receive special disposal treatment because its sharpness poses a health hazard (Arnold 1990,

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916; Deal & Hayden 1987). Santley & Hirth (1993, 7) note that hazardous trash such as broken glass is 'immediately thrown into pits ... or taken away from the houselot' whereas less hazardous trash can be left almost anywhere. The discarded obsidian consists of fragments from used prismatic blade fragments. Figure 7 shows the distribution of obsidian across the open spaces of 'Aak and Muuch (see Table 1 for obsidian data for all pits; much larger quantities of obsidian were found in association with architecture in 'Aak). Comparing Figure 7 with Figure 5a shows that the distribution of obsidian in these two houselots closely matches the distribution of pottery. Obsidian also exhibits a strong, positive statistical correlation with sherd density. These results indicate that obsidian was disposed of in the same way as pottery, a non-hazardous material. Though the cutting edges of most blade fragments were worn, they were still sharp. Since post-abandonment disturbance at Chunchucmil is limited to the edges of houselots, such disturbance cannot account for the patterning of the obsidian. Thus, the practical concern with obsidian as a hindrance appears not to have been a concern.

Large items of trash also can clutter activity areas (Hayden & Cannon 1983, 156). Since removing larger trash requires more effort, Hayden & Cannon reason that occupants will stow it provisionally close to where it is generated. Thus, larger pieces should follow a different pattern of disposal than smaller trash. Eventually, when provisionally discarded clutter becomes a nuisance, occupants find it worth the effort to cart it away to dumps. According to this model, large trash at Chunchucmil should not match the distribution of the rest: it should be found along the edges of structures, for example, or in dumps further away. At first glance, discard patterns at Chunchucmil do not sup-

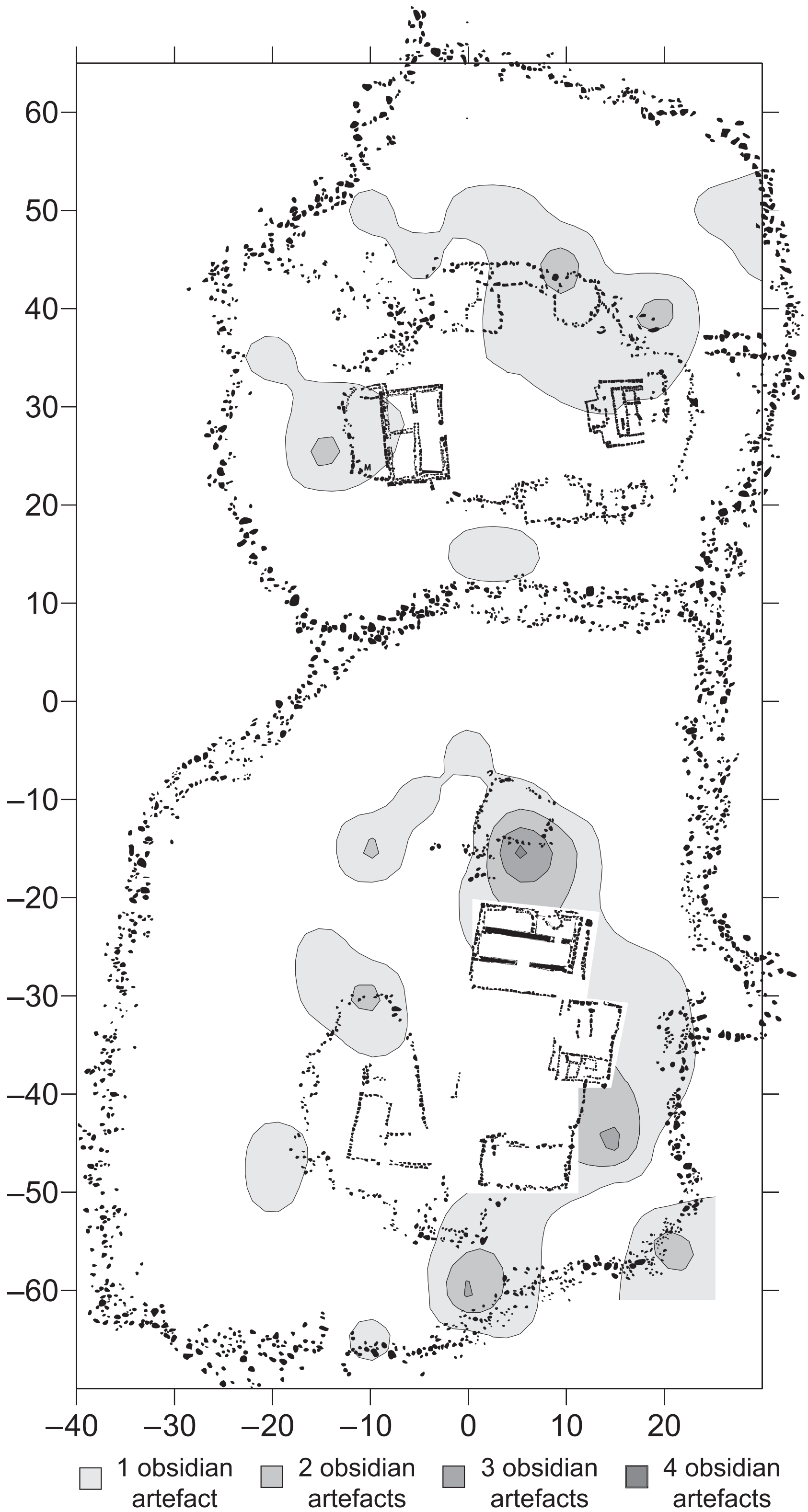

Figure 7. *Distribution of obsidian across the 'Aak (lower) and Muuch (upper) houselots, measured in artefacts per test pit. Grid is in metres. Data for excavation loci can be found in Table 1.*

port these expectations. Large trash appears not to have received special treatment. In all three houselots, the resemblance between distribution maps of average sherd size and of sherd density shows that larger potsherds are generally found where total potsherd density is highest (compare Fig. 4a with 4b, and 5a with 5b; Table 1 lists average sherd mass for all pits). In 'Aak and Muuch, there is a significant correlation between these two variables. Yet closer inspection of maps of average sherd size (Fig. 5) reveals dumps of large sherds at the edges of the houselots and dense clusters of trash near the structural core with few large objects. Horizontal excavations in 'Aak revealed provisional discard consisting of large potsherds. Thus, the data give modest support to the effort minimization model: the locations of some deposits of large trash found in 'Aak and Muuch match the expectations stated above.

Is garbage more common lower down?

Hayden & Cannon (1983, 126) and Arnold (1990, 918) note that, in contemporary houselots, garbage with little hindrance potential is often placed downhill from structures. Ball & Kelsay (1992, 248) found that within ancient houselots at Buenavista and Guerra, Belize, areas 'downslope' from the structural core often contain phosphate 'hotspots' generated by organic trash. Hayden & Cannon state that trash is tossed downhill so that it will not roll back into the house. Of course, natural processes such as erosion and water run-off may also result in trash moving to lower elevations.

Though the topography of Chunchucmil contains no steep hills, the natural surface contains micro-variations produced by irregular weathering of the bedrock. Relief maps of the three houselots (Figs. 3 & 4a) show that the natural surface varies by nearly a metre, providing both low spots and high spots within the three houselots. Balam even has a semi-artificial pit (dug to extract limestone) that was test-excavated for garbage.

Our data fail to show a statistically significant correlation between pottery and elevation in 'Aak (Pearson's $r = 0.154$, $p = 0.101$, $n = 115$) and Balam (Pearson's $r = -0.173$, $p = 0.174$, $n = 64$). In Muuch, however, elevation exhibits a significant positive correlation with ceramic density (Pearson's $r = 0.339$, $p = 0.005$, $n = 68$). For organic trash, we examined correlations between quantities of phosphate and elevation. In 'Aak and Balam, there was virtually no correlation between the two variables (for 'Aak, $r = 0.015$, $p = 0.883$, $n = 99$; for Balam, $r = 0.096$, $p = 0.456$, $n = 63$). Yet, in Muuch, we found another statistically significant positive correlation ($r = 0.453$, $p < 0.001$, $n = 64$).

These data show that only one of the three houselots shows a pattern of garbage that suggests the placing of refuse in low spots. This conclusion also suggests that natural processes have not had a drastic effect on the location of trash. It is interesting to note that, in all three houselots, there are significant positive correlations between the quantity of trash and depth of soil ('Aak: $r = 0.211$, $p = 0.026$, $n = 112$; Muuch $r = 0.328$, $p = 0.005$, $n = 72$; Balam: $r = 0.338$, $p < 0.001$, $n = 95$).

In summary, the four predictions about rubbish discard account only for a portion of the actual patterning in the three ancient houselots at Chunchucmil. The partial failure of explanations based on a universalized logic of expedience invites consideration of forms of practicality lodged within a cultural logic not governed by expedience.

Cultural logic in practical activities: contemporary Maya farming

Since practical logic only partly explains patterning in a seemingly utilitarian activity, we now explore an example of a utilitarian activity in which practical and cultural logic coexist. Using a variety of examples, such as Japanese sumo wrestling, Sahlins (1999) has argued that practical logics fit within cultural logics. We illustrate this point with the example of milpa farming (slash & burn) in Yucatan. In their classic ethnography of the Yucatec Maya of Chan Kom (Fig. 1), Redfield & Villa Rojas (1962, 127) state, 'What man wins from nature, he takes from the gods'. This makes clear that, before anything else, farming (and all other activities which extract goods from the environment) is a moral relationship with supernaturals, in this case the guardian spirits of the milpa and the forest. Successful farming depends on feeding the guardians at many points in the agricultural cycle. Neglecting this relationship results in sickness, injury or a failed crop. Thus, as organized by cultural logic, subsistence, one of the most practical activities, is a relation with supernaturals. Maximization and efficiency depend upon cosmological harmony. Details of the size and shape of milpas bear this out.

When a farmer clears his milpa plot, he clears only the precise amount of land needed. Though rational, this logic is also cultural and moral. When the farmer cuts trees, the trees ask the guardians of the forest for permission to retaliate against the farmer. The guardians of the forest convince the trees not to harm the farmer and promise the trees that a good chopping has the benefit of letting new trees come up. However, if the farmer does not sow crops on

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all of the cleared land, the farmer has chopped too many trees, which therefore betrays the promise that the guardian made to the trees. Rightfully angered, the guardian will no longer intercede with the trees on the farmer's behalf. Thus, when a farmer sustains injury while felling trees for a milpa, Redfield & Villa Rojas' informants (1962, 134) suspect that the farmer offended the guardians of the forest.

In addition to the size of the milpa, its shape — roughly square or rectangular — also shows how cultural logics underlie utilitarian behaviours. A rectangle allows easier measurement of land to be cultivated. Yet, to the Yucatec farmer, this shape is basic to the frame of reference in which all aspects of his life are lived (Hanks 1990). Quadripartition and a four-cornered world anchor Yucatecan cosmology and phenomenology. In Maya myths, the world itself was created as a four-cornered place and, in contemporary times, centring the self in a four-cornered world is a prerequisite for proper life. Thus, one's home is only inhabitable after it is centred with offerings to the house's four corners and centre (Stuart 1998; Vogt 1976, 52–4). Likewise, Yucatec farmers plant in four-cornered milpas and make offerings to the four corners and the centre (Hanks 1990, 362; Redfield & Villa Rojas 1962, 134). A farmer explicitly pointed out to William Hanks (1990, 378) the congruence between the four-sided milpa and the four-sided altar used in traditional ceremonies. These offerings do not simply appease the guardians of the milpa, they create a world in microcosm, a world that is inhabitable by the guardians and in which the all-important relationships between human and deity become possible. From this perspective, the offering is not necessarily a ritual but a kind of work, a practical measure dictated by cultural logic (see also Brück 1999).

Broken pottery in ancient Mesoamerica

Having shown that practical activities like farming are embedded in cultural logic, we now provide Mesoamerican examples that show that the practical activity of discard can also be embedded in cultural logic. The main form of trash discussed thus far for Chunchucmil is broken pottery. Ethnohistoric sources from both central Mexico and northern Yucatan attest to powerful cultural meanings that broken pottery can carry. In Louise Burkhart's analysis of filth among the Nahuas (Aztecs) of the Basin of Mexico during the sixteenth century, potsherds assume a moral value as *tlazolli*. The word *tlazolli* expresses the concept of pollution. It refers to things that have become old, useless, and worn out (Burkhart 1989, 87–8). Noting that it often refers to matter out of place (see also Douglas 1966, 2, 35), Burkhart sees *tlazolli* as an interference in a normally tidy world: 'The term … covers a whole series of impurities used in moral discourse to connote negativity'. These impurities include 'rags, potsherds, cobwebs, dust, mud, straw or grass, charcoal, dishevelled hair, excrement, urine, vomit, nasal mucus, pus' (Burkhart 1989, 88). Yet such excretions and decay are not inherently impure: they become impure when excessive or out of place (Burkhart 1989, 89; Hamann 2005). As Burkhart explains, the connection between physical and moral impurity was not merely metaphorical for the Nahua; polluting the body polluted the soul. This explains why something like pottery could be so dangerous. 'Death, cosmic disturbance, filth, and immorality were intermingled in such a way that harmful forces, once unleashed, could affect anyone or anything in their path' (Burkhart 1989, 95). Sweeping a floor, therefore, a way of removing casual refuse with little value or hindrance potential, could be a 'weapon against peripheral danger, a means of defending the ordered, settled space of the city' (Burkhart 1989, 121). It comes as no surprise that the Nahua kept brooms, which came into contact with *tlazolli*, outdoors and away from children (Burkhart 1989, 95).

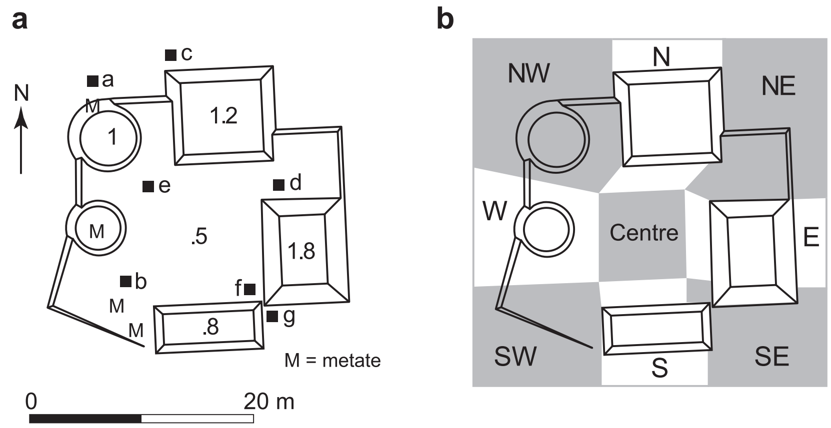
Diego de Landa's sixteenth-century account of the Maya in Yucatan shows that, at least in some contexts, discarded pottery could also be harmful.

> The first day of … the first month … was their new year and was a very solemn festival ... To celebrate it with more solemnity, they renewed … all the objects which they made use of, such as plates, vessels, stools, mats and old clothes and the stuffs with which they wrapped up their idols. They swept out their houses, and the sweepings and the old utensils they threw out on the waste heap outside the town; and not one, even were he in need of it, touched it (Tozzer 1941, 151).

This ceremony closely resembles the central Mexican New Fire ceremony (Sahagun 1953, 25), during which the Nahua threw out household goods.

Landa's passage is intriguing because it shows that discarded items are still extremely meaningful to the Maya, even if they were never touched again. The fact that discard can be meaningful blurs Schiffer's distinction between systemic context and archaeological context (see also Stanton & Magnoni in press). In Schiffer's model, items are part of a cultural system until discarded, at which point they enter archaeological context. Discarded items no longer 'participate in a behavioural system' (Schiffer 1972, 157). Yet pottery thrown out in the Yucatec new year ceremony holds a very meaningful place (though negative and proscribed) in cultural systems.

A related and widely reported phenomenon that is rarely discussed in detail is the deposition of potsherds in caves throughout the Maya area (Rissolo 2003). Although whole vessels, burials and other artefacts have been treated in some detail (Brady 1997; 2000; Brady & Scott 1997), very little attention has been paid to the reasons why potsherds may have been transported to subterranean contexts. In many cases, individual potsherds were placed in natural niches or on cave floors. In other instances, midden-like deposits consisting of numerous unreconstructable potsherds have been found deep underground. Given the lack of refits and evidence for other domestic activity (including water, clay, or mineral collection), the logical assumption is that such materials were brought into caves from surface contexts. Yet ethnoarchaeological models of modern Maya trash disposal do not account for the transposing of ceramic trash to deep underground contexts. In fact, such behaviour may seem irrational to many archaeologists. Looking at such behaviour from the perspective of cultural logic, however, might allow us to relate these depositional patterns to the disposal of ideologically dangerous materials in symbolically charged places such as the underworld (MacLeod & Puleston 1978). As in other cultures, some ancient Maya trash, whether domestic or ritual (see Walker 1995), may have been treated with rules not pertaining to our Western ideas of rational rubbish disposal.



35% NW	8% North	9% NE
13% West	3% Centre	5% East
15% SW	8% South	3% SE

Figure 8. *a) Sample houselot (Op. 72) showing placement of test pits. b) Schematic map that shows the nine spatial zones into which houselots were divided. c) Table showing the distribution of dense trash pits in the nine spatial zones. Darker shading indicates higher frequency of trash pits in that zone.*

Broken pottery at Chunchucmil

Some of the strongest evidence for the proposition that domestic trash from Chunchucmil can be meaningful comes from the location of refuse in houselots. Excavations show that pottery dumps are most commonly located on the west side, particularly off the northwest corner of the central patio. The data for this claim come from test pitting in a representative sample of houselots conducted between 1999 and 2005. These houselots were chosen through a 10 per cent stratified random sampling programme. The houselots (over a thousand have been mapped thus far) were stratified by location and type (small, medium and large lots, lots with limestone quarries, etc.) so that houselots from all areas of the site and houselots of varied kinds were certain to be included. The sampling strategy is representative of all domestic contexts at the site and it is random in so far as each of the houselots mapped had a chance to be selected. Though 117 houselots have been excavated (six with broad horizontal exposure and test pits, 111 with off-mound test pits alone), 56 had to be excluded from the present analysis because no dense trash dumps were found or because excavation was not conducted in enough areas within the houselot.

A sample of 61 houselots was therefore available for study of the location of ceramic deposits. The deposits consist of cookware and serving ware and are often accompanied by high concentrations of other artefacts such as obsidian. To systematize the treatment of location, we divided each houselot into nine zones: centre, north, northeast, east, southeast, south, southwest, west and northwest (e.g. Fig. 8). Since

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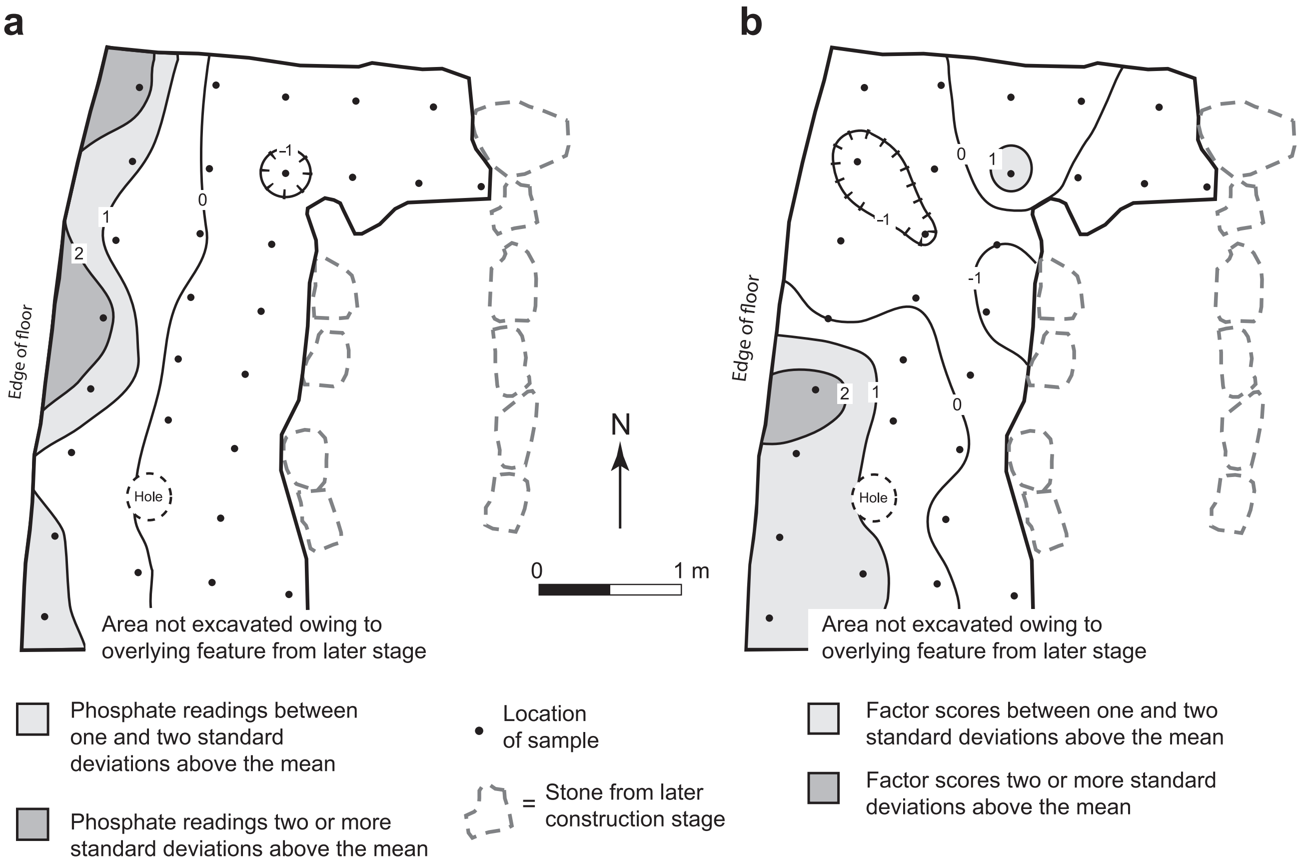

Figure 9. *Structure 23 floor showing: a) distribution of phosphorous; and b) trace metals likely resulting from activites involving pigments.*

the main goal of the test pitting was to recover large samples of artefacts in order to address chronology, productive specialization, consumption patterns and other topics, pits were placed in locations that would maximize the chances of uncovering dense trash deposits. Nevertheless, in the 61 cases included in this analysis, the pits were placed in ways that maximized spatial coverage (see, for example, Fig. 8a). Very few houselots had pits in all nine zones but this was often because one or more zones contained only bedrock and therefore could not be excavated.

Of the 61 houselots, the densest trash deposits were located in the northwest portion of the houselot 35.2 per cent of the time. The preference for the northwest is statistically significant at the 0.001 level (χ^2 = 47.6, n = 61). The second most common area was the southwest, which accounted for 14.8 per cent of the houselots (see Fig. 8c for percentages in each of the nine zones). Thus heavy accumulations of trash are more commonly found on the west side (northwest, west and southwest), which accounts for 63 per cent of the dense trash deposits, whereas the east side (northeast, east and southeast) accounts for only 17 per cent.

The relative absence of dense trash deposits on the east sides of houselots may relate to the fact that shrines and temples are most often found on the east side of patios both at Chunchucmil (Hutson *et al.* 2004) and other Maya sites (Becker 1991). Tourtellot (1988, 112) notes that the common location for houses is on the north and west sides of the patio. This tendency might explain the preference for the northwest as a dumping ground at Chunchucmil if most of Chunchucmil's houses were located to the north and west and if a large portion of the trash around patios comes from houses. However, houses are also common on the south sides of patios at Chunchucmil and refuse from houses in general is generally less than that from productive activities on patios. The popularity of the west side as a dumping location could make sense if winds blow from the east: dumping trash to the west would ensure that unwanted scents were blown away from the houses. At Chunchucmil, however, winds blow from both east and west: from the east in

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the rainy season and from the west in the dry season (Wilson 1980, 21).

Exploring the broader cultural context may help to interpret this discard behaviour. The common use of the west side of the houselot for dumps may relate to the fact that the ancient Maya saw the west as a place of death and decay. West is defined through the setting of the sun (Barrera Vazquez 1980), where the sun goes to die (Schele & Freidel 1990, 66). Among the contemporary Tzotzil Maya of Chiapas, west can symbolize death (Gossen 1974, 33). Clemency Coggins (1980; 1988) has argued that the association of west with death also characterizes Classic period symbolism. Since the ancient Maya saw the west as a place of decay, throwing out rubbish to the west makes sense. The fact that, in contemporary Maya societies, west carries bad connotations (Gossen 1974, 35) and is associated with malevolent spirits (Hanks 1990, 299) suggests that refuse may have been dangerous, analogous to the danger and impurity of Nahua tlazolli.

Tozzer's 1907 account of the renewal of god pots among the Lacandon Maya of the Usumacinta region (Fig. 1), a group whose rituals are similar to those of sixteenth-century Yucatec Maya, resonates with Chunchucmil's pattern of dumping ceramics to the west. In the mid-twentieth century, the renewal ceremony occurred about every eight years (McGee 1990, 51). God pots are used to burn incense and feature the face of a god modelled on them, yet they are neither representations of the gods nor the gods themselves but, rather 'a medium through which an offering is transmitted to the god' (McGee 1990, 51). Once the Lacandon completed the production of the new pots, they brought them into the sacred hut housing the old pots. The Lacandon then gave the old pots a final meal or offering of corn gruel and placed them on the west side of the hut, facing west. At this point, the Lacandon consider the old pots dead (Tozzer 1907, 138–40). Admittedly, the placing of Lacandon god pots to the west is not an exact analogy for the discard of Chunchucmil potsherds to the west, because god pots are quite different from the cookware and serving ware in the Chunchucmil deposits and were not discarded in houselots. Yet, combined with other data on the meaning of west, the Lacandon case helps to make sense of western disposal at Chunchucmil. Following Brück (1999, 335), dumping trash to the west should be seen not simply as odd or fanciful, explicable only in terms of a seemingly abstract cosmology, but rather as part of the practical work of 'maintenance' that contributes to the well-being of the houselot's inhabitants.

The Lacandon example also shows that the meaning of the pots (whether they are dead or alive, for example) shifts with spatial context. Moore (1986) emphasizes that nothing inherently fixes the meaning of discard, and demonstrates this superbly with her discussion of ash among the Marakwet. Though ash has many meanings, the particular meaning invoked in a circumstance derives from its unambiguous spatial and practical context. The same can be said for sherd deposits in the 'Aak houselot. For example, a deposit of broken ceramics near the houselot's shrine carries a very different meaning from a deposit of ceramics near the kitchen, owing to variation in what accompanies these deposits (see also Brück 2001, 662). Unlike the kitchen deposit, the ceramics near the shrine were mixed with ear spools and shell adornments and contained a higher portion of sherds from serving vessels, likely indexing ceremonial meals by the shrine (Hutson 2004, ch. 5). The association of pottery with personal adornments and with ceremonies at the temple likely gave these pots a sanctified meaning not attributed to potsherds found by the kitchen.

Attending to what accompanies or does not accompany different types of refuse opens additional areas of interpretation. The kitchen deposit mentioned above had low phosphate readings, yet an adjacent area had high phosphate readings and relatively little durable trash. This pattern suggests that organic refuse from the kitchen was separated from inorganic refuse. A practical logic may underlie this separation if the 'Aak occupants collected some of the organic remains and spread them as fertilizer in the gardens within their houselot.

Practical logic does not as easily explain other separating behaviours. The discard of what are probably pigment residues, traces of iron and copper, detected by Inductively Coupled Plasma/Atomic Emissions Spectroscopy, manifests this point. A rectangular floor from the earliest house in 'Aak had high phosphate readings on the west edge (Fig. 9). Also along the western edge, but to the south of the high phosphate readings, we recovered high concentrations of trace metals. The phosphates and trace elements most likely result from residues swept from the centre of the floor to the western edge (Hutson & Terry 2006). We found a second 'hotspot' of high trace metals in the north/central area of the floor just east of the phosphate 'hotspot'. Given its location in the centre of the floor, this 'hotspot' may index a primary context of work. If some of the trace elements found on the western edge of the floor originally came from this 'hotspot', 'Aak's occupants made the less practical choice of sweeping these residues to the south and then west as opposed to directly west (where it

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is high in phosphates but low in trace metals). Thus, the 'Aak occupants took the extra effort to keep these kinds of trash separate.

Conclusion

Ethnoarchaeological studies of contemporary houselots presume that the Maya conceive of trash as an impediment to productivity or as a resource to be recycled. Such an attitude toward trash exemplifies practical logic, in which expedience and efficiency guide behaviour. According to this logic, common sense is that which is most economically sensible. A different kind of logic — cultural logic — historicizes economic sensibility. It grounds common sense within culturally particular contexts. In these contexts, ways of discarding trash make sense through potentially moral and, or, cosmological principles.

The patterns of discard recovered at Chunchucmil partly support the idea that expedience guided rubbish maintenance. Although data from three intensively and extensively excavated contexts do not support the utility-based prediction that smaller households expend more effort in trash maintenance, the houselot which did not fit the prediction — the smallest houselot — also had a relatively short length of occupation. The utility-based model predicts this aberration: houselots occupied for less time see less effort in trash maintenance. Although harmful trash such as obsidian was not carefully disposed of, thus challenging the prediction that trash with hindrance potential will be carefully managed, there is evidence that special effort was made to manage a second form of debris with hindrance potential, large potsherds.

Since expedience does not entirely account for the observed patterns and since expedient aspects of another seemingly utilitarian practice, subsistence farming, make sense within a deeply rooted cultural logic, we proposed that cultural logic shapes refuse discard too. The fact that broken ceramics were meaningfully constituted in Yucatan and central Mexico at the time of Spanish contact makes this proposal plausible. The data from a broad sample of houselots showed that the ancient Maya of Chunchucmil most often located their trash dumps to the west of their residences. This fits ancient Maya understandings of the west as the direction of decay, and it could not be predicted by wind patterns or other practical considerations. Yet disposing of trash in sanctioned locations can be seen as practical from within a logic in which well-being depends on cosmological order. Economizing logics also do not fully explain why certain types of trash were kept separate.

Thus, at Chunchucmil, rubbish disposal in residential contexts is both cultural and practical. Cultural and practical logics do not necessarily oppose each other. Our conclusions, therefore, do not respect old, dualistic battle lines such as those between substantivism and formalism. For several reasons, we follow Marx and Sahlins in seeing practical logic as embedded within cultural logic. This perspective recognizes the fundamentally social and relational aspects of human life. This perspective also makes room for actors working practically to further their goals, while at the same time acknowledging the power of cultural traditions to influence which goals are desirable. This approach therefore reconciles agent-centred views with an historically dynamic structuralism while eliminating the excesses of both approaches. Such an accommodation between these logics should be seen as a contribution to relational, practice-based archaeologies.

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