OPEN PIT POTTERY FIRING ON THE HIGH PLAINS: THE EVIDENCE FROM THE CENTRAL PLAINS TRADITION KING SITE (25DW166)

by

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Abstract

This thesis is primarily focused on the evaluation of evidence for ceramic production, specifically open pit firing, at the King site (25DW166), a Central Plains tradition site located near the Pine Ridge in Dawes County, northwestern Nebraska. A tandem goal of this work is to better understand the nature of the occupation of the King site. Several different spatial analyses are employed to provide a general understanding of the function of the site, range of activities performed at the site, the duration of the occupation and, subsequently, the context of and evidence for ceramic firing activities. These spatial analyses are also applied to data generated by an analysis of the ceramics from the site in order to evaluate the strength of the evidence for ceramic firing activities.

The results obtained from this study identify the King site as an extended, probably seasonal, Itskari phase occupation. Several refuse pits and activity areas are identified at the site and the evidence suggests that some of the activities conducted by the inhabitants included bone grease processing and ceramic manufacturing. As ceramic manufacturing has been infrequently identified in the Central Plains, the King site and the methods used to evaluate this evidence, provide an example for how this form of craft-production, which is often difficult to see and/or conflated with other activities, might be approached at other sites.

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Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Ceramic production in the Central and High Plains has long been a difficult activity to identify archaeologically. However, recent research at the King site (25DW166) has presented an opportunity to address this problem through a careful analysis of evidence that may too often be conflated with the archaeological signatures of other activities. The investigation and identification of ceramic open pit firing at the King site contributes to our understanding of ceramic manufacturing among highly nomadic and semi-sedentary groups occupying these two regions.

The King site is Central Plains tradition (CPt) occupation located approximately 7 km southeast of Chadron in Dawes County, Nebraska. Broadly speaking, the site is situated near the northern limit of the High Plains physiographic region, where comparatively little previous archaeological research has been conducted. Though the presence of peoples bearing a CPt-like material culture in the High Plains has been recognized for some seventy years, there is still an interesting debate concerning the origins of these groups and their relationship to the peoples occupying sites farther east, who were practicing agriculture along the larger streams and tributaries in the Central Plains. Much fruitful debate has focused on the function of these sites as hunting camps but this issue is far from settled. There are still many questions regarding how the sites in the High Plains fit into the established settlement patterns for the region and time period, the level of residential permanency with which CPt groups utilized the High Plains, and how CPt groups may have differentially used the region based on cultural differences, individual choices or local environmental constraints.

Understanding the interactions between the people inhabiting the Central and High Plains requires us to look closely at CPt manifestations in both regions in terms of what they represent as well as what they do not represent. In order to investigate the context of ceramic production, it was necessary to examine the general nature of the occupation of the King site (25DW166). Both of these topics were approached through the spatial analyses of the distribution of cultural materials within the site. Consequently, this thesis provides insight into what the King site occupants were doing on the High Plains and yields evidence for ceramic manufacturing that suggests a level of residential permanency and activity diversity not frequently encountered at High Plains sites.

Statement of Problem

The first challenge of this project was contextualizing the occupation of the King site within the current taxonomic schemes for the northern, central and northwestern plains archaeological/geographical divisions. Given the site's peripheral location to the accepted heartland of both the Central Plains and Middle Missouri village traditions, it is advisable to proceed with caution when attributing the site to any derivative taxonomic unit. There are a number of sites on the periphery of the Black Hills, the White River Badlands, the Sand Hills of north-central Nebraska, and parts of eastern Colorado that have yielded ceramics displaying attributes with either Plains Woodland, Middle Missouri (MM) or Central Plains tradition (CPt) affinity. Based on the ceramic assemblages, some of these sites are more clearly attributable to a single phase within one of the Plains Village traditions, while others share only some similarities or resemble several different phases resulting in more ambiguous affiliations. Some of these sites will be addressed in greater detail during the discussion of the CPt

occupation of the High Plains in Chapter 2. However, it should be noted here that this thesis assigns the King site occupation to the Itskari phase (AD 1100-1350) of the CPt based on attributes of the ceramic assemblage, a point that will be elaborated in Chapter 4.

Though research concerning Central Plains tradition (CPt) settlement, subsistence, and technology has been prolific, there has been a paucity of evidence for ceramic manufacturing, particularly the aspects of firing method and organization on which this thesis is primarily focused. The relative invisibility of these components of ceramic technological production is most likely related to several factors. First, ceramic manufacturing was organized at the level of the household, meaning that it was not conducted by craft specialists working in specialized workshops. It is more probable that each household produced pots locally, as needed, within the context of other domestic and subsistence activities. Second, several ubiquitous traits of CPt ceramics, combined with the lack of known permanent enclosed kiln features, suggest that CPt people used open firing methods to produce pots (Krause 1995, 2007, 2011). The combination of small-scale production and the use of open firing techniques result in very indistinct archaeological markers of production that are difficult to identify because they are not necessarily spatially segregated from other activities and leave remains that may appear similar to those resulting from a number of other activities.

The presence of an anomalously large pit feature yielding evidence of extensive burning and a number of ceramic remains displaying attributes of firing failure presented an opportunity to test the feasibility of identifying ceramic firing activities at a CPt site. If ceramic firing took place at the site, the spatial distribution of the materials with failure

attributes is expected to be concentrated within a discrete area and to coincide with concentrations of ash, charcoal, large rocks, fire-altered rock, and broken ceramics.

The identification of such a large pit feature within a site lacking evidence for substantial domestic architecture is unusual, though not unheard of (e.g. the McIntosh site has many pits but limited architectural evidence) and thus leaves open the possibility that this pit may have had some sort of specialized function beyond storage or trash disposal. The examination of the spatial distribution and composition of the contents of this feature as compared to the rest of the site, allowed for interpretations of its use, as well as of the spatial structure of activities performed at the King site. The general identification of these patterns not only facilitates the identification of ceramic firing activities at the site, but also leads to an understanding of how the King site compares to other CPt High Plains sites in terms of site function.

Organization

This thesis is organized with background information in Chapters 2-4 followed by a discussion and interpretation of the spatial analyses applied to the King site data in Chapters 5-7. In order to familiarize the reader with the CPt, Chapter 2 provides a discussion of the taxonomy used to organize the archaeological record in the region, as well as a background concerning the CPt settlement and subsistence patterns, material culture, and the spatial and temporal distribution of the tradition. Chapter 2 also provides a discussion of the CPt occupation of the High Plains and the three hypotheses proposed to explain the relationship between the eastern village sites and the High Plains sites associated with the CPt.

Chapter 3 provides a background concerning CPt ceramic production methods and an overview of the different firing techniques. This is followed by a discussion of the archaeological evidence for firing ceramics in open pits derived from experimental studies and several published archaeological contexts. This chapter also provides a summary of the material evidence known to be associated with these firing features, as well as a set of expectations for identifying High Plains CPt pottery firing contexts.

A background on the King site is provided in Chapter 4. This includes a description of the environmental setting and a history of the research conducted at the site. This background is followed by a discussion of the post-depositional disturbances to the site. Chapter 4 concludes with a summary of the features and cultural materials recovered, including some preliminary interpretations concerning the site function based on these materials.

Chapter 5 introduces the methods utilized in the spatial analyses of the King site materials and Chapter 6 presents the results and interpretations of these spatial analyses. The interpretations section begins with a discussion of the vertical distribution of materials to determine the effects of post-depositional disturbances and the duration of the occupation at the site. The majority of Chapter 6 is devoted to the interpretation of the horizontal spatial analyses. These analyses are used to identify possible activity areas across the site, including ceramic firing activities, and to determine the function of the anomalous pit feature as an open firing pit kiln.

Finally, Chapter 7 provides a summary of the interpretations of the site function and spatial structure, as well as the strength of the evidence for ceramic firing activities at the King site. Chapter 7 also provides a discussion of the future research potential of

the King site data, including a number of avenues to be pursued to better understand ceramic manufacturing at CPt sites in the High Plains and the relationship between High Plains sites and the eastern lodge sites of the Central Plains tradition.

Chapter 2: Taxonomy and Culture History

Taxonomy

In order to understand the culture history of the Central Plains, it is important to first address how the archaeological cultures of the Central Plains have been studied and classified. The taxonomic system currently used for the late prehistoric period was developed through the initial application of the Midwest Taxonomic System (McKern 1939) and the later adoption of the Willey and Phillips Taxonomic System (Willey and Phillips 1958). Some scholars have criticized the current system as inconsistent and largely dependent on variable and unsystematically applied ceramic analytical methods (Page 2009; Roper 2006). Another problem plaguing the current taxonomic scheme is the practice of assigning components to phases primarily based on geographic location, which serves to subsume great spectrums of diversity in material culture, settlement, and subsistence patterns into coherent cultural units (Roper 2006; Steinacher and Carlson 1998). This practice has been implicit in the assignment of sites within the High Plains to the Central Plains tradition Upper Republican phase despite a paucity of formal comparative analyses (Gunnerson 1987; Scheiber 2006; Steinacher and Carlson 1998; Strong 1933; Roper 1990; Roper 2009; Wood 1971). Recognizing the lack of clarity in the current taxonomic system, it will still serve to provide a brief account of how the regional taxonomy has developed and what it means for our understanding of the relationships of archaeological cultures across time and space.

Midwest Taxonomic System (MTS) and Willey and Phillips Taxonomic System (WPTS)

The earliest use of the Midwest Taxonomic System (MTS) in the Central Plains was by Strong (1935) and Wedel (1935). They classified the recognized archaeological cultures of the region into the MTS, which consists of the *component, focus, aspect, phase, pattern* and *base* in order from lowest to highest taxon. These classifications within the system are based on hierarchical degrees of shared traits in material culture and lifeway and are not intended to order archaeological complexes spatially or temporally (McKern 1939:308-312). In actual usage the system is frequently reduced to *component, focus and aspect* (Krause 1977:6). The addition of a temporal component to this scheme was proposed in the results of Champe's (1946) Ash Hollow Cave excavations. Using the data from stratified sites, Champe proposed the Lithic, Ceramic and Historic period temporal sequence for the Central Plains. The Ceramic period was further classified into Early, Middle and Late stages, with the Central Plains tradition falling into the Middle Ceramic stage (Champe 1946:89-90).

Lehmer (1954a:139-154, 1954b) proposed the modern concept of the Central Plains tradition in conjunction with the Middle Missouri and Coalescent traditions. The tradition concept was borrowed from the 1953 Willey and Phillips Taxonomic System (WPTS) and the three traditions combine to form the larger Plains Village pattern also defined by Lehmer (1954a, 1954b) for the Northern and Central Plains subareas. These traditions are not viewed as dramatically divergent cultures but more as "stylistic variations on a set of common themes" (Krause 1977:5). Lehmer's (1954a, 1954b) taxonomic contribution of the Middle Missouri, Central Plains and Coalescent traditions has

persisted as the regional scale framework for Northern and Central Plains archaeology despite the fact that it was derived from a fusion of the MTS and the WPTS (Krause 1977; Roper 2006).

WPTS Adopted and Revised

The fact that the MTS was not conducive to enumerating developmental and temporal relationships between archaeological cultures prompted some researchers to attempt a more complete transition to the WPTS (Brown 1966; Lehmer and Caldwell 1966). The WPTS is a more complex system than the MTS but it also facilitates the demonstration of relationships between archaeological cultures through time and space. The WPTS is composed of "archaeological unit concepts" that are defined by content, spatial distribution, and time (Willey and Philips 1958).

The spatial component of the system includes the *locality, region, subarea* and *area*, which Lehmer and Caldwell proposed following with the addition of an intermediate unit between the locality and the region called a *district* (Lehmer and Caldwell 1966:512; Willey and Phillips 1958:18-20). The basic archaeological units of *component, subphase* and *phase* serve as the temporal facet of the system and were adopted as is by Lehmer and Caldwell (1966:512; Willey and Phillips 1958:21-24). Finally, the integrative units of *horizon* and *tradition* are proposed to account for relationships between archaeological units through time and across space (Willey and Phillips 1958:30). The *horizon* denotes "spatial continuity" of traits between archaeological units that are roughly contemporaneous while the *tradition* emphasizes "temporal continuity in technology or other systems" that is noted to exist across the various spatial scales (Willey and Phillips 1958:33-37). Lehmer and Caldwell (1966:513) felt that the Willey and Phillips

definition of a technologically based tradition was not broad enough and so, instead, incorporated Goggin's concept of a *cultural tradition* by which "persistent themes dominate the life of the people." The difference between the two types of traditions is viewed as one of scale whereby the *cultural tradition* encompasses a number of persistently associated *technological traditions* (Lehmer and Caldwell 1966:513). The WPTS *horizon* concept was viewed as representative of *technological traditions* that are present in a number of otherwise dissimilar phases and, as such, are "an extension of cultural elements rather than extensions of whole cultural complexes" (Lehmer and Caldwell 1966:515). In an attempt to keep the structure of the WPTS more or less intact, Lehmer and Caldwell (1966:515) proposed a modified version of the *horizon* that includes two or more contemporaneous phases that share enough common traits "to appear as manifestations of the same basic cultural complex." The result of this reworking of the *tradition* and *horizon* concepts is the current taxonomy for the Northern and Central Plains that defined three traditions including the Central Plains (CPt), Middle Missouri (MMt) and Coalescent (Ct). The MMt and the Ct each possess three horizons that were later converted to *variants* to accommodate issues of temporal overlap (Lehmer 1971).

While the bulk of what Lehmer (1971) discussed pertained to the Middle Missouri subarea of the Northern Plains, Brown (1966) applied the WPTS to the data for the Central Plains. Brown (1966:295) accepts Lehmer and Caldwell's (1966) definition of the *area* as the Plains, the *subarea* as the Northern Plains, the *region* as the Central Plains, as well as the three cultural traditions. He then goes on to suggest that localities are readily definable in the settlement pattern of Central Plains villagers and that these

are composed of loose clusters of sites located along river valleys (Brown 1966:295). Brown has a lengthy discussion of the two cultural traditions pertinent to the Central Plains region, the Central Plains tradition (CPt) and the Coalescent tradition (Ct). Four phases are proposed for the CPt including the Nebraska, Upper Republican, Smoky Hill, and St. Helena phases (Brown 1966:296). The three phases proposed for the Ct include the Redbird, Lower Loup, and Anoka phases in addition to four other archaeological complexes that are contemporaneous with, but distinct from, the Ct including Oneota, White Rock, Great Bend, and Dismal River (Brown 1966:295-296).

Current Taxonomy

For the purposes of this paper, it is only necessary to briefly mention subsequent modifications and additions to the original four phases outlined by Brown (1966). In a critique of Brown's (1966) and Lehmer and Caldwell's (1966) application of the WPTS to the Central Plains, Krause (1969) defined two more variants within the CPt that he called the Solomon River and Loup River. These have subsequently been re-classified as phases, with the Solomon River phase often subsumed as a division of the Upper Republican phase. Additionally, Loup River has been renamed the Itskari phase to limit confusion with the later Ct Lower Loup phase (Blakeslee 1988; Roper 2006). Though there is some debate surrounding the addition of the Steed-Kisker phase and the Initial Coalescent variant to the CPt, these have been included and are important to consider in terms of the development of the CPt through extra-regional interaction (Roper 2006, 2007; Steinacher and Carlson 1998).

As the foregoing discussion indicates, there has been considerable debate concerning the appropriate ordering of the taxonomic units within the Central Plains, as

well as significant attempts to hybridize systems and modify existing schemes. Despite the decades of debate and efforts to reorganize the taxonomy of the CPt, Lehmer's (1954a, 1954b) and Lehmer and Caldwell's (1966) modified WPTS scheme remains the predominant organizing framework for Central Plains archaeology (Roper 2006:105). The current state of taxonomy for the CPt is one in which many agree that the individual phases lack the internal consistency and level of distinguishing traits to be considered phases in the proper sense of the WPTS and that many components have been assigned to phases primarily based on geographic location (Roper 2006; Steinacher and Carlson 1998). Roper (2006:106) summarizes the situation best stating that the "taxa are really just arbitrary divisions of a continuum" and the material culture diversity we see within the Central Plains can often be "attributable as much to available raw materials as to cultural differences."

Summary

To summarize, the Central Plains tradition is currently configured to encompass seven distinctive cultural units that include the Steed-Kisker, Nebraska, Smoky Hill, Upper Republican, Itskari, and St. Helena phases, as well as the Initial Coalescent variant (Roper 2006, 2007; Steinacher and Carlson 1998) (Figure 1). The CPt sites located on the High Plains have often been uncritically attributed to the Upper Republican phase. However, recent research involving both the analysis of stylistic attributes, Instrumental Neutron Activation Analysis (INAA), and petrographic analysis of High Plains pottery has demonstrated that though many of these sites are correctly attributed to the Upper Republican phase (e.g. the Donavan site (5LO204)), some are also associated with the Itskari phase (Page 2009; Cobry and Roper 2002).

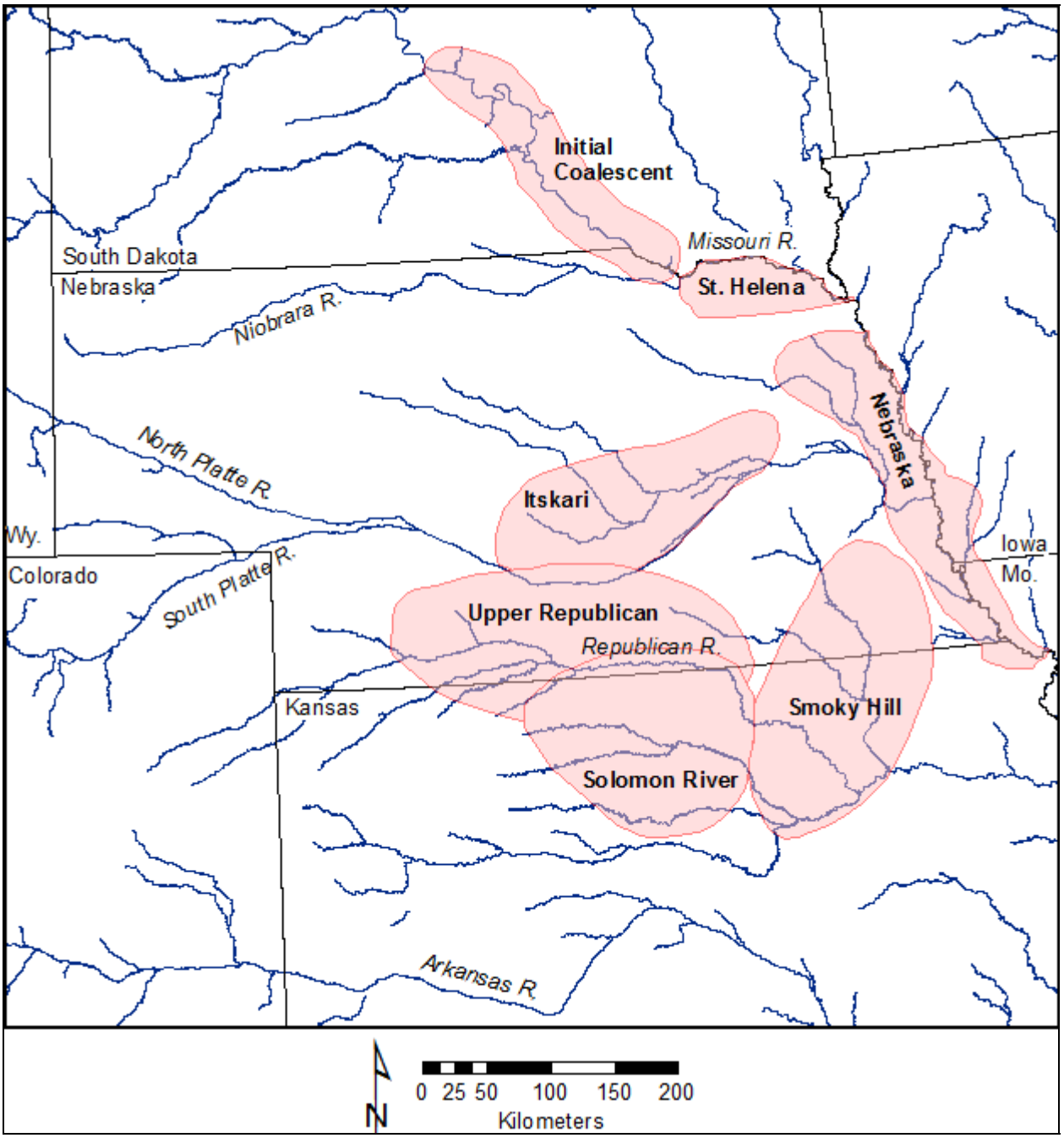

Figure 1. Map of the Central Plains region showing the distribution of the CPt phases.

Culture History

Though the exact mechanisms responsible for the origin of the Central Plains tradition are still unclear, its appearance is marked by a greater investment in horticulture than is apparent during the preceding Woodland period (Roper 2007; Steinacher and Carlson 1998). The accepted duration of the CPt is approximately AD 1000-1400 (Roper 2006, 2007; Steinacher and Carlson 1998). Cultures practicing this semi-horticultural lifeway and bearing the recognized material culture were distributed across the Central Plains from the Missouri River in northeastern Kansas/southwestern Missouri north to the southern tip of South Dakota. The CPt also spread eastward across north-central Kansas and Nebraska to about the 100° W longitude, a boundary that marks a precipitation threshold west of which receives <20 inches of rainfall annually (Roper 2006, 2009). The High Plains west of the 100th meridian were occupied by groups possessing material culture identifiable as belonging to the CPt but living a lifeway not conducive to inclusion in the tradition due to the lack of evidence for horticulture or permanent lodge structures. These groups have been termed High Plains Upper Republican (Roper 1990).

Overview of the CPt

The CPt adoption of a more agriculturally based lifeway was attended by changes in material culture, population size, and settlement patterns (Roper 2007). Technological changes to accommodate a horticultural subsistence focus included the development of agricultural tools, such as the bison scapula hoe, mortars and grinding implements, and an abundance of bell shaped storage pits located interior and exterior to the houses (Steinacher and Carlson 1998). Changes in the formal properties of ceramics include a

shift from thick-walled conoidal shaped Woodland vessel forms to thinner-walled globular shaped vessels with constricted orifices (Roper 2006, 2007; Steinacher and Carlson 1998). This change in vessel form is attributed to the greater thermal efficiency of the latter vessel type in terms of the prolonged cooking times required by dried maize and beans (Braun 1991:326).

The investment in horticulture also necessitated the adoption of a more sedentary settlement pattern and the development of very characteristic durable house structures. The dispersed settlement pattern consisted of isolated lodges or small clusters of lodges located on terraces overlooking the larger streams and tributaries (Steinacher and Carlson 1998). Utilizing a diversified and generalized subsistence base composed of cultigens, wild plant species, small game, bison and aquatic species, the CPt peoples relied on the rich ecological zones that existed around the stream valleys (Nepstad Thornberry et al. 2002; Roper 1995). These environments provided ready access to water, small game and aquatic species, wild plant resources, arable land along the floodplains, and clay sources, as well as wood for fuel and farmstead construction (Roper 2006). Access to predominantly grassland dwelling species, like bison and antelope, was also close at hand. The increase in the number of sites during the CPt period suggests the growth in population that often accompanies a more sedentary agriculturally focused lifestyle (Steinacher and Carlson 1998).

Radiocarbon dates have been somewhat problematic within the Central Plains due to the unreliability of a large number of the earliest obtained dates from the Gakushuin Laboratory in Japan (Blakeslee 1994). Other issues can be attributed to inconsistencies in interpretation related to the varied practices of averaging dates from multiple

contexts, the uncritical use of multiple and widely variable dates from single contexts, and from the habitual dismissal of dates that do not conform to preexisting expectations (Blakeslee 1994; Roper 1995). Despite these difficulties, some reassessments within the last two decades have attempted to clarify the CPt chronology and elucidate the origin, expansion, and termination of the tradition (Blakeslee 1993, 1994; Roper 1995, 2007, 2009; Roper and Adair 2011, 2012).

CPt Origins

Traditionally, the CPt has been viewed as an expansion of traits from southeastern cultures that spread, by some undefined mechanism, south-north along the Missouri River and across Kansas and Nebraska in a similar fashion by appearing in a south-north trend along the major waterways (Strong 1935; Wedel 1934). Two theories have been proposed in the literature concerning the origin of the Central Plains tradition. One theory proposes that the CPt originated, through significant Mississippian influences, in the Steed-Kisker and Glenwood localities of northwestern Missouri and southwestern Iowa and spread north and west across the Central Plains (Roper 1995, 2006, 2007; Roper and Adair 2011, 2012). The second hypothesis is that the CPt developed more directly out of the indigenous Woodland populations in the Smoky Hill and Solomon River valleys of north-central Kansas (Krause 1995). These theories are not mutually exclusive and both have supporting evidence that will be considered in further detail below.

In an effort to clarify the CPt origins and assess its expansion through space and time, Roper (1995) analyzed radiocarbon dates from sites assigned to the Upper Republican, Nebraska, Smoky Hill, Itskari, and St. Helena phases, the Initial Coalescent

variant, and the CPt sites on the High Plains lacking lodge remains. Roper (1995:216-217) argues that the complex of changes in material culture and lifeways that we see during the CPt arose as a result of the expansion of maize-centered horticulture into the region where previously there had been very limited use of cultigens. In other words, the changes seen at the beginning of the CPt were “accommodations to the changed subsistence base” (Roper 1995:217).

In her analysis, Roper used a set of 208 radiocarbon dates from 97 sites and displayed the dated components on a series of maps to show their geographic distribution by century-long intervals. This method allowed for an assessment of not only where the earliest manifestations of the CPt were, but also in what directions it expanded, the occupation length of localities, and the process of abandonment of localities (Roper 1995:205). There are twenty-five dates from the study sample that are earlier than AD 1100, with sixteen of these derived from Steed-Kisker or Glenwood locality sites (Roper 1995:208). The other seven dates, scattered across Kansas, Nebraska and Colorado, are cited as problematic due to extremely large standard deviations or questionable context (Roper 1995:208-209). Though the available sample of dates is still short of excellent and is biased toward some phases and localities (Blakeslee 1994; Roper 1995:204), the results of Roper’s (1995:214) study suggest that the CPt originated on the eastern edge of the Central Plains prior to AD 1100 with the earliest manifestations of the CPt being the Steed-Kisker phase and Nebraska phase in the Glenwood locality. The greatest Mississippian influences in terms of traits are also seen in these more eastern CPt components (Steinacher and Carlson 1998), supporting the inference that the CPt developed out of the interactions of local Central Plains

groups with southeastern Mississippian groups. Additional dates have been published from Steed-Kisker and Nebraska phase components and these dates still support the claims of the earlier study and suggest the possibility of an even longer persistence of these phases into the 14th century (Roper and Adair 2011, 2012).

Krause (1995) proposed a different hypothesis for the genesis of the CPt in the Smoky Hill and Solomon River valleys in north-central Kansas and south-central Nebraska that suggests an in situ development out of local Woodland Keith variant groups. Krause (1995) developed a sequence of changes in ceramic manufacturing between the Middle Woodland period and the CPt Upper Republican phase in the Smoky Hill and Solomon River localities. These ceramic changes include an increase in paneled rims, decreases in vessel wall thickness, and increases in the use of sand and grog temper, as opposed to calcite temper, from Woodland to CPt assemblages. Additional support for the Woodland genesis of the CPt is suggested by the radiocarbon dates for the Sumpter, Roots, Hills and Lebeau sites, which fall within the 10th century and are some of the earliest dates for the CPt (Krause 1995:313). However, some of the dates that Krause uses to demonstrate the early appearance of the CPt are called into question by Blakeslee's (1994) reassessment. First, the date for the Hills site (910±100 BP) was obtained from the Gakushuin Laboratory, dates from which have been shown to be unreliable (Blakeslee 1994:209, Table 10). Blakeslee's (1994) reassessment removes the very early dates for the sites in the Smoky Hill and Solomon River localities and derives a beginning date of 950 BP (AD 1000) for these CPt manifestations. Though Krause's (1995) argument certainly hasn't been definitively refuted, the appearance of the CPt at some point in the 11th century AD in the regions

he discusses has gained broader acceptance in the literature (Steinacher and Carlson 1998; Roper 1995, 2006).

Geographic and Temporal Distribution of the CPt

The two hypotheses discussed above emphasize different processes for the development of the Central Plains tradition. One centers on cultural diffusion, possibly combined with small-scale migration (Roper 1995), and the other on local development through existing Woodland populations with less outside influences (Krause 1995). These two theories are not at odds when one considers the potential mechanisms for the expansion of the tradition. The most prolific contributions to the topic of CPt expansion, both in terms of timing and mechanisms, has come from Roper (1995, 2006, 2007, 2009).

In her chronological study of the CPt, Roper (1995) mapped 97 dated components in 100 year increments across the Central Plains. These maps are also accompanied by graphs plotting each intercept date with its one sigma calibrated range (Roper 1995:207). The data show a marked trend of continued occupation of the Steed-Kisker and Glenwood localities with westward expansion through the Kansas River basin including the Smoky Hill phase and Upper Republican phase occupations of the Solomon River and Medicine Creek localities (Roper 1995:209). Nearly half of the dates utilized in Roper's study fall within the 1200s with the occupations in the early part of the century consisting mostly of the areas already occupied by CPt peoples. During the mid-latter part of the 1200s the Nebraska phase expanded north of the Platte River, the Itskari phase became established along the Loup River, the Initial Coalescent variant develops in the Big Bend region of South Dakota and there is evidence of a non-

horticulturally based CPt occupation in the High Plains (Roper 1995:212). The period between AD 1200-1300 appears to have been the height of expansion for the tradition with the number of dated components declining during the 1300s, which Roper (1995:212) interprets as evidence for a less intense occupation of many localities and suggests that the "'population center' may have shifted northward." Recently published dates also concur with this trend showing that by AD 1400 there is no indication of Smoky Hill phase occupations, which was one of the southernmost expressions of the CPt (Roper and Adair 2011).

In a later treatment of the origins and expansion of the CPt, Roper (2007) elaborates on the possible mechanisms for this dramatic shift in lifeways that we see between the Woodland and Plains Village periods. She suggests that we must view this transition as "the emergence of a distinctive and fully developed, if fairly short-lived food production system" (Roper 2007:55). Earlier conceptions (Wedel 1940) attributed the appearance of the CPt to migrations of horticulturally based populations from the east and southeast. Roper suggests that there is nothing that necessitates an interpretation of immigrants moving in with a full-blown agricultural system and displacing indigenous Woodland populations (Roper 2007:55-57). In fact, the mechanisms she suggests for the spread of this new adaptive system are accommodating to both the previously discussed theories concerning the origin of the CPt as they allow for both internal local development and the small-scale movement of people into and out of the Central Plains.

The two processes Roper (2007:57-58) proposed for the development and spread of the CPt are demic diffusion and individual frontier mobility. Demic diffusion involves the

multi-generational movement of small groups or individuals into areas surrounding a center of domestication, while individual frontier mobility operates through contact and the exchange of individuals and small groups between populations with some kind of established kin-based relationships (Roper 2007:57-58). These two processes do not involve the movement of entire communities nor do they require movement into targeted localities (Roper 2007:58). However, the gradual and cumulative nature of these mechanisms does account for the time-transgressive spread of CPt traits along the Kansas River basin in the 1100s and north along the Missouri River in the 1200s (Roper 2007:58-59). The variability in certain classes of material culture across space is another indication that large-scale migration is not a satisfactory explanation for the spread of the CPt. The phases that express the most Mississippian-like traits (especially in decorative and formal ceramic traits) occur in the Steed-Kisker and southern Nebraska phase sites, which are temporally the earliest CPt sites and spatially the closest to the Mississippian center from which people, ideas and technologies were presumably emanating (Roper 2007:59). The strength of the idea for a local population base that was differentially affected by this diffusion of people and ideas is the fact that ceramic variability is largely not temporally significant within phases but rather spatially variable and is "more gradual along drainages and more marked across them" (Roper 2007:59). Roper argues that the spread of the CPt in the span of less than two centuries is:

> "best accommodated by a model of leapfrogging by small demic units followed by further expansion from multiple centers as former hunter-gatherers settled down to farm, as populations grew, and as daughter settlements budded off and filled out the landscape" (2007:62)

The processes Roper (2007) proposes of demic populations mingling with and being incorporated into local populations explain the spatial variability in ceramic trait distribution and the process of population growth through the "budding off" of communities. These mechanisms may also help to explain the appearance of non-horticulturally based CPt groups in the High Plains. As populations grew and filled in the ecological niches conducive to agriculture, some groups may have chosen to maintain a more nomadic hunting-and-gathering lifeway, while still retaining some of the material traits of their eastern kin, a possibility which will be discussed in more detail in a following section.

CPt Depopulation and Regional Abandonment

There is general consensus concerning the significant depopulation of the Central Plains during the 14th century (Blakeslee 1993; Bozell et al. 1999; Roper 1995, 2006; Steinacher and Carlson 1998), though the precise movements of various populations are still debatable. However, it is fairly clear that there is a general trend of later occupation in the northern and eastern portions of the geographic extent of the CPt (Blakeslee 1993; Roper 1995). The virtual disappearance of the Upper Republican, Smoky Hill, Steed-Kisker and southern Nebraska phases by AD 1300 in some places and throughout the following century has been explained mainly through migrations into adjacent areas. Some have argued that Upper Republican peoples migrated into the Loup River region to become part of the later Itskari phase (ca. AD 1100-1350) (Krause 1969). Others propose that Itskari and Nebraska phase populations migrated back east and north along the Missouri River at about the same time (Bozell et al. 1999). Roper (2006) has proposed that Smoky Hill phase populations migrated out of the Central

Plains to join Southern Plains groups forming the Great Bend Aspect. However, with the exception of a few Nebraska phase localities, it is clear that by the late 14th century only the St. Helena phase and Initial Coalescent variant remained as significant CPt manifestations (Blakeslee 1988:10, 1993:211; Bozell et al. 1999:108; Roper 1995:214; Steinacher and Carlson 1998).

The accepted terminus for the St. Helena phase is ca. AD 1450-1500 (Blakeslee 1988; Roper 1995; Steinacher and Carlson 1998) but there is little consensus concerning the ultimate fate of these communities. Two hypotheses have been proposed to explain the termination of the CPt and partially account for the genesis of the Initial Coalescent variant (ICv) in South Dakota (Steinacher and Carlson 1998). The first of these postulates that the St. Helena peoples migrated north to subsequently become part of the ICv, and later the historic Arikara, while Itsaki phase peoples remained in the Loup River area and developed into the protohistoric Lower Loup phase and eventually the historic Pawnee (Steinacher and Carlson 1998:258). The other hypothesis suggests that both St. Helena and Itskari peoples moved north as part of the ICv but that the Itskari returned to central Nebraska as the Lower Loup phase (Steinacher and Carlson 1998:258). Though some interaction between St. Helena, Itskari, and ICv peoples is likely, simplistic concepts about developmental relationships between specific Central Plains groups and Middle Missouri groups resulting in the ICv are no longer supported (Steinacher and Carlson 1998:259). There is also a gap in the record between the CPt and the protohistoric Lower Loup phase in central Nebraska that argues against the idea of a developmental Itskari-Lower Loup-Pawnee sequence (Bozell et al. 1999:102; Steinacher and Carlson 1998:259). Though it is widely accepted

that there are significant relationships between the latest phases of the CPt, ICv, and the historic Pawnee and Arikara, specific developmental relationships have yet to be identified (Bozell et al. 1999:102; Steinacher and Carlson 1998:259).

Droughts have often been cited (Lehmer 1954a, 1954b, 1971; Wedel 1959, 1986) as the cause of the CPt contraction and the depopulation of the Central Plains by the mid 15th century (Blakeslee 1993; Roper 1995, 2006; Steinacher and Carlson 1998). Blakeslee (1994) evaluated the model of drought induced regional abandonment and proposed a second model based on the swidden horticultural subsistence system of the CPt (Blakeslee 1993). After modeling the effects of the Pacific I climatic episode, which has been correlated to the abandonment of the Central Plains, Blakeslee (1993:211) concluded that the drought hypothesis is not supported by the spatial patterning and timing of abandonment at various localities. In fact localities that should not have seen significant reductions in rainfall were abandoned very early and areas that should have been drier were occupied later (Blakeslee 1993:211).

Blakeslee (1993:211) suggests that a model based on resource depletion in areas supportive of swidden horticulture better explains the spatial and temporal patterning of the population contraction and final abandonment. This model suggests that the initial occupation of any given area was likely small and, as the populations grew, the small forested stream environments critical to the CPt settlement pattern were filled up gradually (Blakeslee 1993:202). The lack of regular flooding along the small tributaries would have necessitated field rotation to maintain fertile soils, thus requiring regular small-scale movement. As populations grew within these restricted ecological zones, critical resources, such as fertile soil and timber, would have become depleted and

populations forced to move on to other more distant locations (Blakeslee 1993:202). The population expansion of the CPt and the abandonment process display different timing for different localities, as would be expected based on this model of initial settlement, local population expansion, resource depletion, and abandonment (Blakeslee 1993:211). While Blakeslee makes some valid points and discusses some interesting mechanisms for population movement, there are issues with the use of ^{14}C dates in his study and, therefore, the associated chronology is not conclusive.

Summary

Though our knowledge of the precise timing and spatial patterning of CPt population movement is still limited, there is an overall understanding of the timing and directional trends for the expansion, contraction, and abandonment of the Central Plains. We do know that this new lifeway flourished and spread rapidly across the region within three hundred years of its inception. Just as rapidly, populations migrated out of the heartland between north central Kansas and central Nebraska back toward the Missouri River and north into South Dakota during the next two centuries. The exact processes that led to the abandonment of the Central Plains are far from clear at this point, but it seems reasonable to assume that there may have been multiple factors involved. Droughts and an unsustainable subsistence practice in the horticulturally marginal environment of the Central Plains may have been compounding factors resulting in abandonment. However, regardless of causation, by AD 1500 the CPt ceased to exist in its currently recognized form within the Central Plains.

Central Plains Tradition Sites on the High Plains

The High Plains is an expansive, and relatively uneroded, fluvial plain that extends east-west from the central lowlands bordering the Missouri River valley to the Rocky Mountains and north-south from the Nebraska-South Dakota border to the Llano Estacado of Texas. The High Plains region west of the 100th meridian is a region dominated by short grassland environments and marked by a semi-arid climate, receiving less than 20 inches of precipitation annually (Prentiss and Rosenberg 1996). Due to the high prevalence of surficial exposures of bedrock, sand, and gravel deposits and a paucity of permanent water sources, this region was unsuitable for the prehistoric swidden horticultural component of the CPt subsistence base that existed farther east on the Central Plains (Prentiss and Rosenberg 1996; Steinacher and Carlson 1998). The High Plains have seen substantial use and occupation throughout the human history of North American but, as Wedel (1963:3) described, “the High Plains must be considered a region of limited possibilities.”

For more than 70 years, archaeologists have recognized sites on the High Plains bearing materials indistinguishable from those found in sites from the heartland of CPt occupations along the tributary streams of the mixed grass prairie to the east (Bell and Cape 1936; Champe 1946; Cobry and Roper 2002; Lehmer 1954b; Page 2009; Reher 1973; Roper 1990, 2009; Scheiber and Reher 2007; Strong 1935; Wedel 1963; Wood 1971, 1990). Though these sites have long been the subject of interest in Great Plains archaeology, there has been little research conducted on these sites when compared to that concerning the eastern farmsteads and hamlets. Dating to AD 1000-1400, the approximately 50 known High Plains sites are generally located in rock shelters or on

butte tops and high stream terraces (Peterson 2008; Scheiber 2006). The material culture is similar to that of the eastern earthlodge sites with the main differences being a lack of evidence for permanent houses and horticulture and, generally, a less diverse suite of artifact classes (Roper 1990). The pottery at these sites appears most similar to that from sites of the Upper Republican or Itskari phases, which are two largely contemporaneous manifestations of the Central Plains tradition with minor differences in ceramic types, settlement pattern, and subsistence strategy (Steinacher and Carlson 1998).

It is noteworthy that the same phenomenon of sites with Plains Village like ceramics located far west of the established village territories can be found in the Northern Plains as well. In fact, some of the sites in relatively close proximity to the King site have been identified as Plains Woodland, Middle Missouri or Coalescent occupations. There are several Initial Middle Missouri (IMM) occupations (39CU206 (Phelps), 39FA23, 39FA83, 39FA8 (Stephen's Ranch)), Extended Middle Missouri (EMM) occupations (39BU217 and 39CU206 (Phelps)), as well as several Extended Coalescent (EC) occupations (39FA45, 39FA48, 39FA6 (Lord's Ranch)) located on the periphery of the Black Hills, at most 140 miles from the King site and some as close as 40 miles (Alex 1989; Lippincott 1996; Wheeler 1995; Figure 2).

In the Badlands, upstream from the King site on the White River, there is also the Johnny site (39JK4), which is a IMM, and possibly Plains Woodland, occupation within the Fog Creek drainage, the Woodland occupation at 39JK68, as well as a possible Dismal River (protohistoric Apache) component at 39SH68 (Johnson 1989, 1993; Keller et al. 1984; Figure 2). Some researchers still find the cultural designations of some of

these sites unsatisfactory. For example, the ceramics from both the Johnny and Phelps sites possess characteristics (collared rims and cord roughening up to the lip) that are only occasionally found in the eastern village assemblages, making their classification as IMM somewhat questionable (Johnson 1989:23).

The ambiguity often involved in the identification of these western Plains Village components is particularly evident in several sites located near the northern Black Hills, in eastern Colorado, and in the Sand Hills of north-central Nebraska. First, the Smiley-Evans site (39BU206) is a fortified occupation located on the northern periphery of the Black Hills. Similarities between the Smiley-Evans ceramics and those found at other IMM villages led researchers to propose it as a western manifestation of the IMM. However, due to the poor manufacturing quality of the Smiley-Evans ceramics, as well as the minimal similarities to IMM pottery, further research suggests that the occupants of Smiley-Evans were most likely related to late Plains Woodland groups (Johnson 1993:123).

The McIntosh site (25BW15) is another example of a Plains Village manifestation that presents difficulties in phase designation. McIntosh is a seasonal spring-fall occupation located in the Sand Hills region of north-central Nebraska. Aspects of the McIntosh ceramic decorative motifs suggest St. Helena phase affiliation but the frequency of collared rims resembles Upper Republican assemblages. The preponderance of western lithic sources present at McIntosh is further reflective of the Itskari phase (Koch 2004:129). Similarly, the Buick Campsite (5EL1) and Barnes site (39LA9187) in eastern Colorado both have Upper Republican-like pottery made by apparent resident populations of the High Plains. The similarities to Upper Republican

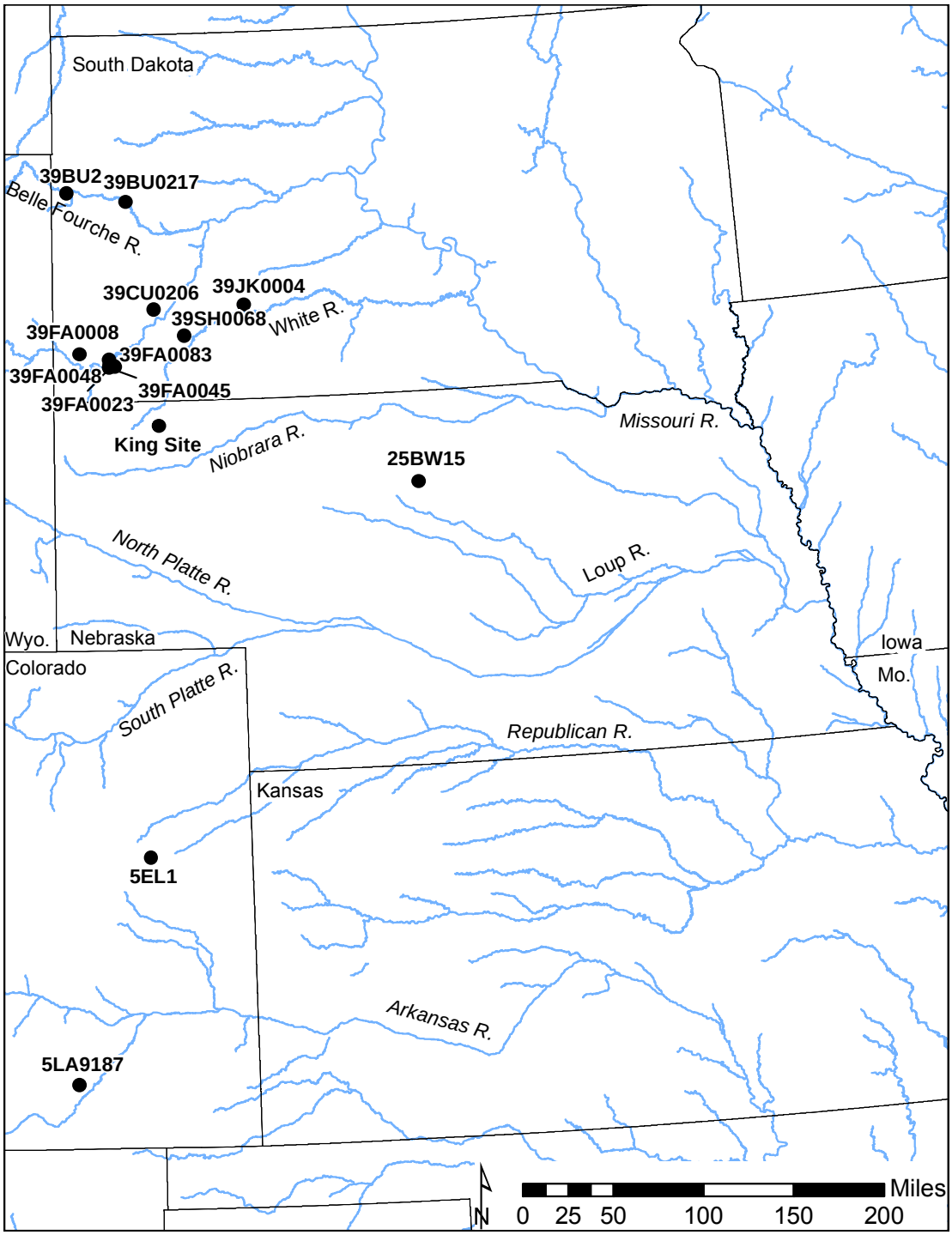

Figure 2: Other Plains Village sites in the Sand Hills, Black Hills, Badlands, and High Plains with reference to the King site.

pottery suggest a connection to CPt groups, either ancestrally or through population interaction, but are different enough to warrant a designation as a separate ceramic tradition (Lindsey and Krause 2007:104).

As the cultural designations for these western sites are often far from clear, some researchers have suggested that it may be more fruitful to develop local taxonomies in lieu of continuing to attempt "best-fit" classifications (Alex 1989:179; Lindsey and Krause 2007). In the absence of such local taxonomies, it was still useful to examine the King site pottery with reference to Woodland, Middle Missouri, Coalescent and Central Plains tradition ceramics to determine where the assemblage lies on this continuum. The results of such comparison suggest that the King site ceramics most closely resemble Itskari phase pottery (Chapter 4). Thus, the following explanatory hypotheses are discussed in reference to the CPt but the concepts involved in each are equally relevant to the above referenced sites in the Northern Plains.

Explanatory Hypotheses

There have been three hypotheses proposed to explain the origin and function of these High Plains ceramic sites: 1). the hunting camp hypothesis states that these were seasonal camps occupied by CPt horticulturalists from the east making periodic trips into the High Plains to exploit faunal, floral and lithic resources, 2). the resident population hypothesis proposes that these sites were occupied by CPt groups who, over time, became more and more invested in a nomadic hunter-gatherer way of life and eventually abandoned their gardens and the traditional semi-sedentary CPt settlement pattern and 3). The residential mobility hypothesis suggests that these are sites occupied by members of these eastern groups who periodically abandoned a more

settled way of life, possibly due to drought induced resource stress, and took residence in the High Plains as more fully nomadic bison hunters and gatherers (Roper 2009; Steinacher and Carlson 1998). The following is a review of these three hypotheses and some of the data that either support or refute them.

The Hunting Camp Hypothesis

The hunting camp hypothesis was the earliest proposed explanation for the presence of apparent CPt sites in the High Plains lacking evidence of horticulture and lodge structures (Bell and Cape 1936; Lehmer 1954a: Wood 1971). Lehmer (1954a:146) suggested that "these sites were seasonal camps established by bison-hunting parties of Upper Republican people" and viewed this as an explanation for the lower proportion of bison bone recovered from CPt village refuse as compared to that from Middle Missouri village sites. For Lehmer (1954a:146) this comparatively low incidence of bison bone in CPt lodge sites was due to the fact that only "usable parts of the carcass such as meat, hides and bones to be made into tools" would be transported back to the village. He goes on to extrapolate that the presence of these CPt sites on the High Plains likely represents a pattern similar to that known from the historic period Plains Villagers, in which large groups would embark on extended long-distance bison-hunting trips away from the villages (Lehmer 1954a:146). The relatively low number of bison present at lodge sites has been noted by a number of researchers (Blakeslee 1999; Bozell 1991; Koch 2004; Ludwickson 1978) and there is often a disproportionate number of scapulae, likely due to their utility as gardening implements.

The fact that unmodified bison remains are regularly found at lodge sites with disproportionately large numbers of high utility elements and that bison processing sites

are virtually unknown from the Central Plains (Scheiber 2006; Scheiber and Reher 2007) has led researchers to believe that the sites in the High Plains are more than just evidence of occasional CPt hunting. In fact, the evidence from some of these High Plains sites, particularly the Donovan site, indicates the extensive and repeated processing of large quantities of bison for bone grease extraction (Bell and Cape 1936; Reher 1973; Scheiber and Reher 2007). Scheiber and Reher (2007:356) have also noted that a lack of high utility elements, such as scapulae and metapodials in High Plains sites, may indicate the transport of these elements elsewhere, possibly back to the farming hamlets. Given the patterns discussed above, the speculation has continued as to why CPt peoples would travel across several hundred miles of presumably suitable bison territory to hunt on the High Plains (Reher 1973).

Recent research conducted by Page (2009) demonstrates a correlation between some High Plains sites and Itskari phase sites in the Davis Creek locality (Loup River region of north-central Nebraska) in terms of the types and proportions of lithic source materials present. Additionally, Itskari phase sites on the High Plains are almost invariably located near notable sources of tool stone as opposed to being evenly distributed across the landscape in a manner more inclusive of the procurement of resources from a variety of environmental settings (Page 2009:296). This suggests that, at least for Itskari phase groups, hunting on the High Plains was likely embedded within a resource procurement strategy that involved the acquisition of lithic raw materials from western sources.

Roper (1990) attempted to test the hunting camp hypothesis based on a model developed from ethnographic data on historic period Pawnee hunting practices. She

defined five types of sites for the Pawnee model and inferred that each site type should vary in terms of the number and types of activities performed and thus the number and types of tools represented in an assemblage. She then classified these tools into functional categories and compared assemblages from CPt High Plains sites and Lower Loup (proto-historic Pawnee) sites to the expected functional classes for the different types of hunting camps in the model. Roper's (1990:15-16) results show that assemblages from CPt sites on the High Plains contain more functional classes of tools than would be expected for extra-local hunting parties and that Lower Loup sites conform to the model. Roper (1990:16) states that her results are strictly an indication that "the High Plains sites are not hunting sites on the historic model" and that they may have been occupied by a resident CPt population instead. She goes on to argue that we would do better to "reject the assumption that all peoples with an Upper Republican material culture had a single settlement system" and instead "view Upper Republican as the material culture of a people or peoples who were generalized hunter-gatherers and sometimes horticulturalists…differentially interacting with localized settings" (Roper 1990:16).

Criticism of Roper's model has drawn on the seemingly huge disparity in group size between the family-level organization of prehistoric hunting and the large-scale proto-historic and historic period communal hunting practices (Blakeslee 1999:88). A critique by Blakeslee (1999:88) suggests that the differences in the functional richness of assemblages between the High Plains ceramic sites and the Lower Loup sites may merely be a result of the fact that smaller groups hunting smaller numbers of animals may be able to provision themselves more easily and are thus able to remain in one

location for longer periods of time. Remaining in one location for a longer period of time will likely produce a richer assemblage as a wider range of activities are carried out.

Separate Residential Populations Hypothesis

The residential population hypothesis suggests that separate groups of CPt people may have occupied the High Plains on a year-round permanent basis (Roper 1990; Scheiber 2006; Wood 1990). Based on the available dates, it appears that the CPt occupation of the High Plains is entirely contemporaneous with the CPt occupation of the Central Plains (Scheiber 2006; Scheiber and Reher 2007; Wood 1990). The first CPt occupation at the stratified Donovan site is contemporaneous with the appearance of intensified horticulture on the Central Plains around AD 1000, while the last occupation appears to be contemporary with the Upper Republican phase in the Central Plains (Scheiber 2006; Scheiber and Reher 2007). This has led Scheiber (2006:141) to suggest that Upper Republican people may have utilized the High Plains to some degree for hunting, but over time some groups decided to stay permanently, abandoning the horticultural subsistence component, and that these people "recreated their identity" on the High Plains. Though the Donovan site presents us with strong evidence for the repeated use of the High Plains over centuries by peoples with some kind of affiliation to the eastern CPt groups and poses the possibility of more resident yet mobile population, it does not conclusively answer the questions surrounding the relationship between High Plains and eastern CPt village sites.

Wood (1990) and Reher (1973) have pointed to the high number of sites on the High Plains, as well as the extensive occupations present at some, as evidence that they represent a more substantial presence in the region than that which would result from

small and occasional hunting parties. Peterson (2008) has demonstrated that the occupants of the High Plains utilized a diversity of environmental settings including upland buttes and associated playas, wooded scarp settings and permanent stream terraces. Such diversity in terms of the environmental setting of these occupations is a pattern that some suggest supports a more generalized hunter-gatherer population, rather than one focused on the specialized task of bison hunting (Blakeslee 1999).

Detracting from the strength of the resident population hypothesis is the fact that there is very little evidence of local High Plains ceramic production. Ceramic sourcing studies are limited in the Central Plains in general but a few have been conducted in order to examine the relationship between these Central and High Plains occupations (Cobry and Roper 2002; Roper et al. 2007; Page 2009). Cobry and Roper (2002) and Roper et al. (2007) have examined ceramic samples and clay sources from the Medicine Creek locality of the Republican River area, the Solomon River area and selected High Plains sites for compositional analysis by INAA. These studies generally show poor results for the sourcing of ceramics to specific clay sources, but they are still preliminary studies and adjustments in sampling methods for clay sources and clay source preparation may yield better results in the future (Cobry and Roper 2002:157; Roper et al. 2007:333). However, some of the collective results do show a general shift in elemental composition of clays from east to west and some affinity between compositional groups from High Plains sites and sites in the Medicine Creek locality (Cobry and Roper 2002:157). The results of the compositional characterization of sites in both regions suggests that the movement of pots was one-directional, with pots made in the Central Plains being transported to the High Plains (Cobry and Roper 2002:162).

Page (2009) conducted petrographic analyses of ceramics from southeastern Wyoming and found similar results in that only very few pots (8%) appear to have been manufactured locally, even at sites that show intensive occupation by Itskari phase groups. While these studies seem to suggest that ceramics were overwhelmingly produced in the vicinity of the horticultural lodge sites and not on the High Plains, this is by no means definitive at this point. Even if it were the case, it does not resolve the questions concerning the mode of transport for pottery. It is possible that the source population was transporting them for their own use while on the High Plains and it is equally possible that some form of trade was taking place between a resident population and the eastern CPt groups. Perhaps they were trading pemmican and scapulae for pots, which would in turn explain the variability in faunal content between assemblages in the two areas as discussed above.

Residential Mobility Hypothesis

Roper (2009) has recently offered an alternative to her earlier proposal of a more properly residential CPt population of the High Plains with an interpretation of CPt residential mobility that fluctuated between periodic residence of both the High Plains and the eastern horticultural villages. She interprets several lines of evidence including house forms, pottery decoration, clay sources, lithic raw materials, and lodge abandonment as indicative of high residential mobility (Roper 2009). At some sites within the Medicine Creek locality and areas in western Kansas there are houses that are smaller than average, show no signs of repair, have fewer internal storage pits, and highly variable abandonment signatures (assemblage size relating to length of occupation) (Roper 2009:27-28). As sites bearing these features are mainly found on

the western edge of the “core” CPt occupation area, Roper (2009:24) interprets these traits as evidence of the instability of the CPt horticultural subsistence pattern near the 100° W longitude annual rainfall threshold of less than 20 inches.

Roper (2009:24) suggests that rather than looking at the semi-sedentary and mobile Upper Republican occupations as evidence for separate populations or a single population utilizing the High Plains only for specific resources, it makes more sense to view the Upper Republican people in this area as a people “making tactical and occasionally perhaps strategic decisions, and moving back and forth across what we might better think of as a threshold rather than a boundary.” The Upper Republican occupations on the western edge of the Central Plains and in the High Plains likely represent a continuum of individual choices by different families; some may have been more or less committed to horticulture and sedentism and some to a more mobile lifestyle (Roper 2009:24). While these fluctuations in settlement and subsistence patterns may have been heavily influenced by individual choice, they were also more than likely influenced by local climatic patterns of drought, which would have occasionally contracted the limit of CPt horticulture eastward (Roper 2009:24).

Despite the frequently applied label of “High Plains Upper Republican” (Roper 1990, 2007, 2009; Scheiber 2006) as an all inclusive term for ceramic sites in the High Plains, recent ceramic analyses have shown that the High Plains were occupied, perhaps more extensively, by populations belonging to the Itskari phase as well as by those related to the Upper Republican phase (Page 2009). Roper’s (2009) residential mobility hypothesis may well account for the patterns seen in the Republican River area of Nebraska and some areas of Western Kansas, but Page (2009) does not believe that it

is a viable explanation for the majority of High Plains sites, which he has identified as related to the Itskari phase. Contrary to Roper's (2009) evidence from Medicine Creek, the Itskari phase sites in the Davis Creek locality, a tributary of the North Loup River in central Nebraska, display consistently small houses, consistent numbers of storage pits, consistently higher frequencies of rim sherds indicating more stable occupation durations, and lithic assemblages that normally contain High Plains source material (Page 2009:299-301). Page (2009:302) views these differences as indicative of more stable occupation lengths for the Davis Creek sites and the prevalence of High Plains lithic materials as particularly strong evidence for regular seasonal occupation of the High Plains by Itskari phase peoples.

Summary

The King site lies along the northern periphery of the High Plains physiographic region of the Great Plains (Wedel 1963). It is farther north than most of the sites utilized in the research discussed above and varies considerably in that it does not appear to represent a typical hunting camp as these generally have more limited subsurface features and limited functional artifact classes than what we see at the King site. There are some indirect indicators of relatively long-term occupancy of the King site, including craft production (bone beads and ceramics as argued herein). The site also contains a large subsurface pit feature with evidence of extensive burning and substantial trash accumulation. Since there is presently no known structural component at the King site, it is difficult to postulate whether the occupants were constructing and occupying mobile shelters, such as tipis, or utilizing some more permanent type of dwelling. Geophysical investigations conducted in 2011, with subsequent testing of two anomalies, did not

yield any conclusive evidence of lodge structures (Bamforth 2012, personal communication). Evidence of house structures have not frequently been reported from High Plains sites and neither have substantial cache pits or trash pits, thus the King site is somewhat unique in that regard as well. What is clear is that the occupation was long-term enough to leave behind evidence of craft-production and to justify the excavation of a large pit that was subsequently filled with substantial amounts of trash regardless of what type of shelters were being utilized by the occupants. The possible purpose of this pit, primarily its use as a ceramic firing feature, and what it may indicate about the nature of the occupation of the site are investigated in the remainder of this thesis.

Chapter 3: Ceramic Production

A large portion of this thesis is devoted to the investigation of the evidence for ceramic firing at the King site. In order to better interpret this evidence, it is necessary to understand this technology in the context of Central Plains tradition practices. The following background on the production process, with some relevant archaeological and experimental examples of ceramic firing, will establish the expectations concerning the material evidence for this activity at the King site.

Vessel Construction

The basic form of CPt pottery is fairly consistent throughout the various phases of the tradition and consists of cord-marked or partially smoothed globular to subconoidal jars, in other words vessels with constricted necks and, less commonly, vessels with constricted orifices that lack a neck and a rim that are called bowls. Rim forms range from straight to flaring or S-shaped and can be unthickened, thickened or collared through the application of an extra strap of clay on the exterior of the rim below the lip. Decoration is often restricted to the outer rim and lip but also commonly occurs on the shoulder in Steed-Kisker and Nebraska phase assemblages, as well as on some Smoky Hill wares. Decorative elements consist of incised linear motifs, pinched, applied or excised node motifs and fingernail impressions. The prevalence of different rim forms and decorative elements varies by phase and geographic location and, in some instances, temporally within phases. A variety of tempering materials are used including sand, crushed quartz, crushed granite, grog, shell, and bone (Roper 2006; Steinacher and Carlson 1998)

Central Plains tradition ceramic manufacturing techniques have been described in detail by Krause (1995, 2007, 2011) in his attempt to develop a production stage grammar that would enable more cross-comparative and systematic analytical terms and methods. Looking at a sample of Upper Republican pottery from sites in Central Kansas, Krause (1995) provides antecedent knowledge of each step in the manufacturing process, observations from the archaeological samples and then discusses his inferences concerning what choices the potters made for that particular step in the production process. The following description of the typical Central Plains tradition vessel construction process is based on Krause's (1995, 2007, 2011) analyses.

Procurement and Initial Processing

Procurement

The first step in the production of any pottery is obviously the identification of a suitable clay procurement site. Clay sources can be either primary sedimentary deposits or weathered and transported secondary deposits such as those from alluvial settings. Secondary sources are far less pure and often have high amounts of organic material introduced during transport. Secondary sources are not only more abundant but are also more fusible at low firing temperatures (600° to 1200°C) such as those obtained in prehistoric open firing environments (Krause 1995:319).

Processing, Tempering and Wedging

After procuring clay from a source it needs to be processed to remove the impurities. The most efficient way of doing this was to thoroughly dry the clay then pulverize it and remove large fibers and debris by hand. Next, in order to make the clay workable, a tempering material would be added. When wet, clay is very plastic and, without the

addition of temper, may be too plastic to hold its shape. The addition of a nonplastic tempering agent interrupts the alignment of the clay particles enough to allow it to dry more evenly and completely, thereby preventing cracking during drying and spalling or explosion due to excessive water content during firing. After the temper is added, the clay mass must be kneaded or wedged in order to remove air pockets that will also cause cracking and spalling during firing (Krause 1995:319-320).

Construction and Decoration

Base Construction

Once the clay mass is properly prepared, vessel construction may take place by three different methods: coiling, molding or mass modeling. The absence of coil fractures or molding seams on most Central Plains tradition pot sherds indicates that pots were likely built by mass modeling. Beginning at the base and building up, the potter would excavate the base by scraping out the clay from the center of the mass, leaving a basin shaped area of the roughly desired thickness and diameter for the base of the pot (Krause 1995:320-321).

Wall Construction

After forming the base to the desired specifications, the remainder of the clay that had been scraped up and away to the edges of the base would be used to form the walls. Walls were extended by pinching and pulling upward and outward by hand. The shape and thickness of wall segments may also be periodically refined by paddling the exterior of the pot with a bone or wood tool while bracing the interior with a flat stone and/or by scraping the exterior with a bone, shell, gourd or ceramic sherd tool during the building process. Once the point of the shoulder (for jars) was reached, the clay would

then be pulled inward and slightly upward to the desired circumference of the neck. The formation of the shoulder likely required significant scraping and thinning to produce the final shape (Krause 1995:321).

Rim Construction

The next step in the manufacturing process is the formation of the rim. In the case of unthickened rims, this was most likely accomplished by the addition of a single strap of clay to the top of the vessel and two overlapping straps were added to form collared rims. The initial strap for the construction of both rim types was welded to the vessel by overlapping the strap with the top of the vessel and welding the two together through pinching followed by scraping and thinning to smooth the welded surface. For unthickened rims the strap would then be further pulled into the desired form (straight, recurved, flaring, etc.). For thickened (collared) rims, the potter would complete the above process and then add a second strap to the exterior of the first and the two were welded together by pinching, scraping and smoothing at the upper and lower junctures. Variations on the thickness and width of the collar strap would produce different exterior rim profiles (Krause 1995:321-324).

Lip Construction

The application of the lip was the last component in the construction of the vessel form. A wide variety of lip shapes were utilized (rounded, flat, beveled, tapered, T-shaped etc.) and all are produced by the addition of a coil to the top of the rim. The coil and the rim are fused by pulling the outer and inner surface of the rim up to the coil and the outer and inner surfaces of the lip coil down over the rim. The junction of the rim and lip would be further smoothed with the fingers or a scraping tool to obliterate the seam.

Then the lip would be shaped into the desired form by manipulation with the fingers or perhaps cut with a tool to produce flat lips (Krause 1995:324-326).

Final Shaping

Once the pot was fully constructed, it would require several days to dry, depending on the clay properties and weather conditions, before final shaping could take place. Final shaping, thinning, and compacting was done by scraping the surface of the pot with a bone, shell, wood, gourd or ceramic tool and by wetting and rubbing the interior and exterior surfaces, most likely with a stone abrader. During this stage, shaping and compacting were accomplished through the use of a cord-wrapped bone or wood paddle with a stone anvil bracing the interior, leaving the characteristic cord-roughened exterior surface of Central Plains tradition pottery. Sometimes, additional rubbing and scraping of the vessel was conducted after paddling that would partially obliterate the cord-marks (Krause 1995:326-327).

Decoration

This leather-hard stage is also the point at which much of the decoration was applied including incising and excising. If these techniques were applied to wet clay the effects would be less distinct as the clay would stick to the tools and would not have the firmness to withstand the application pressure causing designs to be placed too deeply or to leave residual clay along the edges of the incisions or excisions (Gibson and Woods 1997:45). In the case of finger impressions and applied components, such as decorative nodes or appendages, these were more likely to be applied during the construction phases when the clay was still wet in order to achieve proper fusion with the main vessel body or rim. If wet clay were added to a vessel that was already in the

leather-hard state differential drying rates would lead to cracking and detachment of the applied component.

Ceramic Firing

Drying the vessel to an appropriate state is essential to the successful firing of the pot. If a vessel dries too quickly or unevenly it will crack. On the other hand, if the vessel is not sufficiently dried before firing, the remaining moisture within the clay will vaporize during heating and a number of failure patterns may occur including spalling, shattering, cracking or warping. Drying may take a variable amount of time depending on the ambient weather conditions and, if necessary, drying could have been finished by warming the pots near the perimeter of a hearth fire. Firing is a four-stage process that includes water smoking, dehydration/oxidation, sintering, and vitrification. Throughout these various stages of the firing-schedule, there are several main conditions that the potter must be vigilant of: maintenance of low temperatures through the water smoking stage, maintenance of the temperature and draft to produce the desired level of oxidation, attainment of a sufficient temperature for at least incipient vitrification, and avoidance of thermal shock upon cooling the fired vessels (Shepard 1956:86)

The Firing Process

Water Smoking

In the water smoking stage the vessel must be slowly warmed from ambient temperature to 100°C in order to gradually vaporize residual water within the pore system of the clay (Krause 1995:328; Willey 1986:23). If the vessel is heated too quickly, the clay particles will fuse before the moisture evaporates trapping the pressurized steam and causing spalling or explosion of the vessel (Shepard 1956:81).

Spalling is the most common form of waster found in archaeological contexts and appears as circular flakes of clay that have been forced out of the walls of the vessel (Gibson and Woods 1997:26).

Dehydration/Oxidation

Dehydration occurs at temperatures between 400° and 600°C and at these temperatures the clay minerals themselves lose their hydroxyl content or their chemically combined water (Willey 1986:24). During this stage organic matter is also burned out of the clay and is released in the form of volatile hydrocarbons, though some organic matter remains in the claybody at this point (Willey 1986:28). As carbon is removed, the iron oxides in the clay begin to oxidize changing the color of the clay to different shades of red, orange, gray or brown (Krause 1995:328).

Sintering

Sintering occurs between 550° and 900°C and is the point at which the ceramic transformation occurs and the clay particles are weakly welded together at their points of contact (Willey 1986:24). At temperatures above 700°C, oxygen in the firing environment will begin to bond with remaining carbon residues in the fabric of the pot, releasing carbon monoxide or carbon dioxide. If sufficient oxygen is not present and there are reducing conditions, this carbon will remain in the clay. This results in a black core on the interior of the vessel walls that is highly diagnostic of low firing temperatures and short firing times, such as those that occur in open-firing contexts (Gibson and Woods 1997:53; Willey 1986:28). This black core appears as a dark layer on the interior of a sherd profile that is sandwiched between more oxidized clay on the interior and

exterior surfaces of the sherd. The firing process may be terminated at this point and the ceramic vessel will be useable but very porous (Velde and Druc 1999:100)

Vitrification

Impurities in secondary clays are beneficial at this point in that the presence of fluxing agents in the form of various oxides (sodium oxide, potassium oxide) promote the initial stages of vitrification at lower temperatures than may be achievable with pure clays (Krause 1995:328; Willey 1986:28). When the activity of these fluxing oxides is increased, they begin to melt the silica within the claybody producing a liquid state. These liquefied minerals begin to fill in voids between the clay particles and eventually reduce their size due to melting (Shepard 1956:83). This process is what produces the fusion between the clay minerals that creates a harder, less porous, and more durable vessel (Velde and Druc 1999:100). Increasing heat will result in increased vitrification, but a temperature between approximately 700° and 900°C is sufficient to produce incipient vitrification in many secondary clays (Gibson and Woods 1997:212).

Firing Methods

There are two basic types of ceramic firing methods: enclosed kiln firing and open firing (Velde and Druc 1999:106-109). The firing method utilized was likely based on multiple factors including established knowledge of different techniques, the scale and intensity of production, the functional requirements of the product (domestic v. market consumption), settlement patterns, fuel availability, and doubtless many other considerations. Based on several very diagnostic features fairly ubiquitous to CPt pottery, and clearly present in the King site collection, it has been inferred that open firing methods were utilized. The presence of fire clouds or dark carbon deposits on the

surface of a vessel, which result from contact with smoky flames or incompletely burned fuel, is a common characteristic of open firings (Gibson and Woods 1997:156). Black coloring in the central zone of sherd profiles is also a hallmark of open firings due to the relatively low firing temperatures and short firing times that are insufficient to completely burn the carbonaceous materials from the clay (Gibson and Woods 1997:53). These two traits combined with the absence of enclosed permanent kiln structures in the archaeological record point to the conclusion that CPt potters utilized open firing methods (Krause 1995:328).

Enclosed Kilns

There are numerous types of permanent enclosed kiln features but the basic principle of such a structure is that firing takes place within an enclosed furnace. These enclosures may be of a type called an *oven* in which there are permanent stone or clay walls with a temporary adobe roof that is reconstructed prior to each use. Ovens function in a similar manner as open firing pits in that the ceramics and fuel are in direct contact within the structure. A true kiln is an even more substantial structure made of stone or clay that may have a temporary or permanent roof and heating is indirect such that fuel combustion occurs in a chamber separate from the vessels (Sinopoli 1991:31-32). These types of furnaces allow for longer firing times and higher temperatures to be achieved. Enclosed kilns are the most fuel efficient in terms of combustion rates but do require more fuel to preheat and operate the structure over longer periods of time. The enclosed kiln structure requires some kind of draft mechanism to regulate the combustion of the fuel, which allows for the selection of either an oxidizing or reducing environment. The greater control over the firing temperature and environment provided

by kilns also yields more control over the finished ceramic product and fewer production failures (Gibson and Woods 1997:196; Velde and Druc 1999:109).

Open Firing: Bonfires

In open firing, the vessels are fired in a surface bonfire or a shallow pit with the vessels in direct contact with the fuel. For bonfires, the temperature can reach between 700° to 900°C, which is sufficient for the ceramic transformation. However, these temperatures can only be maintained for a short period without the addition of more fuel. Though bonfires are the simplest method and require virtually no structural investment, they are also the least fuel efficient. The rapid, short-term heating of the bonfire can lead to irregularities in the firing process. Uneven distribution of fuel and lack of control over the temperatures throughout the fire can lead to unevenly fired vessels (Velde and Druc 1999:107). Despite all of the inherent complications with the bonfire method, it can and does produce perfectly functional vessels when utilized by an experienced potter (Krause 1985).

Open Firing: Pit Kilns

A pit kiln is considered an open firing method but it is somewhat intermediate between a bonfire and a true kiln. The method involves digging a shallow pit, placing fuel in the bottom of the pit, piling the pots on top of the fuel base, and then stacking more fuel over the pots and above the ground surface. The insulation provided by the walls of the pit greatly increases the efficiency of the firing process as it holds heat for longer periods of time than a surface bonfire and thus requires less fuel (Sinopoli 1991:31). The insulating nature of the pit structure also allows for the maintenance of a more consistent temperature over a longer firing time (Velde and Druc 1999:107-109).

The limitations of the pit firing method are similar to those for bonfires in that it is still subject to less consistent temperatures than an enclosed kiln and shifts in the burning fuel or changes in wind patterns can lead to inconsistency in the firing conditions throughout the pit (Shepard 1956:91).

The end result of any firing process requires the control and interaction of many complex variables. The firing temperature, time, oxidation-reduction atmosphere, paste composition, and paste grain size will all affect the characteristics of the finished product (Velde and Druc 1999:110). The variables of time, temperature, and atmosphere are largely determined by the different firing methods and types of fuel used (Sinopoli 1991:33). The effects of different firing conditions can vary significantly depending on the properties of the clay and one must be careful to "not confuse descriptions of the effects of firing on pottery with deductions regarding firing method" (Shepard 1956:214).

Archeological Evidence for Open Firing

Statements concerning the improbability, or at least difficulty, of locating ceramic firing features archaeologically are prevalent in the literature (Balkansky et al. 1997:147; Bernardini 2000:65; Gibson 1986:12; Gibson and Woods 1997:58; Sullivan 1988:31). The fact is that archaeological traces of firing have been scarce in the record of many regions and it appears that this is due not only to the ephemeral nature of these features but also to biases in archaeological sampling. The low intensity archaeological signature of open firing techniques, the misidentification of firing features, and the spatial separation of firing locations from habitation sites have all been cited as possible reasons for the paucity of recorded instances of bonfire and pit kilns (Balkansky et al. 1997; Bernardini 2000; Gibson 1986; Gibson and Woods 1997; Sullivan 1988). In order

to evaluate the large pit feature at the King site in terms of its use in ceramic firing, the following discussion will focus on what kinds of archaeological signatures would be expected from the process of open pit firing ceramics.

Pit Kilns and Associated Materials

Unfortunately, there is a significant lack of reported ceramic firing contexts within the published record for the Central, Northern and High Plains. The author is not aware of any published documentation of ceramic firing features within these regions but will briefly summarize some relevant case studies from other regions, including the North American Southwest and Mexico. The archaeological examples of ceramic pit firing discussed below will serve to further highlight the material expectations for the archaeological identification of such features and present some limitations for the conclusive identification of pit kilns within the Great Plains regional archaeological record.

Despite the difficulties of identifying the actual pit features associated with ceramic firing mentioned above, this activity is often identified by the association of certain tool types and certain ceramic materials within areas that indicate episodes of burning by concentrations of ash and/or charcoal. Generally speaking, there are a number of accepted material correlates of prehistoric household-level ceramic manufacturing worldwide. The tools and necessary materials obviously vary somewhat based on cultural tradition, construction technique, settlement patterns, and resource availability, but the following account includes those materials known to have been used in the Central and High Plains or that can be presumed to have been used based on resource availability.

Manufacturing Tools and Firing Equipment

The list of tools used in vessel construction is quite extensive and includes the following, undoubtedly partial, toolkit: manos and mortars used in the preparation of the clay and temper; chipped stone, bone, ceramic sherd or shell scrapers for shaping and thinning vessels; bone or wood paddles for vessel shaping; anvil stones for shaping; polishing stones; bone awls or combs for incising decorative elements; reed or wood tools for incising and punctuating decorative elements (Krause 1995; Sullivan 1988). The list of tools and equipment associated with firing is far less extensive and includes the pit kiln feature; combustible fuel that most likely consisted of wood, bark, dried grass, brush, dung, and fragmented bone; fire-cracked rock and unaltered stones used for insulation and heat retention; large broken sherds used to insulate pots from contact with the fuel or to increase air circulation within the kiln (Gibson and Woods 1997; Shepard 1956; Sullivan 1988).

Misfiring and Wasters

The term *waster* refers to any vessel damaged during the manufacturing process but particularly those damaged or destroyed during firing. There are many different causes of vessel failure and thus the term refers to a range of effects (Gibson and Woods 1997:274-275). Some of the causes of misfiring can be related to the production process, some to the drying process, and yet others to the firing and post-firing cooling stages of manufacture. The most common types of waster materials do result from firing accidents and many of these do not show the typical signs of misfiring, thus creating assemblages with high concentrations of sherds that appear normal and are difficult to distinguish from sherds that resulted from breakage during use (Curet 1993:429). The

other types of wasters are under-fired and over-fired pieces with specific characteristics that will be discussed below.

Spalling

Spalling is one of the most common forms of waster material and is especially common in open firings. It occurs during the early stages of firing in the water smoking stage. If the vessel is heated too quickly and before residual water within the clay has been slowly driven off, this water will vaporize and expand. The pressure of the vaporized water forces rounded flakes of clay to pop off of the surface of the vessel (Gibson and Woods 1997:156). Spalling may also be caused by the inclusion of particles, such as tempering agents, that expand at significantly different rates than the clay or that increase in volume upon heating (Shepard 1956:91).

Cracking and Exploding

Vessels may crack or explode during firing for a number of reasons, many of which are the same as those that cause spalling. In addition to the vaporization of residual water and the rates of expansion of inclusions, air trapped in the clay body or at construction junctions can cause cracking and explosion. Abrupt changes in wall thickness can cause uneven drying that can lead to cracking and/or explosion of the vessel as well (Shepard 1956:91).

Fire Clouds

Fire clouds are misfires only in the sense that they sometimes represent undesired aesthetic results, but not in the sense that they render a vessel unusable. A fire cloud is a dark carbon deposit on the surface of a vessel that results from contact with smoky flames or incompletely burned fuel. These discolorations are often produced in open

firings because the vessels are in direct contact with the fuel sources (Gibson and Woods 1997:156).

Bloating

Bloating occurs when gases (CO and CO_2), produced by the combustion of organic matter within the clay, become trapped in the pore spaces. If firing has been too rapid and sintering occurs before the organic matter has completely burned out, sometimes the vessel will become bloated or much thicker than other similar vessels. Bloating will usually also result in the cracking or exploding of the vessel (Gibson and Woods 1997:110).

Dunting

Dunting is a form of cracking that occurs when a fired vessel cools too rapidly. These cracks run vertically from the rim of the vessel and horizontally around its circumference. It is thought that this type a failure occurs due to changes in the volume of silica during the cooling process, thus vessels with high quartz content are most frequently affected (Gibson and Woods 1997:148). It is difficult to detect this type of failure in individual sherds as the pattern is not evident until vessels are mostly reconstructed.

Over-Vitrification

Vitrification is the stage in the firing process when clay particles become liquefied and form a glassy flow that fills in pore spaces within the claybody. Vitrification becomes a form of misfiring when the temperatures reached during the firing are beyond the point that can be tolerated by a particular claybody. This is a form of over-firing and causes the ceramic to melt to the point that it becomes deformed and collapses. Due to the

extreme temperatures that are often required for over-vitrification to take place, it is not frequently seen in prehistoric pottery and is even less common in open firing contexts (Curet 1993:430; Gibson and Woods 1997:273).

Underfiring

Under-fired pieces are generally very porous and soft or friable with a tendency to weather and erode more easily than normal sherds (Curet 1993:429). Under-firing will generally occur as a localized effect within a pit kiln due to inconsistencies of temperature. Wind patterns, the uneven distribution of fuel, or poor fuel choices can result in under-fired vessels within a firing that also produces successfully fired vessels (Shepard 1956:91).

Experimental Studies of Pit Kilns

Experimental archaeologists have investigated the traces that low intensity use of pit kilns may leave behind in the archaeological record. During the 1980s, a group of faculty and students at Leicester University formed the Experimental Firing Group in order to study the entire range of variables in the ceramic production process, from clay procurement and processing to use wear. Many of their experiments were particularly focused on the documentation of open firings. In one such experiment, Ann Woods conducted four individual firings in a pit located on the Leicester University grounds over a seven month span between 1979 and 1980. The pit was subsequently excavated by Alex Gibson six years later in 1986. The original pit kiln measured approximately 100 x 75 cm around and was excavated to a depth of about 40 cm below the ground surface (Gibson 1986:10, Figure 3). The pit was backfilled after each of the four firing episodes

and then re-excavated to the ash and charcoal layer prior to the next use (Gibson 1986:11).

During the excavation of the experimental pit, Gibson (1986:8) notes that the outline was clearly marked by a “pink line of burning that changed to an externally pink and internally black line as the pit was cleaned” and that these areas of oxidized soil and charcoal measured approximately 1.5 cm thick each along the walls of the pit. Gibson (1986:11) was not able to stratigraphically differentiate the four separate periods of use as all the ceramic finds from failed pots were recovered from a single charcoal and ash layer at the base of the pit. Furthermore, the failed pieces that remained in the pit did not yield any obvious indications that they were the result of a failed pot (Gibson 1986:14). This has particularly relevant implications for the identification rate of ceramic firing activities within small-scale production contexts. During the course of this research, I was able to examine some sherds from modern replication pots manufactured in the tradition of the Antelope Creek peoples from the Texas Panhandle (Southern Plains). Mr. Alvin Lynn replicates Borger Cordmarked pottery using traditional tools, fabrication methods, and open pit firing methods. Mr. Lynn generously sent me a collection of sherds from pots that had failed during some of his open pit firings so that I could examine them for evidence of failure attributes. To my surprise, the sherds showed no indication that they had broken during firing and looked indistinguishable from sherds that one would assume were broken during use.

The low degree of burning along the sides of experimental firing pits is also of particular interest. Gibson (1986:12) indicates that, due to inexperience, the experimental firings used far more wood fuel than was necessary for the number of pots

being fired. Thus the temperatures achieved were much higher and the length of the firings longer than what would be the case among experienced potters who would have likely been far more fuel conservative. For these reasons, he infers that the level of burning along the surface of an archaeological pit kiln may be expected to be much less than that seen in this experimental context, especially if the pit was used only once or twice (Gibson 1986:12). On a related note, after the first firing episode, the participants cooked and socialized around the remaining coals of the fire and the debris from this barbeque was then dumped into the pit with the backfilling material. Thus, without prior knowledge of the pottery firing activities, Gibson suggests that the excavated context may appear very similar to a pit hearth or a burned trash pit (Gibson 1986:14)

Balkansky et al. (1997) conducted a firing experiment in an attempt to replicate features observed at the site of Ejutla in Oaxaca, Mexico. Similar to the Leicester University firings, the excavated pit kiln left very little evidence that the specific activity of ceramic firing had taken place at that locale. The ground surface was “discolored and partially baked to a depth of 1 cm” with the only other evidence being a number of broken vessels that had been damaged during the firing and a thin layer of ash and charcoal (Balkansky et al. 1997:147). The authors go on to note that few of these residues would remain intact on an exposed surface but if they were rapidly buried the remains would appear as unusual concentrations of potsherds, ash and wasters (Balkansky 1997:147).

Archaeological Examples of Pit Kilns

The previously discussed suite of pottery production tools and features includes many objects that could be, and were, used for other purposes and in other contexts,

suggesting that these classes of material cannot each be taken alone as conclusive evidence for ceramic production. Rather, one must look at combinations of these material markers for a convincing pattern of evidence (Balkansky et al. 1997:142). The best case scenario would be to locate a combination of fabrication tools with a pit displaying extensive evidence of burning and significant amounts of waster materials. However, it is evident from the following archaeological case studies that this perfect convergence of evidence is far from common.

Four pit kilns were unearthed at Ejutla in Oaxaca, Mexico that consisted of shallow basins carved into the soft underlying bedrock (Balkansky et al. 1997:145). Most of these kilns were overlain by midden deposits that contained a wide variety of domestic debris. Despite this, the levels that were in direct association with the pits contained materials consistent with firing contexts including ash, potsherds, clay concretions, and a few rocks that served to differentiate them from the midden deposits (Balkansky et al. 1997:148-149). Additonally, the excavations recovered a high quantity of misformed, over-vitrified, exploded, and miscolored vessels and figurines. These waste materials totalled approximately 8% of the figurines and 0.5% of the total ceramic assemblage using conservative classification standards. Moreover, these misfired ceramic materials were concentrated within the four defined pit kiln locales (Balkansky et al. 1997:151-152, Figure 10). One of the reasons cited by Balkansky et al. (1997:154) for the paucity of identified pit kilns in Mesoamerica is the inattention to midden deposits and the possible misidentification of firing areas within them as ““burnt areas within middens” or the ubiquitous “ash-filled pit.””

In a paper discussing the limitations of the evidence for ceramic manufacturing in prehistoric Southwestern sites, Sullivan (1988) outlines several identification issues. Variability in the location of firing areas with reference to settlements is one such issue, with firing features sometimes located very close to the potter's house and in other cases up to a mile away from a settlement (Bernardini 2000: 365-366; Sullivan 1988:24). The strongest evidence for pottery production comes from contexts where artifacts associated with ceramic manufacturing are found in close association with pottery-making and pottery-firing areas (Sullivan 1988:24). However this is rarely the case as shown by Sullivan's (1988) survey of southwestern sites. Several of the sites (Snaketown and AZ I:1:17(ASM)) discussed by Sullivan (1988) produced significant evidence for pottery production workshop areas as well as multiple nearby kilns. Some sites (NA 8163) produced evidence of clay processing and firing but no evidence for the fabrication of vessels, and yet others (AZ BB:13:223(AMS)) yield evidence for pottery making, unclear evidence for firing, but no signs of a pottery production area or workshop. Numerous other sites have yielded pottery fabricating tools from domestic or midden contexts. However, without clear evidence of discrete manufacturing areas or firing contexts it is difficult to interpret the tools as definitive evidence for production. To summarize:

> "even when there is strong assemblage and contextual evidence for potential vessel manufacture, we generally have no direct evidence for where the vessels actually were made or fired. Similarly, some sites with strong evidence of pottery firing often disclose no evidence about the locations of vessel manufacture…Because of the substantial variation and nonspecificity of the formal and locational properties of thermal features, the probability of misidentifying them is rather high." (Sullivan 1988:31-32)

Archaeological Expectations for High Plains CPt Pottery Firing

As noted at the beginning of this chapter, there are certain attributes ubiquitous to CPt pottery that indicate open firing methods. The incomplete combustion of carbon in the clay (black core) is a feature present throughout the King site assemblage and is a very diagnostic indicator of open firing. Black cores were present on approximately 28% (n=115) of the sample analyzed (n=409) in this study. The complete absence of formal closed kiln structures within the Great Plains record does not necessarily indicate that they were never used but does support the inference that open firing is the method most likely employed by CPt potters.

Despite the fact that the author is unaware of any published accounts of the organization of ceramic production in terms of firing activities within the Plains Village traditions of the Great Plains, or the presumably related groups of the High Plains, some assumptions are warranted based on widely accepted interpretations of the social organization of Central Plains tradition peoples. The settlement pattern of the CPt suggests that group size was small and that settlements were composed of autonomous households or small clusters of two or three houses likely belonging to closely related family groups (Steinacher and Carlson 1998). Technological production within CPt groups appears to be household-based as there is a lack of evidence of full-time craft specialization within CPt settlements. The household-scale of production is believed to have been common worldwide among many “small-scale nonhierarchical societies” (Sinopoli 1991:99). In fact, it has been demonstrated that the use of open firing methods have a strong cross-cultural correlation with low-volume production (Balkansky et al. 1997:155). However, this level of production does not preclude

movement of pottery beyond the household through various exchange mechanisms (Sinopoli 1991:99), which is a concept of particular importance for our understanding of the relationships between CPt sites in the Central and High Plains.

Defining what expectations one can reasonably hold for the feature structure and content of a pit kiln is necessary prior to any interpretations concerning the function of the King site pit as a kiln. It is apparent from Sullivan's (1988) discussion of ceramic production in the Southwest that the spatial organization of production will determine what types of evidence are likely to be located in the immediate vicinity of a kiln. To date, much of the excavated area of the King site has focused on the large pit feature, and it remains unclear if there are additional activity areas on the landform beyond the current excavations or on any of the nearby landforms. I will therefore formulate conservative expectations for the definition of a pottery firing area founded on an assumption that the other stages of manufacture took place either in an unexcavated portion of the same landform or in some location entirely removed from the current site area. These assumptions fit most comfortably into the expectations for an isolated kiln (Sullivan 1988). The following material characteristics of pit kilns are drawn from the above discussion of archaeological and experimental evidence.

The Pit Kiln

The size of a pit kiln will likely vary based on the number of pots being fired at any given time, which also relates to the scale of production (Bernardini 2000:365). Some of the data from archaeologically known pit kilns in the Southwest and Oaxaca indicate that these features can measure anywhere from one meter in diameter to over eight meters in length (Balkansky et al. 1997:144, Figure 4; Bernardini 2000:366; Sullivan

1988). The shape of the kiln can vary significantly as well, with some being rectangular like the trench kilns in the Southwest (Bernardini 2000; Heacock 1995), subrectangular (Heacock 1995) or round and oval-shaped (Balkansky et al. 1997; Sullivan 1988). The excavated depth of a pit kiln can range from very shallow (as little as 10 cm below the ground surface) to a considerable depth of 70 cm deep (Balkansky et al. 1997; Bernardini 2000; Heacock 1995).

One line of evidence for burning within a pit kiln is in the form of oxidization rinds in the soil on the walls and the base of the pit, as well as concentrations of charcoal and ash at the base of the pit. The oxidation rinds may or may not be present based on the intensity of the heating, duration of use, and properties of the soil. Experimental and archaeological kilns show oxidation and baking of the soil to depths ranging from 1.5 cm to 5 cm and in some cases baking of the underlying soil is not mentioned as present at all (Balkansky et al. 1997; Gibson 1986; Sullivan 1988). In fact, the University of Colorado (CU) field school students working at the King site conducted an experiment in soil oxidation by burning some sediment samples in campfires and were unable to get it to oxidize (Bamforth 2012, personal communication).

Charcoal and ash deposits will also vary in density and thickness based on the intensity of use of the particular pit. Sometimes pure ash deposits are noted (Sullivan 1988) while some features yield deposits of ash and charcoal mixed with sediment (Heacock 1995) at the base of the pit. The differences in the ash and charcoal deposits undoubtedly have to do with the types of fuel used, the extent of the combustion of the fuel, mixing of sediments during the retrieval of pots and wasters, episodes of reuse, backfilling, or lack thereof, after firing episodes, and post-depositional processes

resulting in the mixing of the ash and charcoal with pit fill. It is also important to note that reuse is either difficult to detect or infrequent in many cases, as seen from the sample of Mesa Verde trench kilns of which only six out of 19 showed clear signs of reuse that were based on depth of oxidation rinds, fragmentation of rock linings, and evidence of structural remodeling activities (Bernardini 2000:366).

Kiln Associated Materials

The types of materials associated with an isolated kiln will most likely be restricted to sherds from broken pots, waster materials, burned sherds, and possibly fire cracked rock (Balkansky et al. 1997; Curet 1993; Heacock 1995; Shepard 1956; Sinopoli 1991; Sullivan 1988). Recycled ceramic sherds and other large stones may also be used to separate the pots and/or prop them up to increase air circulation around the vessels during firing (Krause 1995:317). If pots are damaged they may or may not show the typical characteristics of wasters (Curet 1993:429), so one can assume there may be a concentration of sherds that appear to be from normal breakage in addition to a concentration of waster materials. In the context of open firing, the most common waster materials will be fire spalls, sherds with spall scars, cracking, explosion, under-firing, and possibly bloating.

Considering that pots failed from cracking may appear indistinct from normally broken vessel fragments, one method to distinguish these firing failures from materials deposited as trash would be to attempt refitting. If significant portions of the same vessel are in close association it may be more likely to be a firing failure. Spalling and sherds with spall scars would be expected to occur in relatively equivalent proportions and may be indicated in spatially discrete areas or may be scattered broadly throughout

the feature depending on the prevalence of spalling across the vessel batch. Vessels that exploded may be indicated by a high concentration of small fragments in spatially discrete portions of the pit. Under-fired vessels may be inferred from the presence of very friable, weathered or highly exfoliated pieces that are also concentrated in spatially discrete areas of the pit. Bloating will be indicated by sherds that are formally and stylistically similar to other pieces in the assemblage but are much thicker and may contain large pore spaces created by expanding gases.

Burned sherds may be present in the form of large body pieces that were used as insulators to protect the vessels from direct exposure to the fuel. These sherds may have also been placed at the base of the pit and between vessels to increase air circulation within the kiln (Balkansky et al. 1997:149; Shepard 1956:76; Sinopoli 1991:33; Sullivan 1988:27). Fire cracked rock and unaltered rock may be present as props used to elevate vessels from direct contact with the floor of the pit and/or to increase thermal retention within the pit in order to increase firing time and promote slower cooling time (Shepard 1956:75).

The presence of waster materials, burned insulator sherds, and fire cracked rock is dependent on the level of cleaning that the kiln received after firing completion. However, many of the kilns from the studies cited above did contain at least some combination of these materials. As mentioned by Bernardini (2000:366) and Gibson (1986:11), reuse of pit kilns is either infrequent or difficult to interpret yet some did yield concentrations of ash, charcoal, and wasters unlikely to have accumulated during a single firing episode (Balkansky et al. 1997). At this point it remains unclear whether the contents of the majority of kilns represent an accumulation of multiple firings, single

firings or the debris from the last firing performed at the location. Regardless of the number of firing instances in a particular kiln, one can still expect the materials discussed in this section to be concentrated near the base of the pit and within or directly above ash and charcoal rich deposits.

Summary

"Firing areas are expected to produce two kinds of archaeological evidence: firing facility debris and firing by-products" (Curet 1993:428). Though this statement seems straightforward, the above discussion clearly demonstrates that these expectations are not always met in a manner that is recognizable or easily recoverable in archaeological contexts. What these experimental studies and archaeological cases have shown is that the ephemeral nature of pit kilns does indeed make them difficult to recognize archaeologically. For this reason, it is wise to rely on several different lines of evidence when inferring production activities, although this too is often far from ideal due to the redundant nature of many of the tools utilized in the production process. Wasters have commonly been interpreted as solid evidence of local manufacture, but the fact that many ceramics broken during firing lack truly diagnostic evidence of misfiring indicates that the absence of wasters, like the absence of recognizable pit kilns, is not a negative indication of ceramic production. The variety in the shape, size, depth, and location of pit kilns makes discerning between pit kilns, hearths, and other kinds of pits particularly difficult. Finally, pit kilns can be destroyed by formation processes and secondary use as trash disposal areas can easily mask or obliterate their primary function as pottery firing features (Curet 1993:427).

Chapter 4: The King Site Background

The King site (25DW166) is a small Central Plains tradition site located approximately 7 km southeast of Chadron, Nebraska in Dawes County (Figure 3). Broadly speaking, the site is located near the northern limit of the High Plains geographic region, which is a relatively uneroded fluvial plain that stretches east-west from the Missouri River to the Rocky Mountains and north-south from the Nebraska-South Dakota border to the Llano Estacado of Texas. Work has been conducted at the King site since 2006 as part of the University of Colorado at Boulder (CU) summer archaeological field school directed by Dr. Douglas Bamforth.

Environmental Setting

The site is located along the north side of the Pine Ridge escarpment in the northwestern portion of the Nebraska panhandle. The Pine Ridge is a northeast-southwest oriented escarpment between the White and Niobrara Rivers (Figure 3). The escarpment is an erosional remnant of the bedrock that was tilted by the uplift of the Black Hills, which took place 60-35 million years ago during the Laramide Orogeny (Prentiss and Rosenberg 1996). The landform consists of a linear uplift that is approximately 100 miles long and up to 20 miles wide with a landscape consisting of sandstone and siltstone bluffs, escarpments, and areas of exposed bedrock. It differs from the surrounding open plains in terms of its rougher topography as well as the vegetation types present. The slopes of the escarpment are covered in Ponderosa pine forest while the open plains support short prairie grasses with deciduous tree growth along some intermittent and permanent streams. Though the western High Plains are

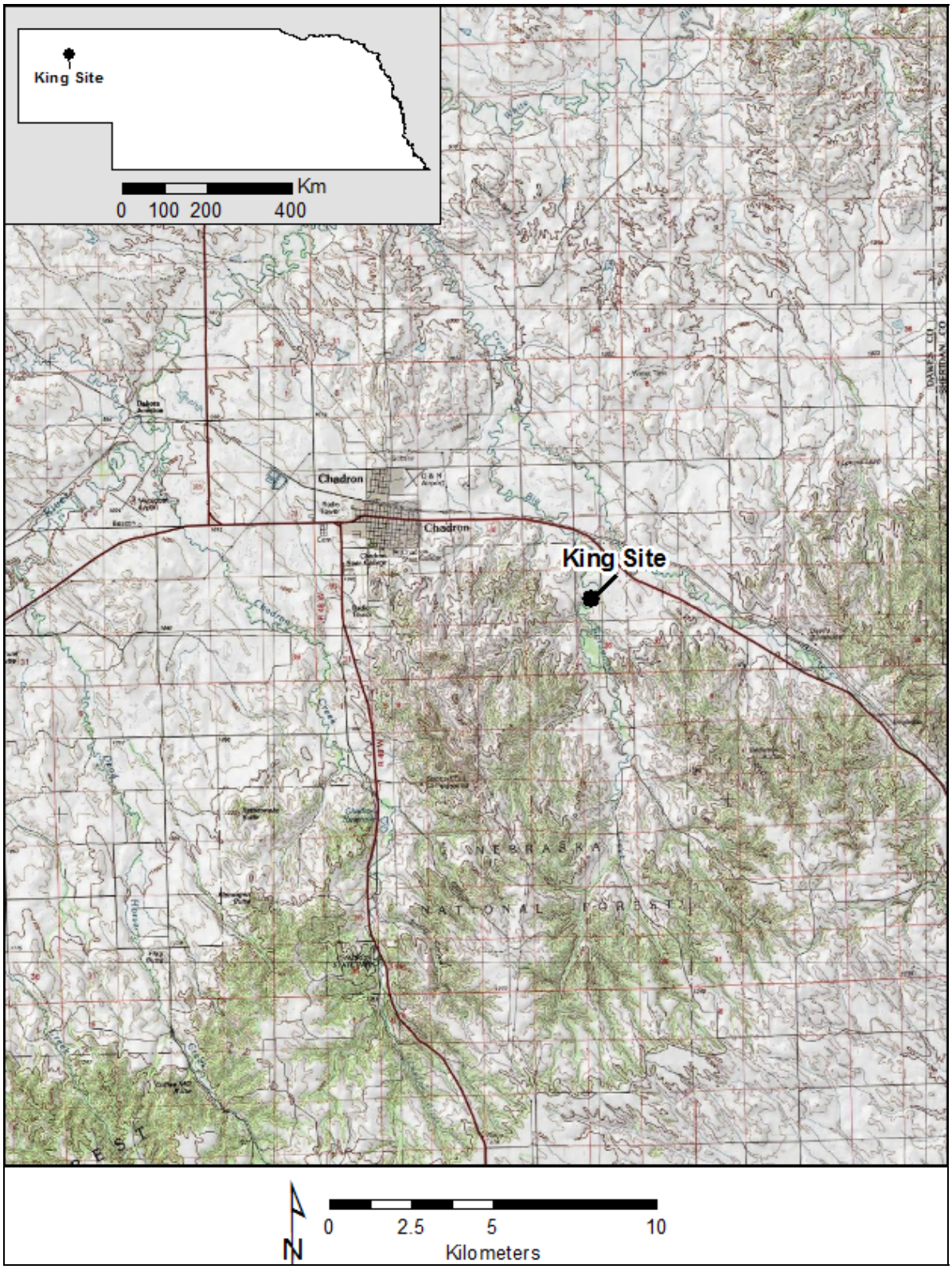

Figure 3. USA Topographic Map showing the location of the King site within the state of Nebraska and in reference to the Pine Ridge escarpment.

often thought of as an endless expanse of open grassland, the diversity found in the Nebraska panhandle demonstrates the great degree of micro-regional variability across this landscape. The escarpment ecosystem provides a stark contrast to the loess-mantled rolling plains and sandy tablelands to the south and the semi-arid Pierre shale plains and White River Badlands ecosystems to the north (Prentiss and Rosenberg 1996).

The site lies on the second terrace overlooking Big Bordeaux Creek, a perennial stream that runs roughly parallel to Little Bordeaux Creek. The two branches are only about 1.5 km apart in the vicinity of the site area (Figure 4) and the two streams converge to form Bordeaux Creek about 6 km to the north of the site area. Bordeaux Creek then flows north approximately 10 km and drains into the White River. The environment around the site consists of short grass species on the terrace and mixed deciduous trees along the banks of the stream. The landform on which the site is located has expansive views to the northeast and east across the low terrace between the two branches of Bordeaux Creek, as well as to the south back toward the escarpment of the Pine Ridge. The site is somewhat sheltered to the west by the presence of higher terraces on the other side of Big Bordeaux Creek and the escarpment beyond. The presence of numerous meander scars between the two branches of Bordeaux Creek suggest considerable past movement of the two stream courses and suggest that, at some point, they may have been as little as 1 km apart (Figure 5).

The location of the site within an area that regularly receives less than 20 in/year of rainfall would make it poorly suited to the agricultural adaptation of the Central Plains

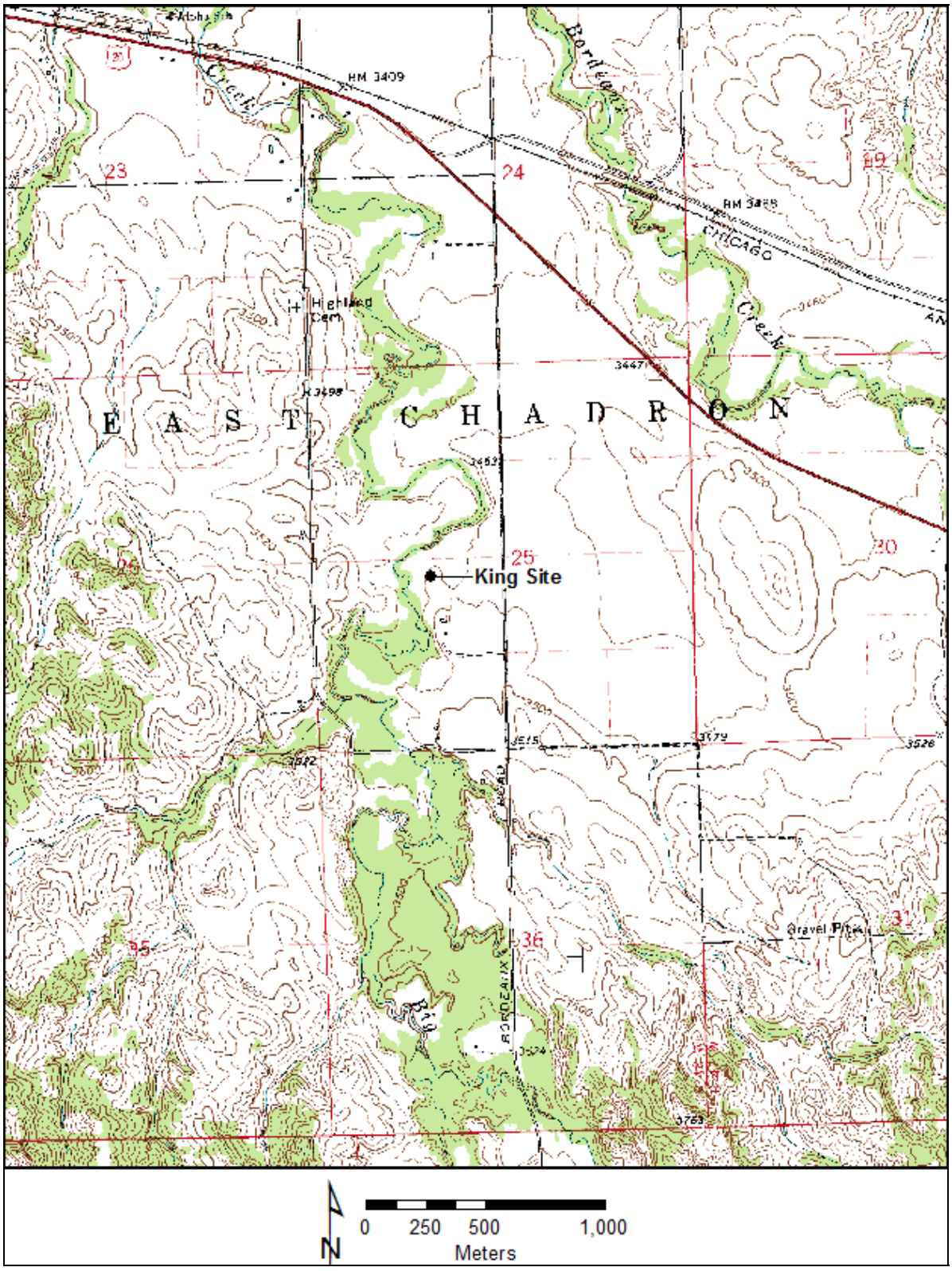

Figure 4. USGS Chadron East Quadrangle showing the location of the King site on Big Bordeaux Creek.

Figure 5. Bing Maps aerial photograph showing the location of the King site and the meander scars of Big and Little Bordeaux Creeks.

tradition settlements farther east (Prentiss and Rosenberg 1996:14). However, the site is located in a boundary area between several different ecosystems, including the Pine Ridge to the south and west, the open plains to the north and northeast, and the riparian zones along the two nearby streams. An abundance of grassland faunal and floral species, as well as a permanent source of water, would have been available in the immediate site area. Forest species living in the more heavily treed Pine Ridge would have been within daily walking distance as were secondary sources of White River Group Silicate lithic materials. This combination of access to a diversity of food resources, lithic materials, and water would have made this location a very desirable choice for people practicing either full-time hunting and gathering or seasonal hunting and gathering as part of a semi-sedentary adaptation that incorporated periods of residential mobility.

Site History

The King site was discovered on private land during the 1980s by the Nebraska State Historical Society, who subsequently did limited testing at the site. However, the data used in this thesis are derived from the more recent investigations conducted as part of the CU summer field school conducted under the direction of Dr. Douglas Bamforth. In 2006, an initial pedestrian survey was conducted and the presence of numerous artifacts scattered on the ground surface prompted preliminary shovel testing of the location resulting in the discovery of significant subsurface cultural deposits. Prior to its discovery, the site had been under wheat cultivation for approximately 40 years and had been more recently used as a hay field. Systematic excavation of the site area was begun during the 2007 CU field school and continued each summer through 2012.

Geophysical investigations, using several different forms of instrumentation, were also conducted in the main site area and on the surrounding landforms in 2011. The materials used for this thesis were recovered from the investigations of the main excavation block between 2008 and 2010.

Excavation Methodology

In 2006, the site area was thoroughly surveyed prior to any excavation and surface artifacts were flagged across the north-south oriented terrace top in an area measuring 45 m north-south and 30 m east-west. A temporary datum was established, the surface artifacts were collected, and their locations were recorded on a site map. Limited shovel testing was then conducted to determine the vertical and horizontal extent of the subsurface deposits, which was determined to be considerably smaller than the surface scatter. In 2007, the surface was resurveyed, the locations of additional finds were recorded, and the artifacts were collected. A 1x1 m grid was established over the defined site area and a series of 1x1 m units were excavated at the southern limit of the subsurface distribution defined by the shovel testing. These test units comprise the southern end of the main excavation block, around which excavations are still in progress. Additional test units have been excavated to the north and to the east and west based on the distributions of materials encountered during the excavation. Expansion of the excavations to the east and the west was terminated as material concentrations become very low in either direction. Expansion of the block to the north has continued each subsequent year as concentrations of material remained fairly consistent and, in fact, increased significantly near the current northern end of the block. To date, a main area measuring 10 m north-south and 8 m east-west has been

excavated within the site area and it is the material from this block that has been used in the following analyses.

Excavations were conducted using trowels to remove 10 cm arbitrary levels and all materials were dry screened through 1/8 inch mesh. All artifacts found in situ were mapped to the nearest millimeter and unit plan views were drawn at the end of each level. All units were excavated to culturally sterile sediments and all unit walls were profiled at the close of each unit or at the end of the field season if the unit was to be further excavated. Soil and flotation samples were collected from areas displaying high concentrations of charcoal and ash that may represent features.

Laboratory Methodology

All materials collected, fieldwork notes, and additional paperwork produced during the excavations were checked for recording errors on a regular basis during each field season. When time and weather permitted, the collected materials were processed and cataloged in a field laboratory. Post-field season processing and cataloging was completed by undergraduate student volunteers in Dr. Bamforth's laboratory at CU. Each point plotted object was assigned an individual catalog number and each separate class of materials from every provenienced screen lot was assigned a catalog number.

The nine different classes of material identified in the assemblage include bone, ceramic, chipped stone, other stone (FCR and unmodified rocks), charcoal, organics (seeds, wood), shell, mineral (burned soil, hematite, unidentified), and historic/modern material. The vast majority of the assemblage is composed of bone, ceramic, and chipped stone artifacts. Screen finds were washed and bagged by material type, point plotted chipped stone artifacts were washed and re-bagged and point plotted bone and

ceramic objects were dry-brushed to remove excess dirt and then re-bagged. All individually plotted and screen recovered materials were also counted during processing. Recording errors or inconsistencies are expected for projects involving many different individuals over numerous years and some such inconsistencies were discovered during the analysis for this thesis, particularly in reference to the charcoal remains. Fragments of charcoal were initially being recorded by count, but during 2010 the procedure was changed, due to the time consuming nature of counting, and the weight of charcoal was recorded instead. This does introduce some error when trying to estimate the distribution of charcoal across the site, but an attempt to compensate for this will be discussed in the interpretations section of this paper.

Point plotted objects were individually measured for maximum length, width and thickness. If larger items found their way into the screen, these were also measured for the same dimensions. Materials with a maximum length or width of less than 10 mm were generally not measured. These recorded dimensions were then used to assign the materials to one of three size classes. These size classes are as follows: Class 1 < 25 mm, 25 mm ≤ Class 2 < 50 mm, Class 3 ≥ 50 mm.

All of the materials collected from the investigations conducted between 2008 and 2010 were entered into a master database file created in Microsoft (2007) Excel from which the various classes of material were separated out into individual sheets to facilitate analyses. Formal analyses have yet to be conducted for most of the materials from the King site so the quantification of faunal species or skeletal elements and the identification of some lithic source materials are not yet available. However, the identification of lithic and bone tools was possible to derive from the catalog records.

Excavation Results

A total of 39 1x1 m units have been excavated at the King site since 2007. Of these, only the 32 units located in the main excavation block are utilized in the majority of the analyses presented here (Figure 6). The other seven units are located far from the main excavation block and/or contained too little, if any, material to significantly contribute to or detract from this study.

Stratigraphy

The natural stratigraphy of the site is quite simple and consists of fine grained silty sediments. The sediments on the steam terrace are composed of the alluvially derived Tripp silt loam, which is a very dark grayish brown silt loam that grades to a grayish brown silt loam (Ragon 1977). The upper strata have been disturbed by burrowing rodent activity, which has caused significant upward and downward transport of sediments to a depth of 50 cm below ground surface across much of the site and sometimes even deeper. The very dark grayish brown upper stratum grades to a lighter grayish/yellowish brown stratum between 30 and 40 cm below the ground surface and appears at somewhat irregular depths across the site.

Post-Depositional Disturbances

In order to properly describe and interpret the spatial patterning of materials at any archaeological site, one must account for the "factors that create the historic and archaeological records" known as formation processes (Schiffer 1987:7). Natural post-depositional formation processes are "highly regular in their causes and effects" and can be accounted for in order to rule them out as the source of the patterning that we use to make behavioral inferences (Schiffer 1987:23). There are two post-depositional

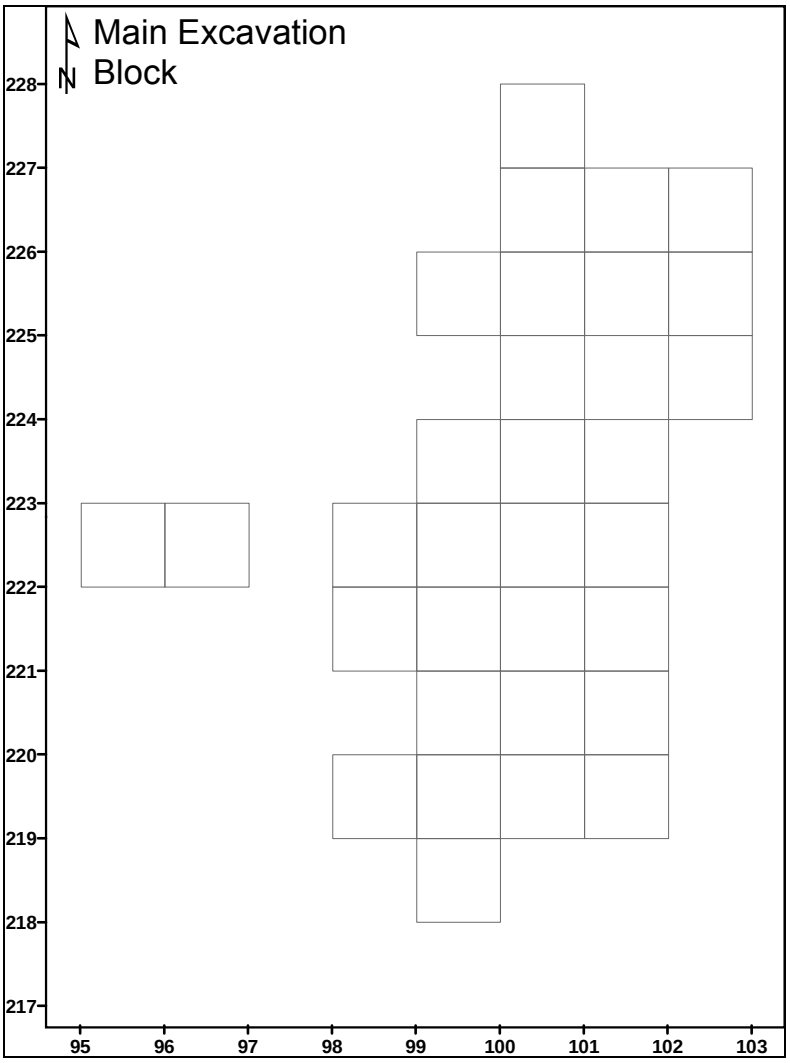

Figure 6. The main excavation block at the King site.

processes that are particularly important for understanding the spatial distribution of materials at the King site, faunalturbation and agricultural plowing.

The natural stratigraphy of the King site is simple in that there is one clear stratigraphic change between 30-40 cm below the ground surface and slightly deeper in some parts of the site. The stratigraphy does not indicate multiple discrete occupations of the site but rather there are materials scattered from the ground surface to a depth of one meter below the surface. In order to propose interpretations concerning the vertical

depth of occupation levels and the number of occupations present at the site, it is necessary to examine the vertical and horizontal distributions of materials and how these post-depositional processes may have affected these distributions before making claims about how the archaeological patterns reflect the activities and behaviors of the past occupants of the site.

Faunalturbation

The greatest disturbance to the cultural deposits at the King site has come from the effects of pocket gopher burrowing. The effects of burrowing rodents on archaeological deposits will vary by species, length of time, population density, and local factors (sediment, precipitation, land use, etc.) but the overall effect of this activity can be artificial horizonation of cultural deposits and the homogenization of the sedimentary matrix (Bocek 1986; Erlandson 1984; Pierce 1992). For archaeological deposits that have been heavily disturbed by burrowing rodents, the vertical distributions can be almost entirely a product of the burrowing activity. However, horizontal displacement of materials caused by burrowing is limited enough that the original spatial structure of the site may be generally preserved (Bocek 1986).

Pocket gophers live and feed underground by digging a network of tunnels. As they dig, they eject sediment and small-sized objects, possibly up to 50 mm in size, upward and onto the surface but dig under and around larger objects (Bocek 1986). Faunalturbation from pocket gophers can result in bimodal vertical material distribution patterns that are the result of the behavior of the animal rather than cultural deposition (Erlandson 1984). In this case, the rodents move materials (presumably of small size) upward creating a peak in material frequencies in upper strata and, as the deeper

nesting and feeding chambers collapse after abandonment, objects are also displaced downward creating a secondary peak just below the rodent zone (Erlandson 1984). However, rodent activity can also result in strongly unimodal distributions that also show size sorting of the materials (Bocek 1986). Overall, the effects of burrowing rodent disturbance can result in horizonation or a vertical spatial pattern where small items are concentrated at the top of the disturbed zone and large items become concentrated near the bottom of the disturbed zone.

Extensive burrowing also results in homogenization, or mixing, of sediments. This process can blur or completely obliterate the outline of features, thus reducing the resolution of archaeological interpretations. The process of homogenization has been modeled by Pierce (1992:198) with results indicating that the upper levels of a deposit, usually the first 30 cm below the surface where the most intense burrowing activity occurs, becomes almost completely mixed (i.e. homogenized) within the first 1000 years of disturbance.

Agricultural Plowing

It is clear from viewing aerial photos of the site location through time that the area had been plowed and used as a hay field continuously for at least fifteen years prior to the initiation of excavations in 2007. Landowner information also indicated that the area has been used as a wheat field for about 40 years. Agricultural plowing has been shown to have several effects on archaeological deposits and modern plowing often disturbs materials up to 30 cm below the ground surface (Schiffer 1987:131). Lewarch and O'Brien (1981) identified two patterns of artifact movement that result from mechanical plowing: that lateral displacement of artifacts tends to be longitudinal (in the direction of

plowing) and that size plays a role in the degree of displacement, such that large artifacts tend to be moved farther than small ones. This pattern of size-graded movement within the plow-zone is in contrast to the pattern seen for gopher burrowing by which smaller objects are more frequently subject to upward displacement. Efforts to quantify the amount of lateral displacement that occurs in the plow-zone have shown the degree of movement may not be so significant as to prevent the interpretation of subsurface spatial patterns. By refitting biface fragments collected from the surface of a field that had been plowed for at least three decades, Roper (1976:373-374) determined that the mean relative lateral displacement of artifacts was between 2-4 m in the direction of plowing. This level of displacement is small enough that surface scatters can be considered reliable indicators of subsurface distributions (Roper 1976:374).

Features

The level of disturbance from gopher burrowing and the lack of long continuous exposures has made interpretation of the profiles somewhat challenging. However, the presence of at least two pit features is indicated at this point in time. The very large flat-bottomed pit evident in the plan views and profiles of 225N 102E – 99E and 224N - 226N 100E is of the greatest interest here (Figures 7-9). The profiles across the south walls of units 225N 102E – 99E show the lowest stratum to be dipping at about 38 cmbd to the east and west toward the center of unit 225N 101E where it is still not fully exposed at a depth of 70 cmbd. The west profiles of 225N 101E and 226N 100E also show southward dipping toward the center of the pit (Figures 8 and 9). There are also at least two distinct layers of ash present in the profiles of 225N 101E between 46 cmbd and 66 cmbd (Figure 8). The presence of a concentration of large bone fragments, fire

cracked rock, larger rock fragments, as well as charcoal and ash rich sediment in the center of 225N 101E between approximately 60 cmbd and 70 cmbd appears to be the approximate location of the center of this pit feature (Figure 8).

The remains of what appears to be a collapsed pot were also recovered from this pit feature. The fragments of this pot are oriented in an articulated manner with some of the sherds lying on their interior surfaces and some on their exterior surfaces, as if the pot broke, collapsed, and was left in situ at the base of the pit (Figure 10). Due to the incomplete excavation of several of the units within and immediately surrounding the pit, the complete size, shape and absolute depth of the feature are unknown at this point, but it appears to measure somewhere between 2 and 3 m in diameter and is at least 30 cm deep. Due to the size, shape, and nature of the remains located in this pit feature it is hypothesized that it functioned as a ceramic firing pit and will be referred to from this point as a pit kiln.

Cultural Material

Though most of the cultural material from the King site has not been formally analyzed, a brief overview of the main material classes will be provided as a background for the following spatial analyses and as a framework for preliminary determinations of the function of the site. The majority of the ceramics from the site indicate a Central Plains tradition affiliation but the thickness of some ceramics recovered from the deepest levels of the site suggest a Woodland component may be present as well. Radiocarbon dates have not yet been obtained to verify and refine the temporal span of the site but the ceramics and projectile points suggest the major occupation to be affiliated with the Central Plains tradition.

Figure 7. West edge of the pit kiln visible in the eastern portion of Unit 225N 99E (white line drawn to highlight edge).

Figure 8. West wall profile of Unit 225N 101E showing the lowest stratum dipping to the south toward the center of the pit kiln; also showing the ash and charcoal layers present near the base of the pit.

Figure 9. West profile of Unit 226N 100E showing the north edge of the pit kiln sloping down to the south (white line drawn to highlight pit fill).

Figure 10. Collapsed pot recovered from the kiln feature in Unit 224N 100E.

Ceramic

The King site ceramic assemblage contains 31 rim sherds, from a minimum number of 23 distinct vessels, and 1487 body sherds. A sample of 409 sherds, consisting mostly of size class 2 and 3 sherds, were selected for the spatial analyses described later in this thesis. The ceramics range in color from a buff tan color to a dark gray and a high proportion (28%, n=115) of those included in the sample posses the dark interior core of incompletely combusted carbonaceous material that is indicative of the low firing temperatures and times associated with open firing. The sherd thickness is between 2-13 mm with an average of approximately 7 mm for the assemblage. There are a handful of thicker sherds that range between 15-30 mm thick that are associated with the Woodland occupation of the site. There are 20 constricted neck jars and three miniature bowls in the assemblage. Direct rims are the most common rim form represented for the jars by far, with 19 of the 20 vessels possessing a direct rim and only one bearing a paneled rim (Figures 11 through 15).

The majority of the vessels have some form of decoration, with only five of the 23 vessels being undecorated. The decorated ceramics display a variety of simple independent decorative motifs, meaning that each motif is the sole decorative element present on the rim as opposed to complex motifs that combine independent motifs on the same vessel (Page 2009:104). These decorative elements are restricted to the top of the lip (Zone 1), the exterior lip (Zone 2), and the rim face just below the lip (Zone 3) (Page 2009:99). Application techniques include modeled, punctated and modeled, impressed and modeled, obliquely punctuated, impressed, incised, and paddle

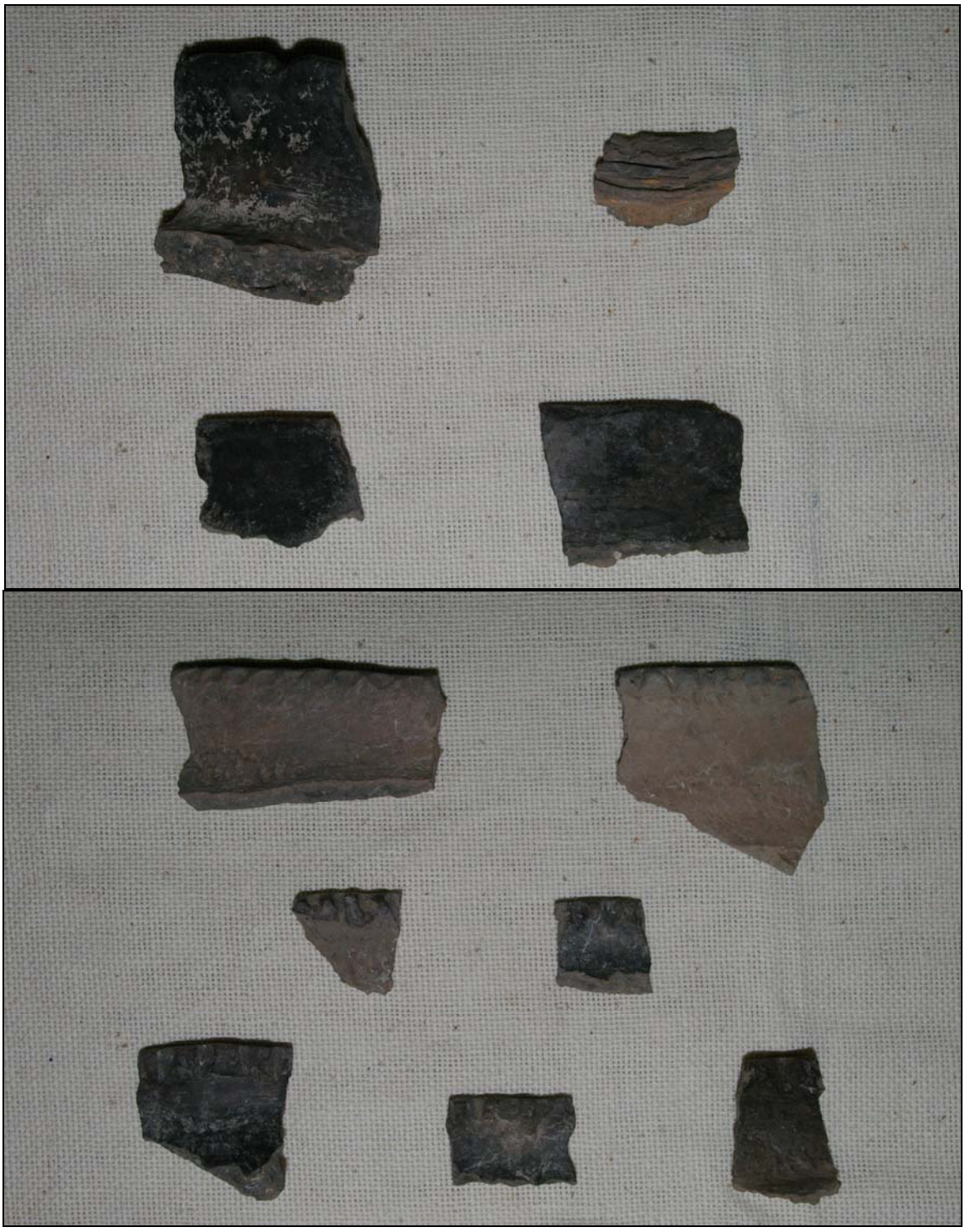

Figure 11: Direct rims from the King site.

Figure 12: Direct rims from the King site.

Figure 13: Refit direct rims from the King site.

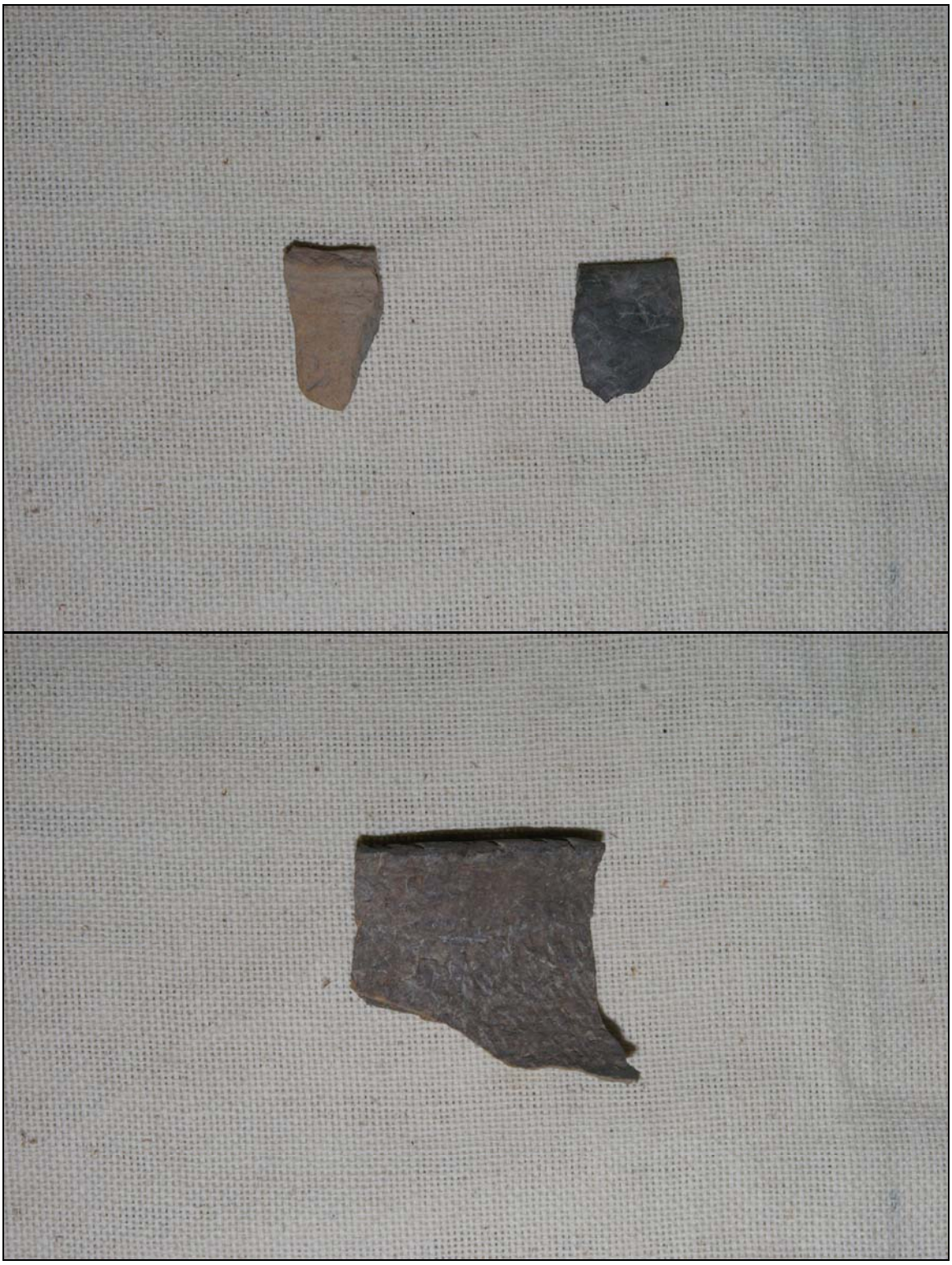

Figure 14: Direct rims from the King site.

Figure 15: Panelled rim (top) and miniature bowls (bottom) from the King site.

stamped. Based on design element and the location of decoration, there are eight unique simple independent motifs within the King site assemblage.

The ceramic rim forms, zones of decoration, and application techniques represented in the King site assemblage do not fit the common pattern for Upper Republican phase pottery. Upper Republican pottery assemblages tend to have a high proportion (50% or greater) of paneled rims, a high occurrence of decoration on panel faces and panel bases, a comparatively low occurrence of decoration on the top of the lip or the lip exterior, and a high rate of incised designs (Page 2009:166, Table 6-17). Most of these characteristics are either completely absent from the King site assemblage or occur in extremely low frequencies (Table 1 and Table 2). In contrast to

Table 1. Ceramic rim form attributes including rim type, decorative zone, and type of decoration.

Rim Form	Decorative Zone			Decoration Type				
	1	2	3	Punctated	Modelled	Incised	Impressed	Paddled
Direct	7	10	-	7	10	-	7	-
Panelled	1	-	1	-	-	-	-	1
Bowl*	-	-	1	-	-	1	-	-

Table 2. Percentage of each rim type, decorative zone, and decoration type.

Rim Form	Decorative Zone	Decoration Type
Direct 95%	Zone 1 42%	Punctated 37%
Panelled 5%	Zone 2 42%	Modelled 53%
Bowl 13%	Zone 3 11%	Incised 5%
		Impressed 37%
		Paddled 5%

Upper Republican pottery, Itskari phase pottery shows a much lower proportion of paneled rims, a higher occurrence of punctate designs on the top of the lip, a high frequency of modeled designs on the exterior lip, and a comparatively low occurrence of decoration on rim faces (Page 2009:166, Table 6-17). Although further excavation and more detailed analysis may modify this conclusion, at present it seems clear that the rim forms and decorative elements from the King site ceramic assemblage most closely resemble those described by Page (2009) as characteristic of Itskari phase ceramics.

Bone

The most abundant material type recovered from the King site is by far the faunal remains. Formal analyses of the species and the skeletal elements represented have not been performed thus limiting statements concerning the subsistence strategies of the site occupants and, to some degree, specialized functions of the site. Multiple mandible fragments, teeth and fragments of a hoof indicate the utilization of ungulate species in general and clear evidence of the use of bison was found throughout the deposit from a nearly complete bison skull in the lowest levels of the site to numerous identifiable elements throughout the upper levels. The majority of the identified remains are of bison, but also present are antelope, rabbit, turtle, and an unidentified bird species. To date, the identified skeletal elements include vertebrae, scapulae, ribs, long bones and mandibles. The use of bone for tools and ornaments is also apparent in the presence of three bone awls and 6 bone beads. Despite the lack of formal analyses at this point in time, it is clear that the bone recovered from the site has been subject to a high degree of processing, reducing the majority of it to extensively fragmented pieces smaller than 25 mm. The measured bone fragments have an average maximum

dimension of 5 cm, which is quite comparable to other High Plains sites displaying intensive bone processing (e.g. the Donovan site) (Scheiber and Reher 2007:355).

Lithic

The lithic assemblage from the King site has a preponderance of small debitage consistent with late-stage tool manufacturing and tool maintenance activities such as re-sharpening. Most of the debitage (98%) has a maximum dimension of less than 25 mm and there is a marked lack of flakes with cortex. The presence of two small cores indicates the manufacture of some tools occurred at the site but the small size of debitage and the lack of primary flake debris indicate that early-stage tool manufacturing was not a primary activity at the site. It is possible that the smaller debris is the result of tool maintenance activities and that the large-sized debitage may be related to expedient flake tool manufacturing.

The formal tools recovered from the site include seven projectile points, one tip from a broken projectile point, six scrapers, three bifaces, one fragment of a broken biface, and one biface that appears to be a knife. The projectile points are consistent with CPt points in that they are triangular and relatively small in size ranging between 18 mm and 22 mm in length, with only one considerably larger example measuring 46 mm in length. As not all of the projectile points were broken, they may represent used points that were discarded while still attached to broken arrows (Bamforth 2012, personal communication). Scraping tools are used for hide cleaning and preparation and the presence of scraping tools in similar proportion to hunting tools indicates that hide preparation was also one of the primary activities of the occupants of the King site.

The lithic materials present at the King site provide evidence of hunting, butchering and hide processing. The low occurrence of formal tools with the clear evidence of extensive bone processing suggests that utilized flakes may have been the primary tools used for skinning and butchering of game. These interpretations are somewhat speculative at this point and a more formal analysis of the chipped stone material will certainly elaborate on these conclusions.

Chapter 5: Methods of Spatial Analysis

The spatial analyses performed in this thesis are designed to examine the general distribution of materials across the site in order to identify possible activity areas. Spatial analyses were also conducted to examine the distribution of the evidence for ceramic firing. The assumption is that the evidence for ceramic firing is strengthened by the close spatial association of the archaeological markers outlined in previous chapters. In other words, if the markers of ceramic firing are clustered together in space, the case for positive identification of this activity is much stronger than if these markers are scattered randomly across the entire site.

The following spatial analyses were performed by importing the Excel database files into ESRI's ArcGIS (2010) software and utilizing several geostatistical, spatial, and spatial statistics tools in the Spatial Analyst extension of the ArcGIS program. The vertical analyses were conducted in Excel. Both of these programs allowed for the catalog data to be queried and grouped by material type, size class, 1x1 m grid unit, individual point provenience, and depth below datum. The grouped data were then displayed in a number of ways to show the horizontal and vertical distributions of materials at the site.

These programs also facilitated the analysis of the distribution of ceramic firing waste products. In order to look for the presence of ceramic firing waster material, a sample of 409 ceramics were selected from the total ceramic assemblage. This sample represents 27% (n=409) of the entire assemblage (n=1518) and was selected based on size class. All of the ceramics belonging to size classes 2 and 3 were analyzed due to the lower probability of larger objects being vertically displaced by gopher burrowing.

Some of the ceramic spalls were smaller in size and, due to the limited effects of horizontal displacement by plowing at the site, a minimal number of size class 1 ceramic materials were also included in the sample. This sample was then coded for the presence or absence of the attributes used to identify ceramic waster materials discussed in Chapter 3. The only failure attributes observed include spalling, exfoliation, and surface cracking (Figure 16). Neither bloating nor over-vitrification was apparent on any of the sample materials. Dunting was not observed either, as the characteristic cracking pattern is difficult to identify on highly fragmented vessels. Extensive cracking on the surface of some sherds was observed and recorded as an indicator of misfiring but it was not common to the sample overall.

During excavation it was noted that some of the ceramics recovered were caked with substantial amounts of residue, presumably from use as cooking vessels or from extended contact with fuel during ceramic firing. The location of the residue on each sherd was recorded with locations being the interior surface, exterior surface or both surfaces. Considering that ceramic failure will often preclude use, the location of residue was recorded on the sherds in the sample in an attempt to distinguish between ceramics that may have been used (residue on the interior) and ceramics that may have been failures (residue on exterior) or ceramics that may have been used in the kiln as insulators or pot props (residue on exterior or both surfaces). Comprising 85% (n=81) of the population (n=95) of ceramics with residue, sherds bearing residue on the exterior or both the interior and exterior surfaces far outnumber those with residue only on the interior surface (15%, n=14) (Figure 17). The expectation here is that the sherds with residue will generally cluster around the pit feature as the majority of them do not show

Figure 16: Refitted spalls (top; right side of sherd) and extensively exfoliated ceramics (bottom).

Figure 17: Residue on exterior surfaces of sherds.

evidence of use in cooking but rather evidence of possible contact with fuel during the firing process.

Vertical Analyses

The King site has been extensively disturbed by gopher burrowing to a depth of 50 cm below the ground surface across much of the site and even deeper in some areas. In order to evaluate the effects of faunalturbation and to determine the depth of the occupation, the vertical distributions of the various materials were analyzed. Graphs were created in Excel to display the distributions of all materials collectively, all materials collectively by size class, as well as the three main material types individually, and the individual material types by size class.

Horizontal Spatial Analyses

In order to look at the structure of the King site and to identify potential activity areas including ceramic firing, bone processing, and possible refuse dumping areas, it is necessary to determine the horizontal distribution of different material types across the site. The general spatial analyses discussed in this thesis focus on the distributions of the four major material types including bone, ceramic, chipped stone, and charcoal. The analyses conducted to identify ceramic firing activities at the site utilize a sample of the total ceramic assemblage as well as the distribution of charcoal, fire cracked rock, and large unmodified rocks. Several different methods were utilized to achieve this and to display the distributions visually. I used three different visualization methods to look at the distributions of the three main material types and size classes within these types, as well as two statistical measures to identify clustering among the ceramic failure attributes and materials related to ceramic firing.

Artifact Frequency Maps

I first created frequency maps based on total artifact counts within each 1x1 m excavation unit. These maps were created by collapsing all the vertical levels of excavated materials into a single all-inclusive level and totaling the counts of all materials for each 1x1 m unit. The counts were segregated into bins based on distribution into equal intervals defined in ArcMap. For most materials, 5 bins were selected and the equal intervals generated by the program were rounded to close even multiples of one hundred or ten, depending on the total sample size. The bin interval was rounded to a close number that accommodated the consistent number of bins such that each bin contains a multiple of the same number. For example, if the first interval generated for a bin was 819 objects, the interval for each bin was rounded down to 800. The maximum for the bin with the highest counts for each display was defined by the maximum count of the material being tabulated; therefore the highest frequency bin total for each map tends to be slightly higher or slightly lower than the defined equal interval. This method was chosen for the ease of display and discussion using round numbers. Since the difference between the actual equal interval (e.g. 819) and the rounded number (e.g. 800) was never greater than the interval itself (e.g. 800), this method did not significantly distort the relative distributions of the materials across the site. These maps were created to show the distributions of all materials combined, each material type individually, and each material type by size class. Since the main focus of this thesis is evaluating the evidence for ceramic manufacturing at the site, the purpose of these initial spatial analyses is to identify general activity areas and obtain a coarse

estimation of the focal points of activity in the known site area as a basis for comparison to the distribution of the evidence for ceramic firing.

Isopleth Maps

For display purposes, isopleth (i.e. contour) maps were created by interpolation to show artifact distributions across the site. Interpolation is a mathematical technique for creating a continuous surface based on discrete observations. In other words, interpolation uses surrounding observations to predict values between observations thus "filling in the gaps" in the data (Conolly and Lake 2006:90). There are a number of interpolation techniques and the selection of a method depends on the structure of the data and the desired outcome. Local interpolation methods use known values from a defined neighborhood of surrounding points to derive a continuous surface across unsampled areas as opposed to global methods that use all known points collectively to derive larger trends across space (Conolly and Lake 2006:91). Based on the results derived from the artifact distribution maps, it appears that there is a considerable level of local distributional variation across the site in terms of total counts, counts by material, and counts by size class. Considering this variability and the fact that local interpolation can provide a very close or exact fit between the original observations and the derived surface model (Conolly and Lake 2006:94), a local interpolation method was determined to be the appropriate choice in order to most accurately reflect the variability in artifact distributions across the site.

The contour maps were created using a local interpolation method called Inverse Distance Weighting (IDW). IDW was determined to be the best choice for creating isopleth maps because it produced results that fit and retain the values of the original

data most accurately. Other methods, such as Splines, produced results with much greater minimum and maximum values than the original counts for the data and thus created undesirable exaggerations in areas with low artifact frequencies. IDW predicts values at unknown locations by calculating the distance to a specified number of known points, or the "neighborhood," surrounding that location. The weight given to the sample of surrounding points is inversely proportional to its linear distance raised to a specific power (Conolly and Lake 2006:95). The power controls the significance that the neighborhood points have on the interpolated value, whereby a higher power results in more distant points in the neighborhood having less influence on the prediction of the interpolated values (Conolly and Lake 2006:96). For this interpolation, I used the default values determined by the program to define the neighborhood and the power of the IDW calculation.

Due to the nature of the archaeological data collection process, large counts of artifacts of small size are often collected during bulk screening and thus have provenience data only to the level of the grid coordinate. In order to include artifacts recorded with greater precision as well as these more generally provenienced quantities of material in the artifact distributions, the data were generalized across each test excavation unit by creating centroids. This means that all of the material from a particular excavation unit was attributed to the centroid, or point in the center, of each unit. The neighborhood used to interpolate the distributions around each centroid consisted of the 12 nearest centroids, thus each point was used in numerous calculations for the distributions around other points. These interpolated distributions were then converted to isopleths with contour intervals selected by an intuitive process

based on the maximum count and the clarity of display. There is some distortion of the data inherent to this method due to generalizing the spatial data to the center point of each unit. This distortion is only significantly obvious in areas of low artifact concentration where the contours are more heavily weighted to the centroid creating less realistic distribution patterns. However, IDW is a "good all-purpose algorithm for well-spaced data points" (Conolly and Lake 2006:96) and, considering the conformity between the count-based distribution maps and the interpolated isopleths maps, it is an effective method for displaying the local variation in artifact distributions within this data set.

Spatial Autocorrelation

Spatial autocorrelation measures the strength of association of the spatial distribution of a single variable. It is defined such that "spatial autocorrelation exists whenever a variable exhibits a regular pattern over space in which its values at a set of locations depend on values of the same variable at other locations" (Odland 1988, as cited in Burt et al. 2009:544). Spatial autocorrelation tests the null hypothesis that there is no dependence between the values of a variable at one location and the values of that variable at neighboring locations; in other words, that the distribution of values in space is completely random. Positive spatial autocorrelation refers to a pattern in which similar values tend to cluster in space while negative spatial autocorrelation indicates that very different values of the variable cluster in space. When no spatial autocorrelation is present the null hypothesis cannot be rejected and the distribution of features based on the values of the variable is considered random.

Index Coefficient of Spatial Autocorrelation

One of the most common statistics used to determine spatial autocorrelation is the Moran's Index coefficient. This statistic measures the correlation among neighboring observations in a dataset and then compares this measurement against an expected value derived from a random spatial distribution of data values (Burt et al. 2009:254). This statistical test can be run in ArcGIS using a spatial statistics tool. This tool generates one measure of the spatial patterning and two measures of the significance of that patterning. The Moran's Index is the measure of the spatial patterning, or level and type of correlation. The tool computes the mean and variance for the attribute being evaluated and then it subtracts the mean from each feature creating a deviation from the mean. The deviation values for all neighboring features are multiplied together to create a cross-product. These cross-products will be either negative (dispersed), positive (clustered) or balanced (=0 and random). The resulting Moran's Index value ranges from -1 for perfect negative correlation to +1 for perfect positive correlation. The tool then calculates an expected index value for random spatial distribution that is compared to the observed index value to generate the measures of statistical significance (z-score and p-value) of the difference between the two indices (ESRI 2010).

The z-score and p-value calculated by the analysis indicate whether or not the data displays statistically significant clustering or dispersion and whether the null hypothesis can be rejected. The p-value is a standard probability indicating the confidence level with which the null hypothesis of complete randomness may be rejected, thus a smaller p-value equals a higher confidence level. The p-value is related to the z-score in the

sense that the higher the z-score the lower the p-value will be. The z-score represents the number of standard deviations the analyzed observations are from the mean of a normal distribution. A higher positive z-score indicates significant clustering and a lower negative z-score indicates significant dispersion. A z-score between -1.65 and +1.65 indicates random spatial distribution (ESRI 2010).

Local Indicator of Spatial Association

The Moran's Index coefficient measures spatial autocorrelation on a global scale, meaning that it is a measure of the presence or absence of a spatial correlation between features based on a certain variable. It does not indicate specifically where in space those correlations exist. When spatial autocorrelation is present in a sample of observations, its location can be defined through the use of a Local Indicator of Spatial Association (LISA). LISA is a local measure of the global Moran's Index statistic that produces a local Moran's Index value, a p-value and a z-score that are interpreted in the same way as those for the global statistic but LISA also produces a code for the cluster type present at each feature. These codes are interpreted such that a high LISA value indicates a clustering of similar values of the variable of interest and low LISA values indicate clustering of dissimilar values of the variable (Burt et al 2009:560). The result is a map indicating statistically significant (p=0.05 level) clusters of high values (HH), low values (LL) and features for which autocorrelation based on that variable is not significant. Also displayed are feature outliers that are indicated as a high value surrounded by low values (HL) or a low value surrounded by high values (LH) (ESRI 2010).

The Moran's Index was used here to determine if there is spatial patterning to the distribution of ceramic artifacts displaying any attribute of production failure during firing. The total sample is n=409 sherds of which n=143 display some form of the variable of interest, which is evidence of either spalling, exfoliation or surface cracking that are unusual to the assemblage as a whole and were determined to be evidence of misfiring (Table 3). The incidence of these attributes was analyzed by the Moran's Index and LISA as the count of each at individual points. The data were analyzed by the above statistics for the following variables, all of which should be present in a firing feature:

1). the presence of any failure attribute

2). the presence of spalling only

3). the presence of exfoliation only

4). the presence of residue

Table 3. Percentage of each failure attribute within the ceramic sample.

% of Each Failure Type
Spalling 14%*
Exfoliation 83%*
Surface Cracking 4%*
Exterior Residue 85%**

* n = 143
**n = 95

Kernel Density Estimates

The third visualization method used to examine artifact distributions was Kernel Density Estimates (KDE). Density measures are used in archaeology in order to define clusters of materials based on changes in the intensity of the presence (i.e. frequency) of that material across space (Conolly and Lake 2006:171). KDE is a nonparametric technique in which the "kernel," or two dimensional probability function, crosses each of

the observed data points and calculates the count for a particular variable at that location and then produces an approximation of its distribution from that point outward to the extent of the defined search radius. The density for each cell in the raster is calculated by adding together the values of the feature density distributions that intersect that cell (Conolly and Lake 2006:175). The choice of a search radius for the kernel is particularly important because smaller search radii generally produce more localized density estimates while larger search radii produce more generalized estimates. In general, KDE produces smooth and easily interpreted results of variations in density of specific phenomena across space.

Kernel density estimates were produced using all ceramics from the main excavation block and then by using the features from the ceramic sample weighted by the presence of failures, failure types, the presence of residue, and for fire cracked rock. The KDE use individual points rather than aggregate data. This means that, instead of being spatially weighted to the center of the excavation unit, as was the case for the isopleth maps that were interpolated from centroids, the KDE are sometimes spatially weighted to the SW corners of the excavation units due to the aggregation of screen finds to the unit coordinate point. Since the point of this analysis is to examine the presence of clustering and the general location of clustered features, this slight spatial distortion does not significantly affect the interpretations. Since KDE produces a very clear visual display for areas with high feature density these maps can easily be compared to the LISA maps as a form of visual cross-checking between the two methods.

Chapter 6: Interpretation of Spatial Analyses

Vertical Distribution of Materials

In order to determine whether single or multiple occupations are present at the site and at what depth these occur, it is important to examine the vertical distribution of materials in light of possible vertical disturbances. The primary post-depositional disturbance at the King site is faunalturbation by burrowing pocket gophers. As previously discussed, the main effect of burrowing activity is vertical displacement and size-sorting of materials. The vertical distribution of materials by size class was examined in order to examine the effects of burrowing and if the King site materials have been size-sorted. If burrowing has not had a significant effect on the material distributions, one would expect the relative distributions of different sized materials to be comparable between levels. By plotting the cumulative percent of each material class by level for the entire excavation area it is clear that size sorting has occurred.

The graphs (Figures 18 through 20) indicate that the proportion of size class 1 (smallest) artifacts is fairly constant from the upper levels to the deeper levels. The proportion of larger size class 2 and 3 (larger) artifacts is much smaller in the first three levels but begins to increase sharply between 30-40 cmbd. The vertical distribution of materials of different size classes clearly peak in different levels. The size class 1 materials peak between 30-40 cmbd and the size class 2 and 3 materials peak between 40-50 cmbd (Figure 20). This pattern conforms to that described by Erlandson (1984) and Bocek (1986) where smaller materials become concentrated in the levels of most intense burrowing activity (0-40 cmbd) and larger materials are concentrated below the disturbed rodent zone (40-50 cmbd).

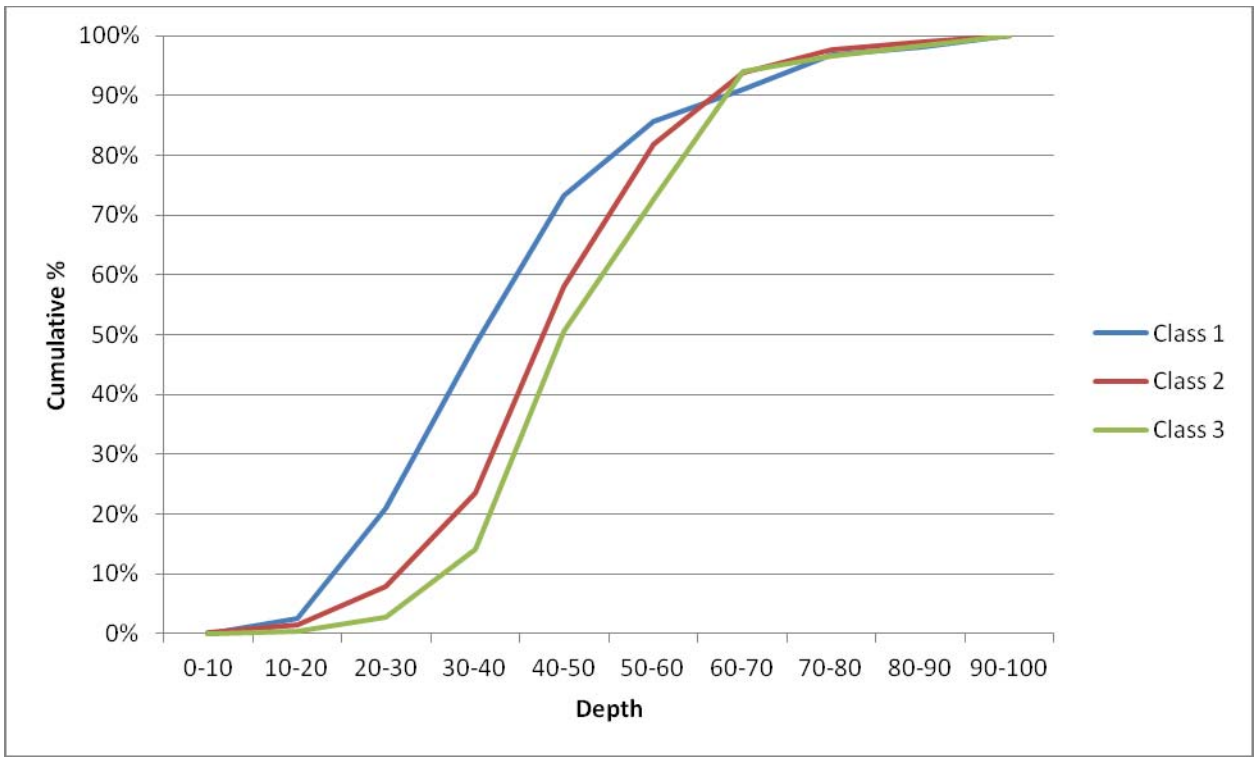

Figure 18. Vertical distribution of all material by size class.

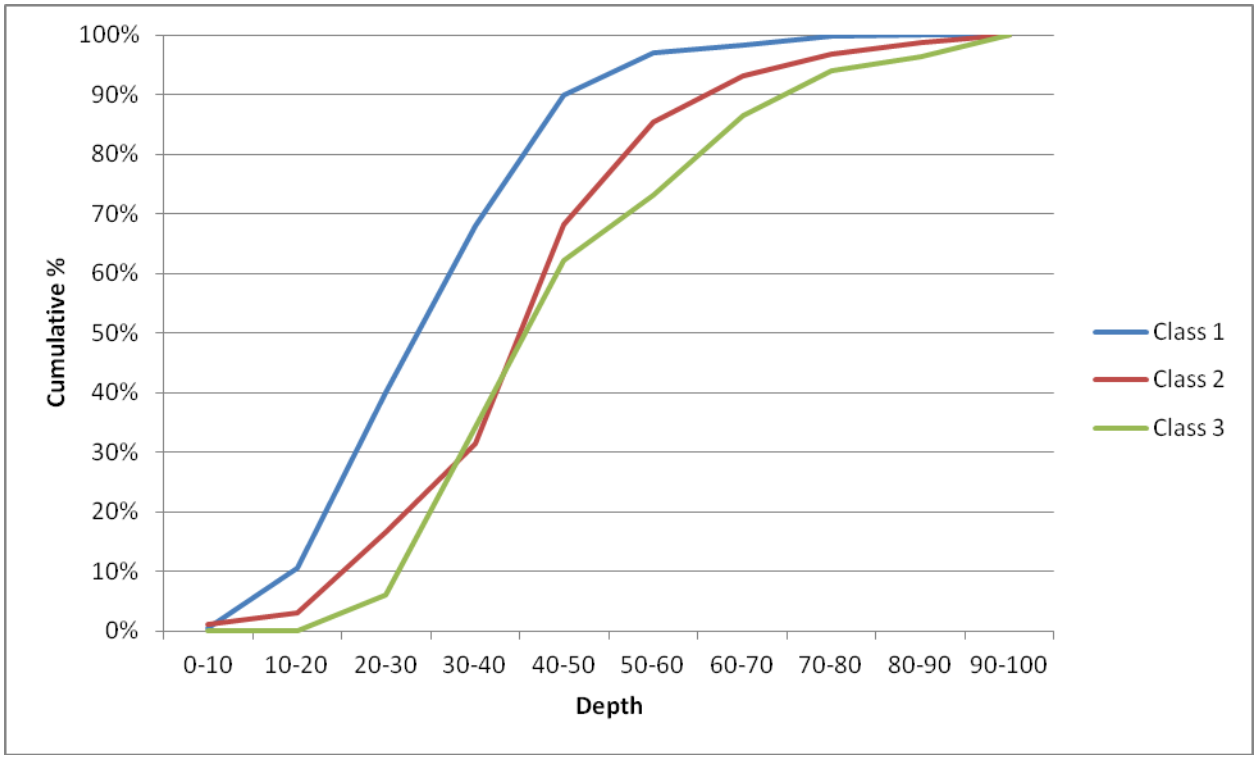

Figure 19. Vertical distribution of ceramic material by size class.

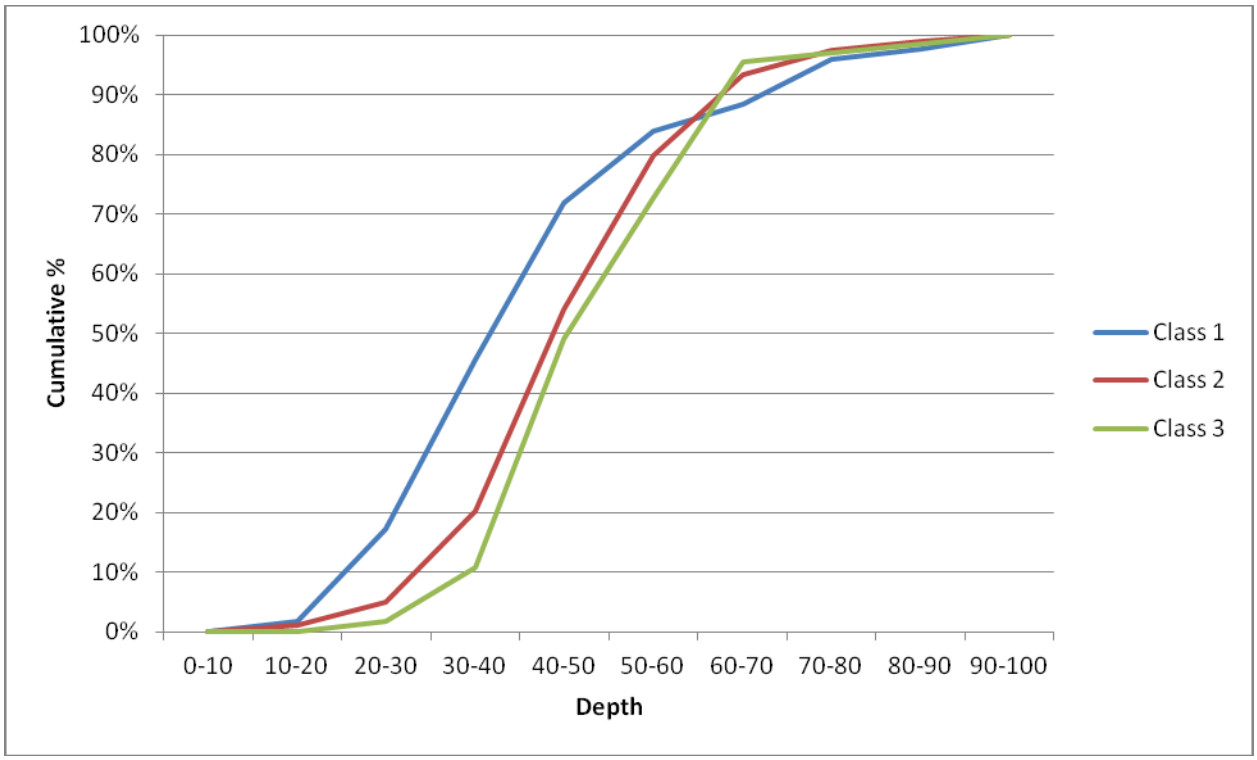

Figure 20. Vertical distribution of bone material by size class.

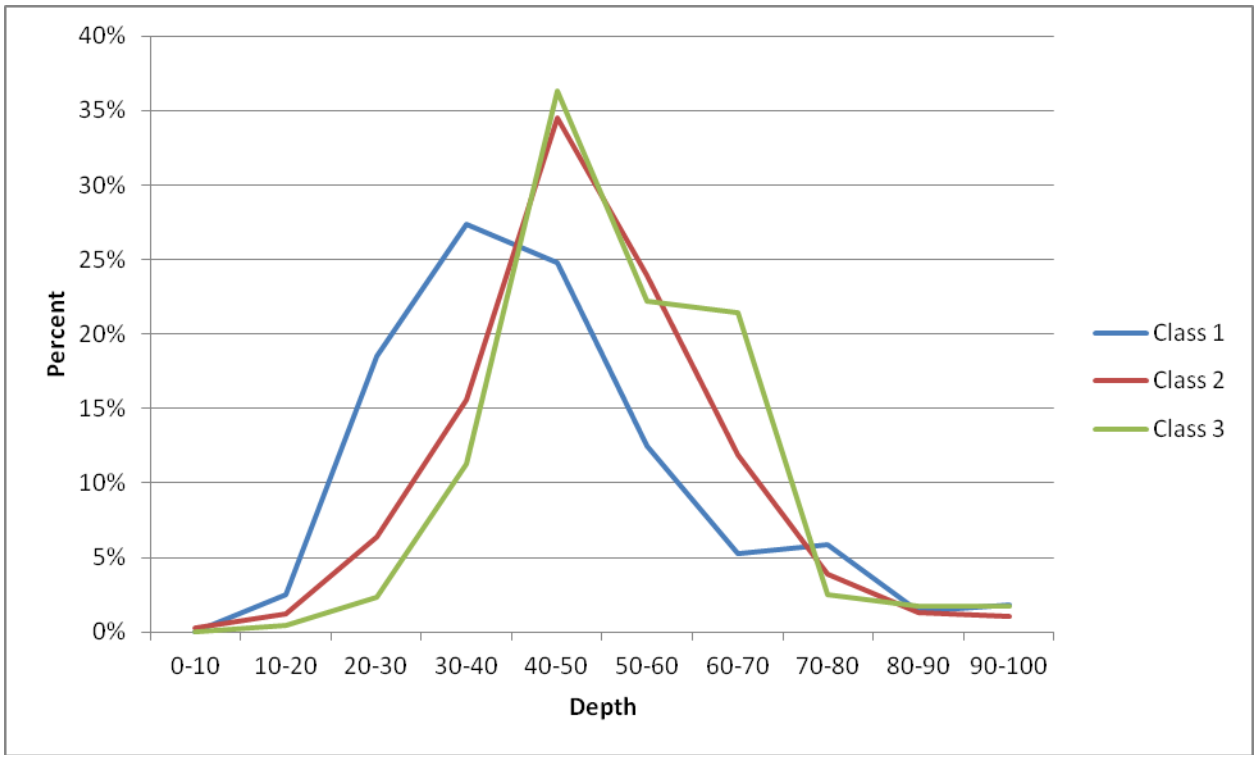

Figure 21. Frequency of material of all size classes by level.

Figure 22 shows the vertical distribution of all materials across the entire site. It is apparent that the majority of material occurs between 30-50 cmbd and then drops off sharply below that. The materials located in the upper three levels of the site have been displaced upward by rodent burrowing. At this point, it is difficult to tell how extensive the occupation of the site was at depths below 70 cmbd since one of the main areas of material concentration has not yet been extended below this or to the full depth of the deposits. The extent of the disturbance from gopher burrowing is significant and extends through the entire excavated deposit in some areas. Thus, there is likely more than one zone of rodent disturbance throughout the deposit and the presence of old

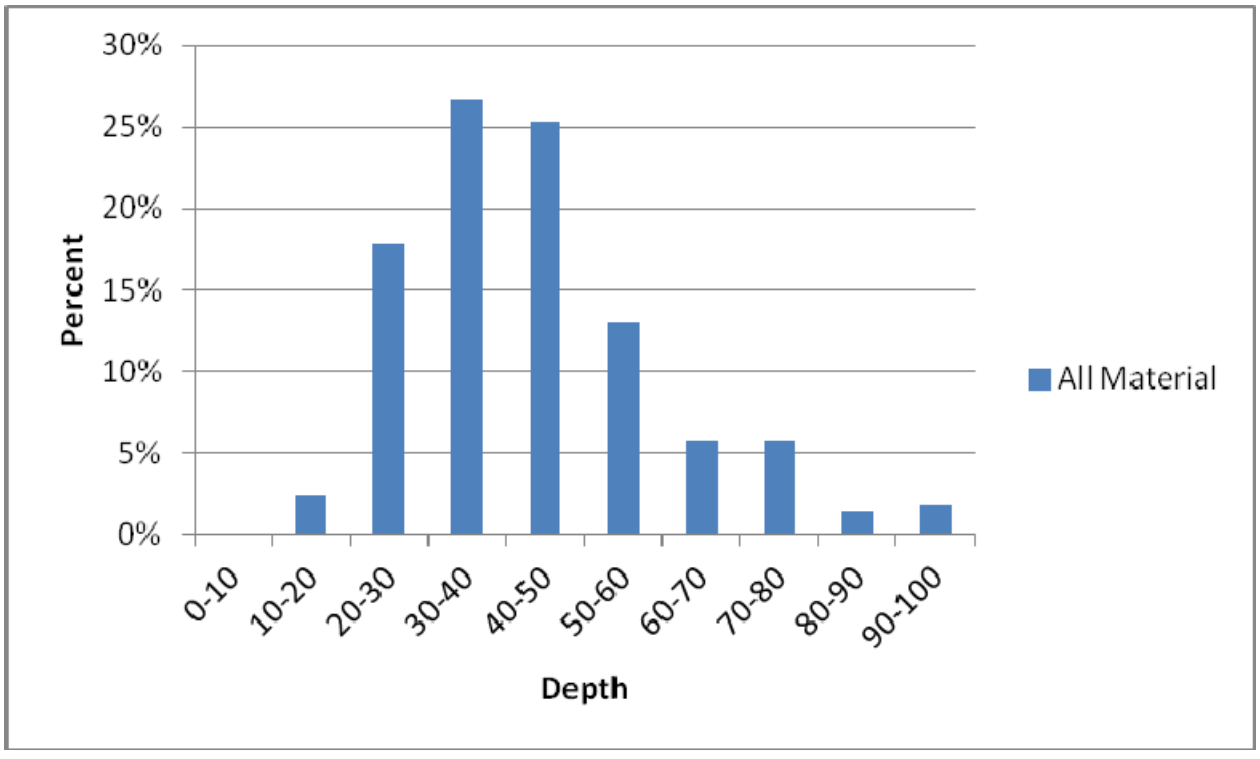

Figure 22. Percent of all material types combined by level.

abandoned krotovina below 50 cmbd indicates that there may be even more downward displacement of materials below this level. The secondary peak in size class 3 materials between 60-70 cmbd (Figure 21) may be evidence of additional size sorting from an older zone of active rodent disturbance. The presence of most of the cultural materials between 30-50 cmbd and the presence of a pit feature between 40-70+ cmbd indicate that the occupation surface was around the contact between the two natural strata at approximately 40 cmbd. The presence of materials below this depth can likely be attributed to the concentration of materials within the large pit feature and ongoing rodent activity at or around the time of occupation. As previously mentioned, there is also a Woodland period occupation in the deepest levels of the site, but the horizontal extent of these deposits is not known at this time due to the ongoing nature of the excavations in some areas.

The level of horizontal clustering or dispersal that the materials display throughout the entire deposit will be helpful for interpreting the nature of the occupation. Long-term intensive occupation is expected to result in more dispersed and overlapping horizontal distributions, while short-term occupation is expected to display a more discrete spatial distributional pattern showing more clearly bounded activity areas. Therefore, the discreteness of the spatial patterns at the site can be used as an indication of the duration of occupation.

Horizontal Distribution of Materials

The analysis of the vertical distribution of materials suggests that, over most of the excavated portion of the site, there is one occupation surface present at the site from which materials have been continuously displaced upward and downward by rodent

burrowing. The lack of clear stratigraphic boundaries between cultural deposits also supports this conclusion. In order to confirm this it will be instructive to examine the level of horizontal clustering or dispersal of materials at different depths in order to see how repetitive the distributions are. If there are in fact several occupation surfaces present, one might expect to see the utilization of different parts of the landform at different times. Alternatively, if a single occupation surface is represented, the horizontal spatial distribution may be expected to display a similar pattern throughout the vertical sequence.

In order to see whether the material distributions appear clustered or dispersed, a series of maps was produced to show the horizontal distribution of materials at the King site by 10 cm vertical intervals (Figures 23 and 24). The first map in Figure 23 shows the location of materials recorded between 0-30 cmbd, which is the depth to which the entire site has been disturbed by plowing. The next map in Figure 23 shows the distribution between 30-40 cmbd even though the plow zone may extend slightly below 30 cmbd in some parts of the site. As this is one of the levels with the highest concentrations of material, it thus warranted display separate from the rest of the plow zone. Each subsequent 10 cm level is shown individually in the following maps.

The maps in Figure 23 and 24 show a high degree of conformity among the distributions throughout the entire deposit. As expected, the most dispersed distribution occurs up to 40 cmbd and can be attributed, in part, to lateral displacement from plowing. The materials become more tightly clustered below 40 cmbd and are consistently concentrated to the same general areas separated by empty spaces. The more restricted distributions below 70 cmbd may be partially related to the stage of

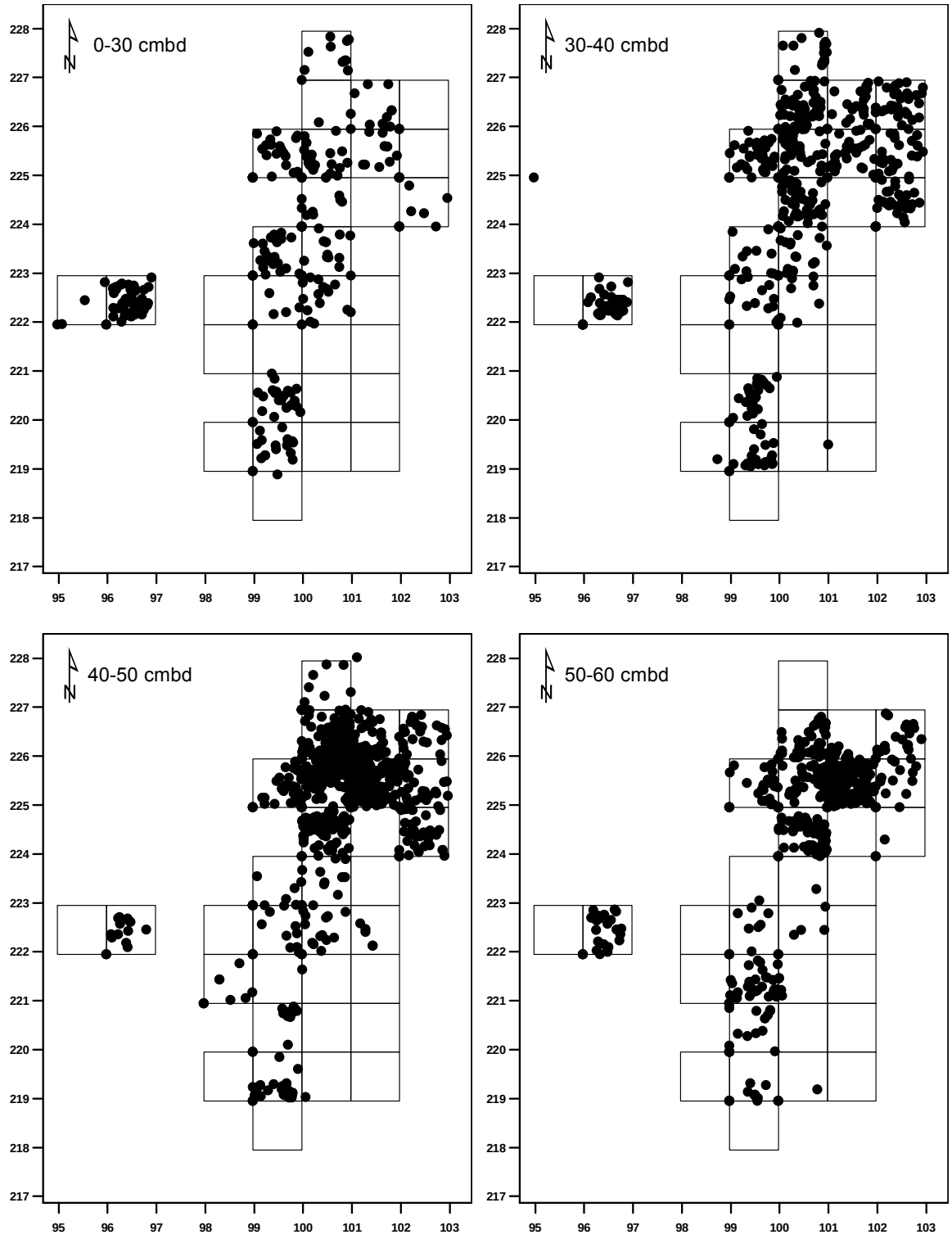

Figure 23. Horizontal distributions of material within the plow zone (0-40 cmbd) and within 10 cm intervals from 30-60 cmbd.

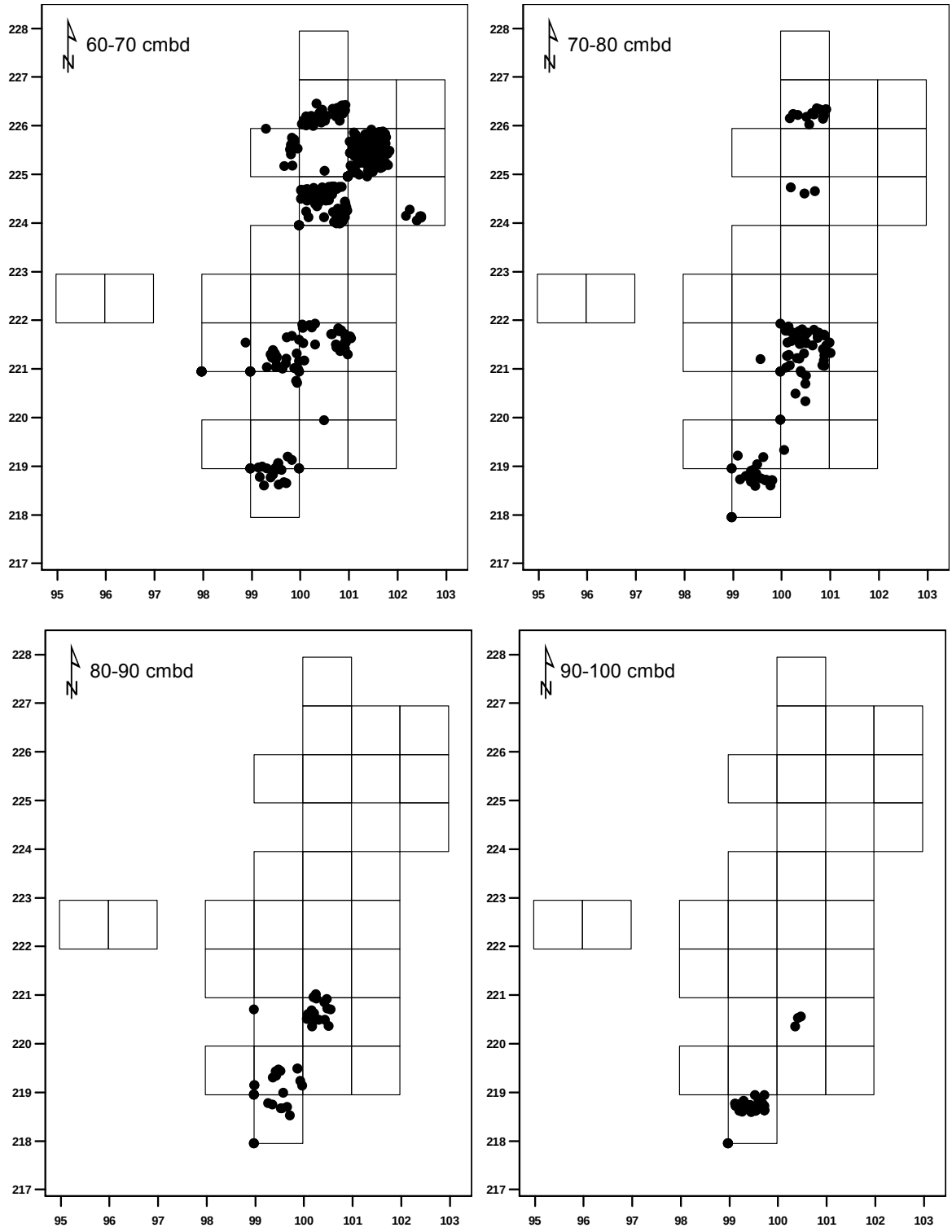

Figure 24: Horizontal distribution of material in 10 cm intervals from 60-100 cmbd.

excavation, as some of the units within the northernmost concentration have not yet been extended below this depth. However, it is clear that the materials below 70 cmbd represent the Plains Woodland occupation.

Based on this repetitive pattern of material distribution, it is reasonable to assume that a single occupation surface is present at the site and that occupation was over a relatively short duration. If multiple occupations did occur, they would have been spaced closely in time such that the occupants habitually reused the same areas of the site during each occupation. Visible meander scars indicate that the creek once wrapped tightly around this landform to the east, north, and west and overbank deposition in this area could have been regular at times in the past. Thus, another possible explanation for the vertical distributions, in addition to continuous rodent disturbance, is that successive occupations of the site were closely spaced in time resulting in a consistent spatial organization of the activities at the site and natural sedimentation rates were rapid enough for significant sediment accumulation over the span of these occupations. However, the lack of discernible flood deposits within the profiles suggests that over-bank deposits are a less likely explanation for the vertical distribution of materials.

At this point there are two conclusions that can be drawn about the number of occupations and their duration. First, the lack of stratigraphic separation between cultural deposits and the vertical distribution of materials discussed above suggest the presence of one occupation surface at the King site. Second, the conformity in the horizontal distribution of material between levels suggests a consistency in the organization of space that would result from a relatively short-duration occupation. Based on the interpretation of a single occupation surface at the King site, the following

analyses of the spatial distribution of artifacts will be accomplished by combining all the materials into a single analytic unit.

Interpretation of Frequency and Isopleth Maps

In order to understand the spatial structure of the site, it is necessary to see how the materials are distributed across space and if there are concentrations of material in certain areas. If there are concentrations, are they composed of similar proportions of different material types and sizes? If so, then they may represent areas where similar activities were conducted. If the material composition of the concentrations differ, it indicates that these spaces were likely used for different purposes during the occupation of the site. This general discussion of the spatial distribution of the main material types and material size classes will provide a picture of the overall spatial structure of the site, the range of activities performed, refuse disposal patterns, and the features present. This overall characterization of the site will provide a background for the interpretation of the evidence for ceramic production at the King site.

The following maps were created by collapsing all of the materials collectively and by type and size class into one analytic unit consisting of the main excavation block shown in Figures 23 and 24. The distributions were then displayed for different material types including bone, ceramic, chipped stone, fire cracked rock, and charcoal. The distributions of the different size classes for each material type were also examined as was the distribution of chipped stone tools. The frequency and isopleth maps indicate that there are several specific areas within the site with major concentrations of material. It is also apparent that there are some differences between these concentrations in terms of the frequency of the different material types and size classes

present. The following is a discussion of these distributional differences and their general implications for the use of space and range of activities conducted by the occupants of the King site.

Distribution of All Material

The first map shows the distribution of all the bone, ceramic, and chipped stone materials combined (Figure 25). There are two general areas with the highest concentrations of material; one 2-3 meter long area at the south end of the excavation block and one 4 m x 2 m area at the northern end of the block. There is a more diffuse scatter of material between these concentrations and the distribution of material drops off sharply on the eastern and western edges of the block. The northern concentration coincides with the large pit feature and the slightly lower concentration within Unit 225N 100E is likely related to the partial excavation of that unit. Since the vertical distributions suggest that there is only one occupation surface at the site, these concentrations can be interpreted as representing discrete areas of activity and/or discard.

Distribution of Bone

The distribution of bone material at the site is similar to that of the distribution of all material types combined (Figure 26). This is due, in part, to that fact that bone comprises the largest proportion of the assemblage when compared to other material types. However, there are some slight differences in the distribution of bone as compared to that of all the material combined. First, though the areas with the highest concentration of bone are basically in the same areas as the overall material concentrations, the highest density concentrations of bone are spatially more restricted than those for all the material types combined. Also, there is a lower occurrence of bone

remains within Unit 222N 96E where a slightly higher concentration was present in the distribution for the combined material types.

The distribution of bone is more interesting when one looks at the results based on size class (Figure 27). The bone in size class 1, the smallest material, has roughly the same distribution as that for the collective bone remains. However, the largest materials in size class 3 are entirely restricted to the northern portion of the excavation area. The concentration of large bone is particularly abundant in Unit 225N 101E, which is the approximate center of the large pit feature. While the bone material is generally concentrated into two main areas, the more scattered distribution of the small fragments is likely due to discard processes, site maintenance, and post-depositional processes like plowing. Small fragments are more likely to remain in-situ as primary refuse due to their unobtrusive size. These fragments can then be easily scattered across the living surface by humans, animals, and the elements. Large bone fragments are more likely to be restricted to specific processing areas and/or gathered and deposited as secondary refuse.

The concentration of small bone in Unit 219N 99E may represent a processing area, particularly bone grease processing, which involves the smashing of bones into small pieces prior to boiling (Vehik 1977). The concentration of large bone within the pit feature may represent the use of the pit as an area for a different stage of animal processing, for example butchering, and/or the use of the pit as a refuse dump. Some of the bone fragments were identified as burned during the cataloging process but I am unsure how consistently this observation was applied. It is useful to note, but with caution at this point, that some of the bone fragmentation may have been for the

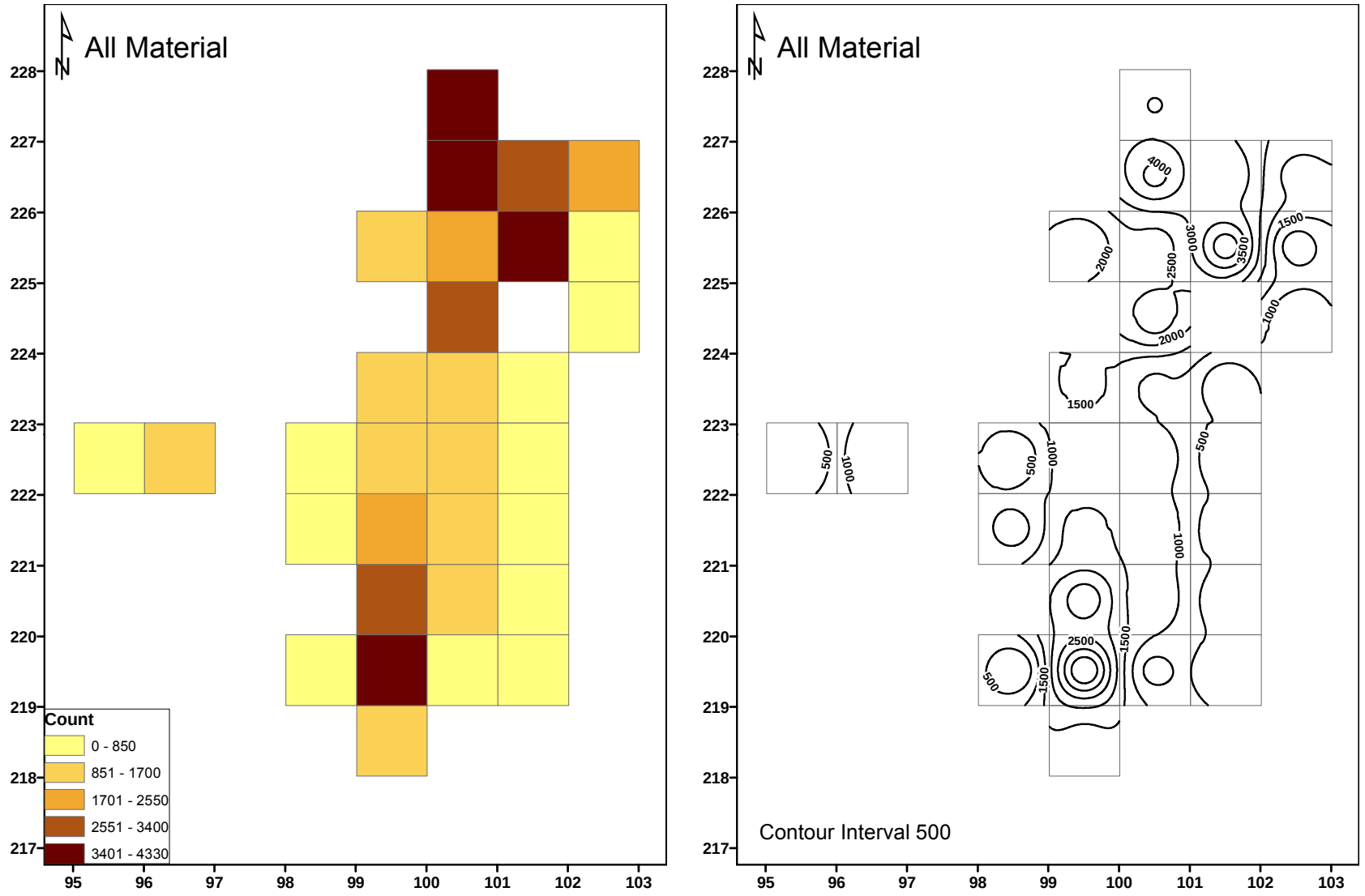

Figure 25: Distribution of all material within the main excavation block.

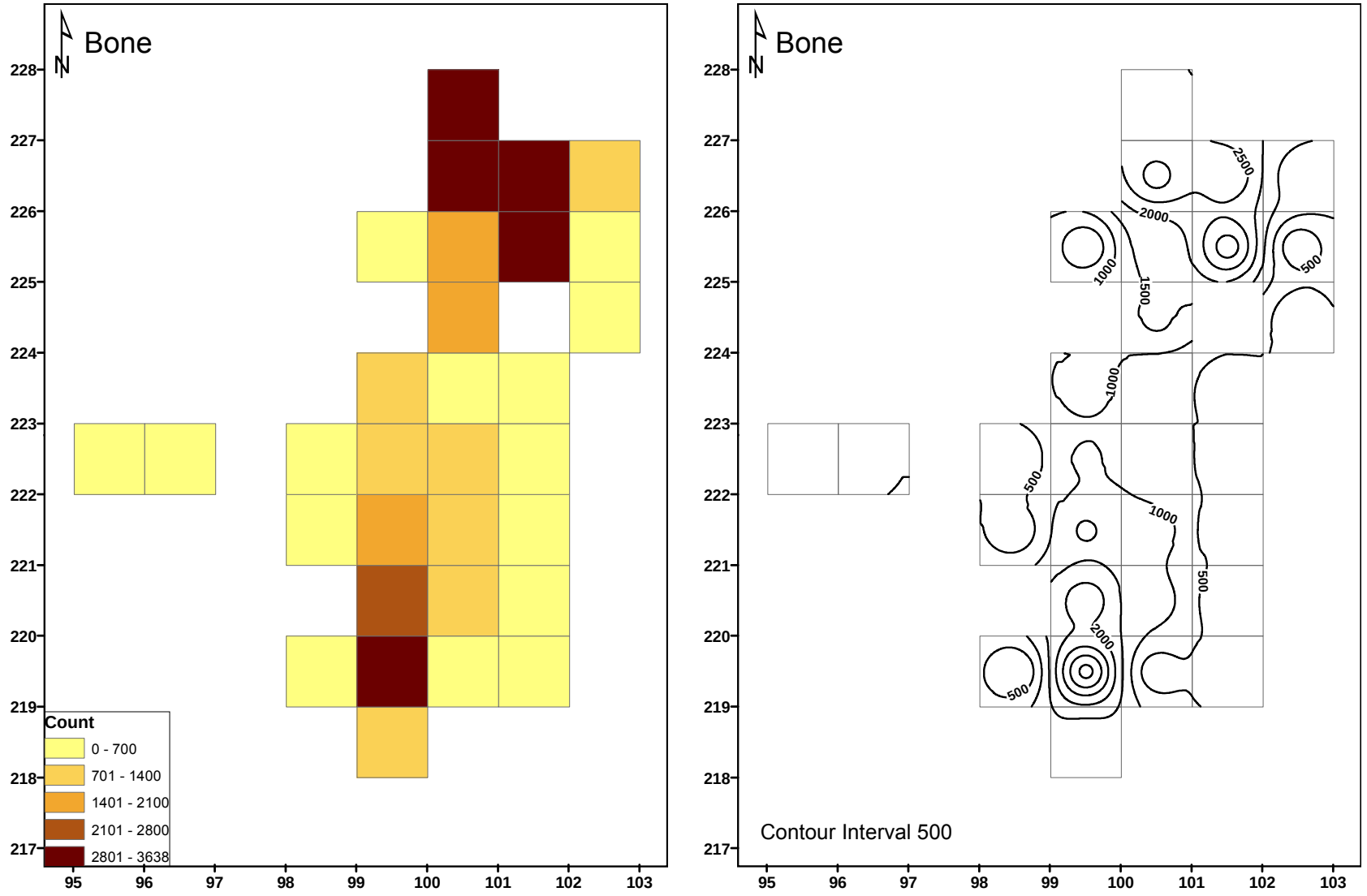

Figure 26. Distribution of bone material within the main excavation block.

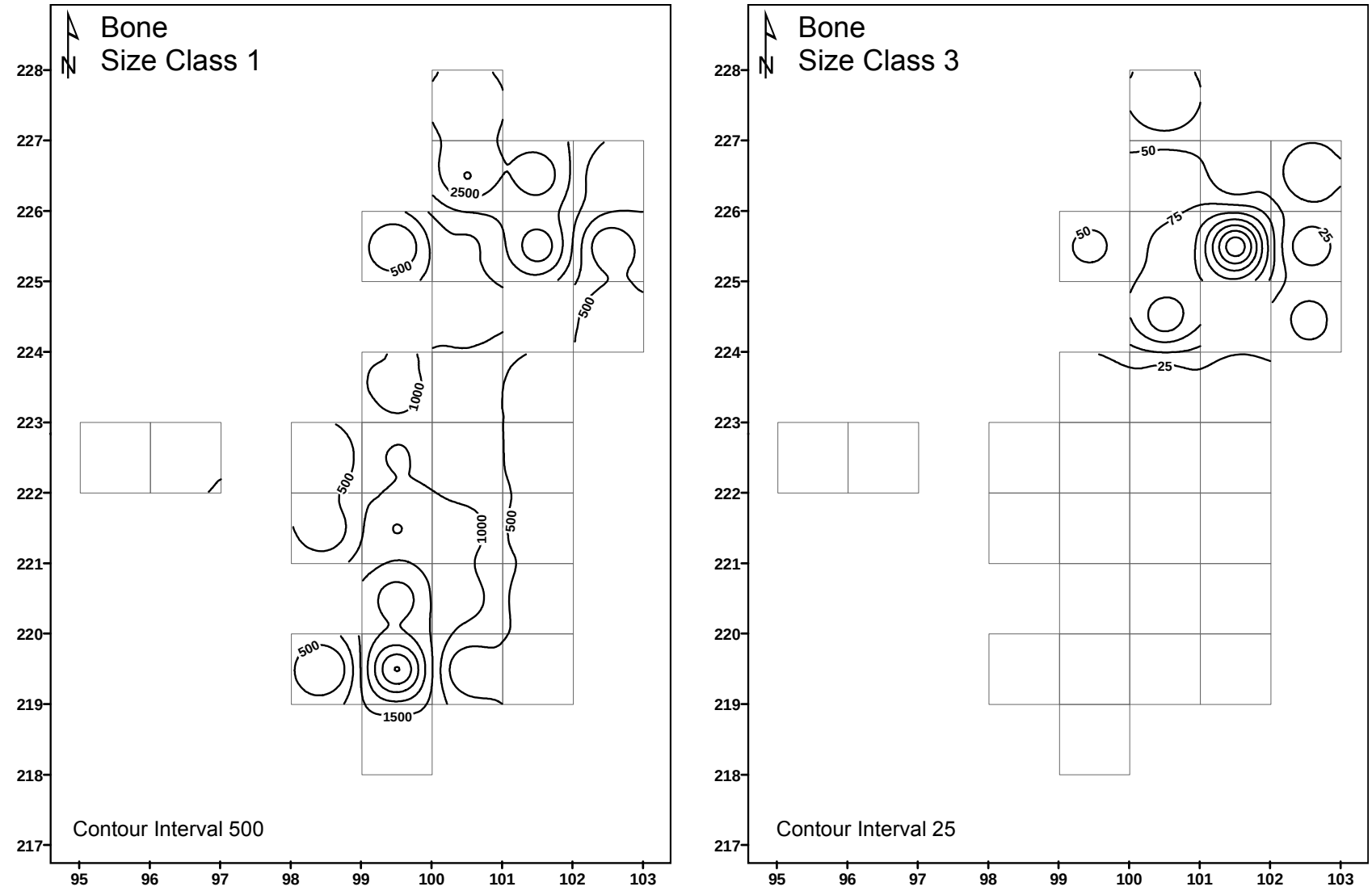

Figure 27. Distribution of bone by size class.

purpose of using bone as a source of fuel during ceramic firing in the pit kiln. This would account for the presence of burned bone in and around the large pit feature but processes, such as discard around other firing features or perhaps use as fuel for cooking purposes, may account for its presence in other areas of the site.

Distribution of Ceramics

As shown in Figure 28, there are two primary areas where concentrations of ceramic materials are found at the King site. One concentration is at the northern end of the site, in the same general location where bone materials are also concentrated, and the other concentration is within Unit 222N 96E. Overall, the distribution of the ceramics is significantly more clustered than that of the bone material, indicating that ceramic materials are more restricted to specific areas of use and/or specific areas of discard than the bone remains are.

When looking at the distribution of the ceramics by size class (Figure 29) it becomes clear that large fragments (size classes 2 and 3) are located in the same area as the large fragments of bone. There is a somewhat indistinct trash-filled pit feature located in Unit 222N 96E and discard as secondary refuse is a reasonable explanation for the concentration of ceramics in this area (Bamforth field notes 2009). Similarly, the concentration of large ceramics within the pit kiln feature (Units 224-226N and 99-101E) suggests that one of the secondary functions of this pit was refuse disposal. The presence of large and small materials mixed within the areas of the these two pits and the distributional pattern in which large materials are restricted to the pit features is indicative of site maintenance processes by the clearing of large obtrusive items from

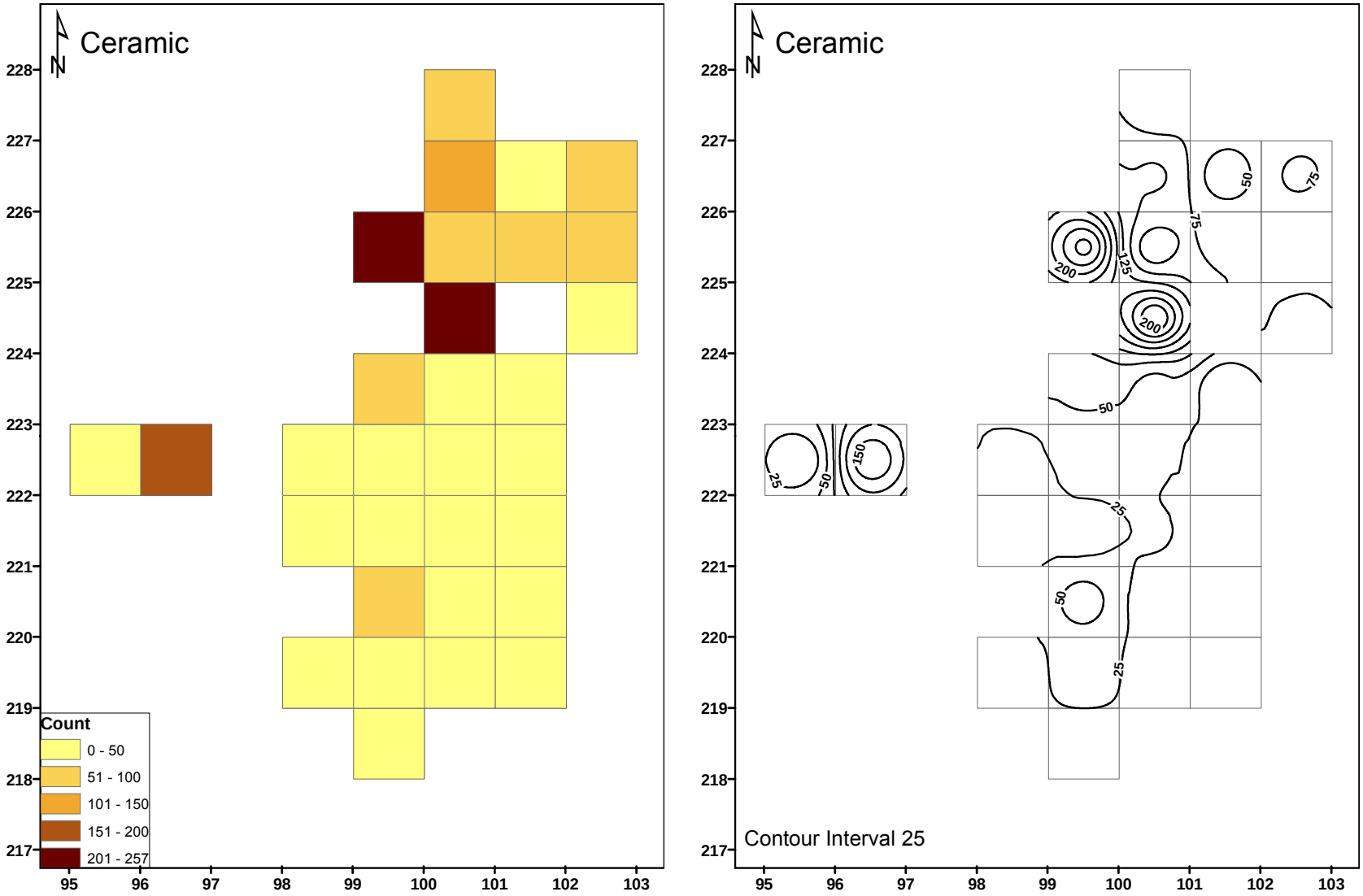

Figure 28. Distribution of ceramic material within the main excavation block.

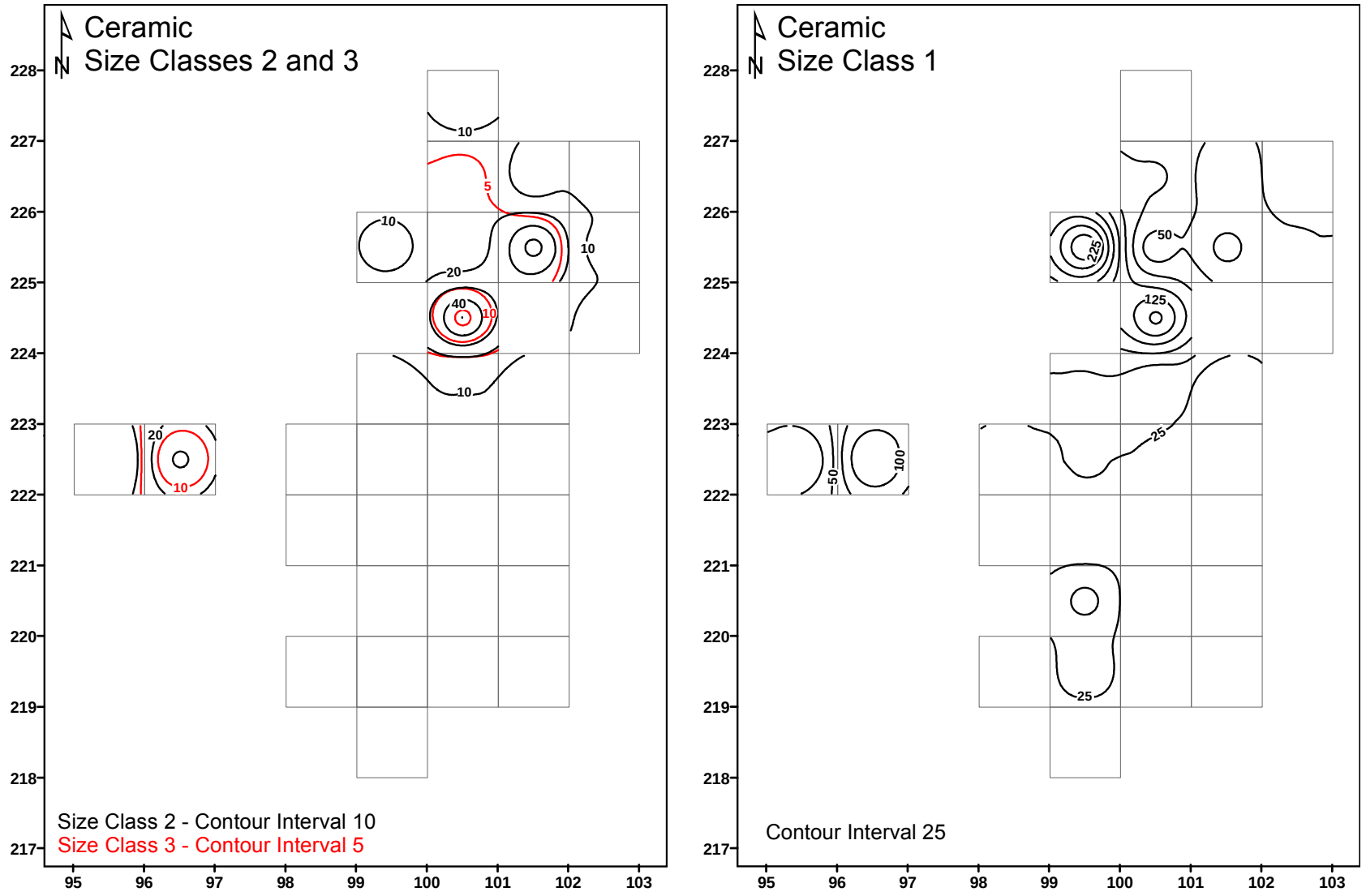

Figure 29. Distribution of ceramic materials by size class.

living and other activity spaces and deposition into designated refuse areas. Another possible explanation for this pattern, which can be applied specifically to the kiln feature (Units 224-226N and 99-101E), is that large ceramic sherds are often the result of pots that have failed during firing and such sherds would be left within the pit after useable pots were recovered.

There is also a concentration of small size class 1 ceramic fragments in Unit 220N 99E. Small fragments of bone and charcoal were also abundant in this area and can be interpreted as indicative of an activity area that was focused on bone processing and boiling activities. A hearth feature was not clearly identified in this location but the presence of small ceramic fragments, small bone fragments, as well as dense amounts of charcoal and lower amounts of small-sized chipped stone debris, provide evidence for the interpretation of this area as a hearth location. Though this is where cooking and/or bone processing activities likely took place, it was kept relatively free of large debris.

Distribution of Chipped Stone

There are two distinct areas of concentration in the distribution of chipped stone materials. Though the overall distribution is more diffuse than that for the ceramic materials, the areas of highest concentration are the same for both material types. As shown in Figure 30, the densest concentration of chipped stone is in the northern end of the excavation block around the large pit feature and the other concentration is slightly west of the excavation block in Unit 222N 96E. These distributions follow the interpretation proposed here, whereby pit features would have the most chipped stone as a result of site cleaning and refuse disposal activities. The distribution of debitage

based on size classes further supports this interpretation since there are high densities of materials of all size classes concentrated within the pit features, as would be expected from refuse disposal patterns. There are also relatively low amounts of chipped stone debris found around the potential hearth feature in Unit 220N 99E (Figure 31). The complete absence of large hazardous chipped stone debris across the rest of the site, including an area of frequent multi-purpose use such as a hearth, is an expected result of site maintenance activities, whereby large waste materials of all kinds are disposed of in a common refuse area, such as the pit kiln feature or somewhere away from the living areas (over the edge of the terrace, for instance).

The low frequency of formal chipped stone tools recovered from the King site indicates that formal tools were either extensively curated and transported away from the site after occupation or they were infrequently used in favor of more expedient flake tools. As formal analyses of use wear and flake modification have yet to be undertaken, it is not possible to determine which of these two scenarios is applicable to this site. However, it has been demonstrated at other known High Plains hunting camps and bone processing sites that expedient tools do comprise a large proportion of the tool kit utilized for game butchering and processing (Scheiber and Reher 2007).

There are two main areas of the site where chipped stone tools are found; one being around the area near the southern end of the excavation block, between Units 220-222N 99E, and the other within the kiln feature (Figure 32). The chipped stone tools found in the more southerly locations coincide with one of the major concentrations of bone fragments, which is consistent with the interpretation of that location as a

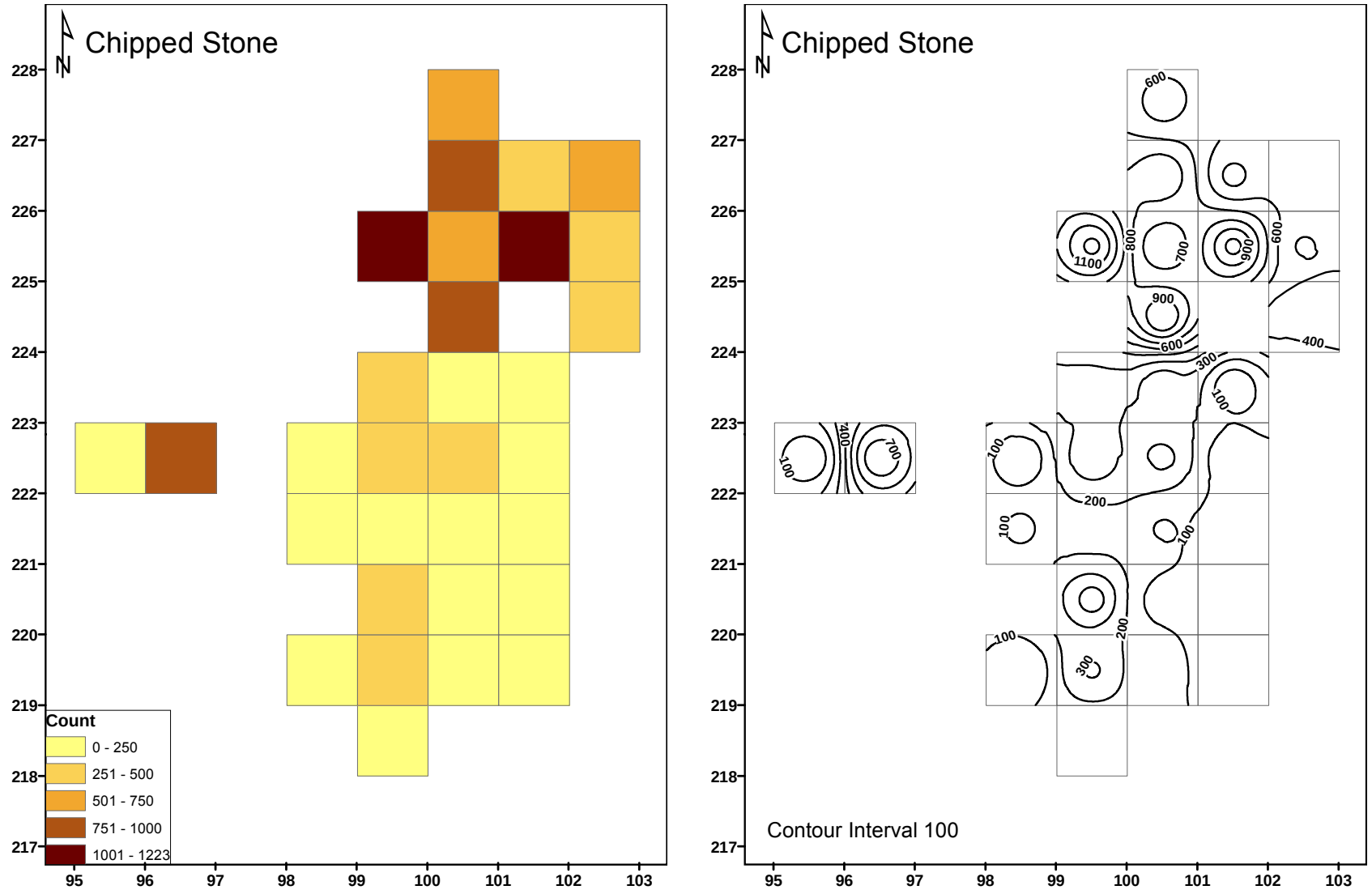

Figure 30. Distribution of chipped stone within the main excavation block.

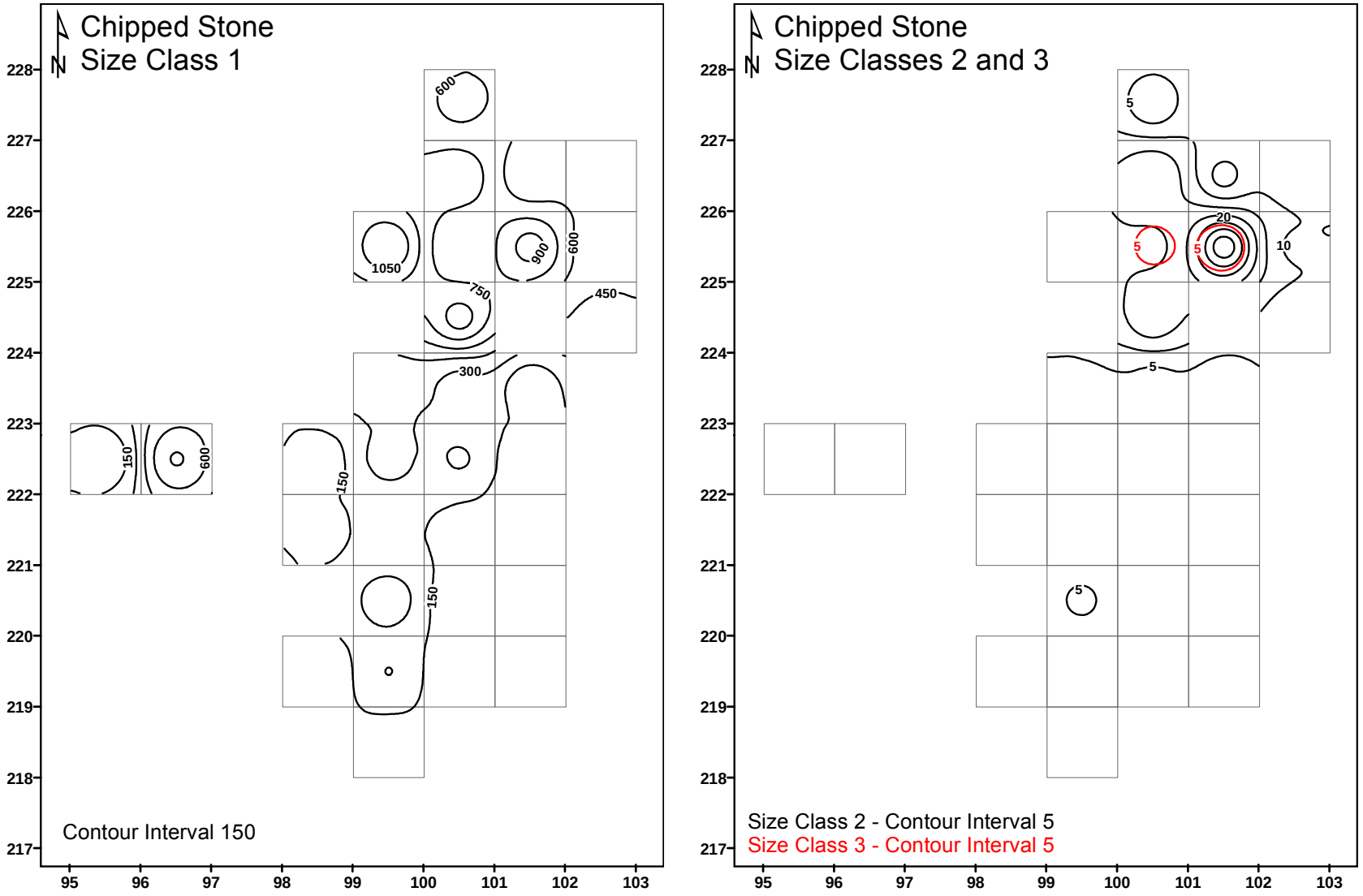

Figure 31. Distribution of chipped stone material by size class.

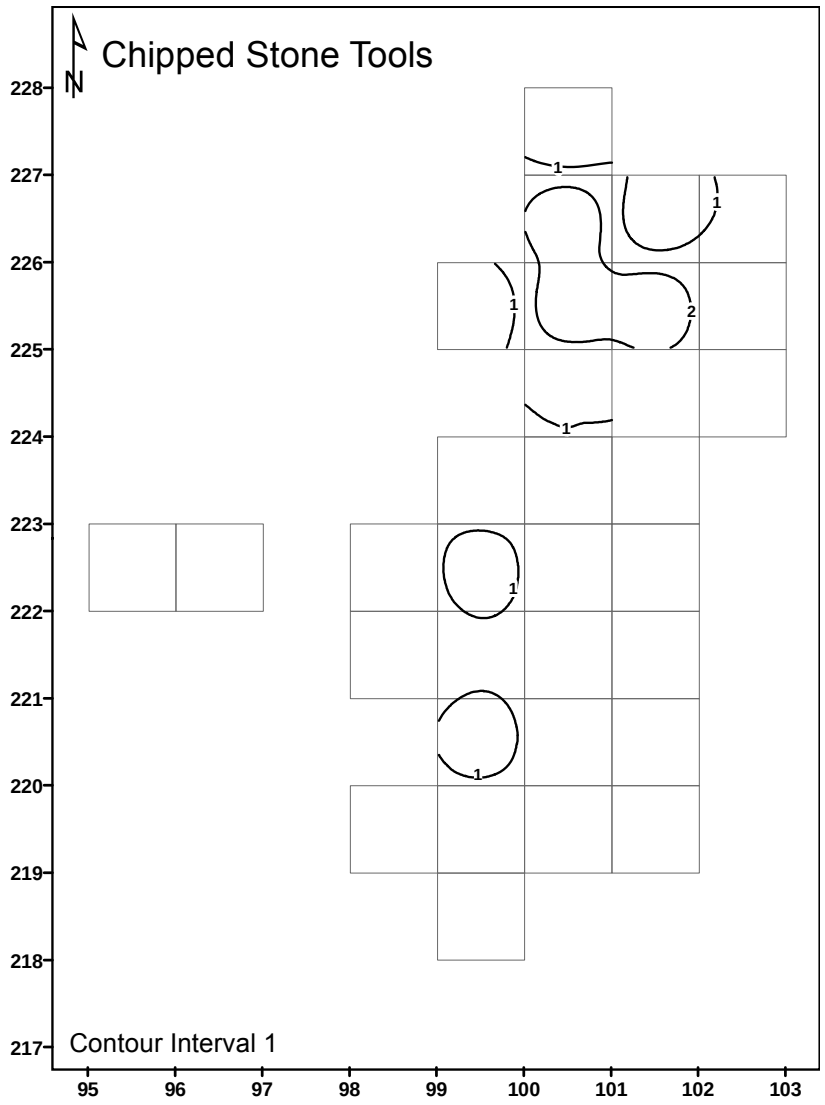

Figure 32. Distribution of formal chipped stone tools within the main excavation block.

game/bone processing area, as one might expect some lost or discarded tools in an area where they were frequently used. Most of the chipped stone tools from the site are located within or in the immediate vicinity of the kiln/refuse pit feature. This too is an expected pattern, whereby expended or broken tools would regularly be discarded in an out of the way refuse area. The presence of small-sized debitage but low incidence chipped stone tools near the hypothesized hearth area is also expected. People may

have fashioned or performed maintenance on tools in this area but larger items, including discarded formal tools, may have been occasionally discarded in areas of use but are more likely to have been transported away from the hearth area during cleaning episodes.

Distribution of Fire Cracked Rock

Almost all of the fire cracked rock was located in and around the kiln/refuse pit (Figure 33). There are two interpretations that may explain this pattern. One possibility is that the fire cracked rock was discarded into the refuse pit as hearths around the site were cleaned out. The second interpretation is that the refuse pit had some additional purpose in which it functioned as a thermal feature, specifically as a pit kiln for firing pots. In the second hypothesis, rocks may have been placed within the base of the pit for a number of reasons. Rocks retain heat and could have functioned as a means to regulate the cooling of the pots by slowing the reduction in temperature after the initial fire was extinguished. Rocks are also used as insulators and props inside a pit kiln to elevate and/or separate pots to increase airflow and even firing.

Most of the fire cracked rock located within the pit feature is between 40 and 70 cmbd, which coincides with the ash lenses within the unit profiles in that area. Both considerable amounts of ash and large rocks would be expected in a pit that was used as a kiln. Therefore, it is here proposed that this pit feature may have been multi-purpose, functioning initially as a kiln and then later as a refuse area.

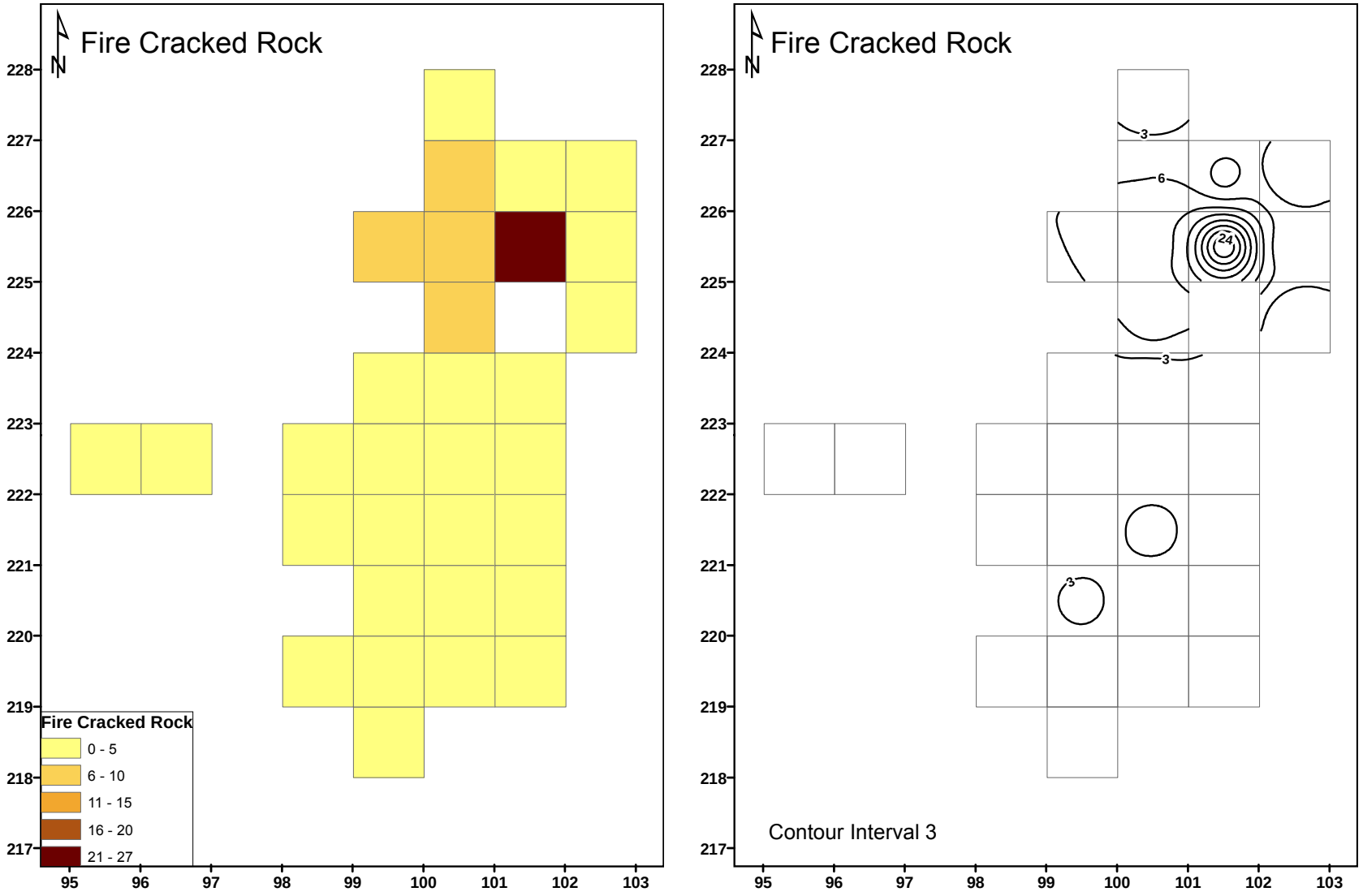

Figure 33. Distribution of fire cracked rock within the main excavation block.

Distribution of Charcoal

In order to examine the intensity of burning activities in different parts of the site, it is necessary to examine the relative distribution of charcoal across the site. Evidence of burning is not directly indicative of any specific activity other than fire-making but evidence for it is expected in hearth areas where cooking and social activities may have been focused as well as in areas where pottery firing took place. Thus, the presence of charcoal and ash are important supporting evidence for the interpretation of these activities.

During the duration of the laboratory processing over multiple years, the methodology used for cataloging charcoal changed. For the first several years, each fragment of charcoal was counted individually and totaled by provenience. Later on, due to the time consuming nature of counting, the process was changed to record the bulk weight of charcoal by provenience. This inconsistency in the recording process makes comparing the relative distributions of charcoal across the site difficult to assess because using either count or weight biases the sample toward different areas of the site based on when they were excavated.

In order to correct for this problem and provide some expedient means of utilizing the data for charcoal distribution measures, I decided to quantify it by collection frequency. So each time charcoal was recorded in the catalog for a specific provenience it was given an incident value of 1 and the resulting distribution map is a display of the frequency of recorded charcoal remains by excavation unit. Figure 34 demonstrates the difference in charcoal distribution that occurs when using the raw counts versus the point frequency quantification. Both maps display high frequencies in roughly the same

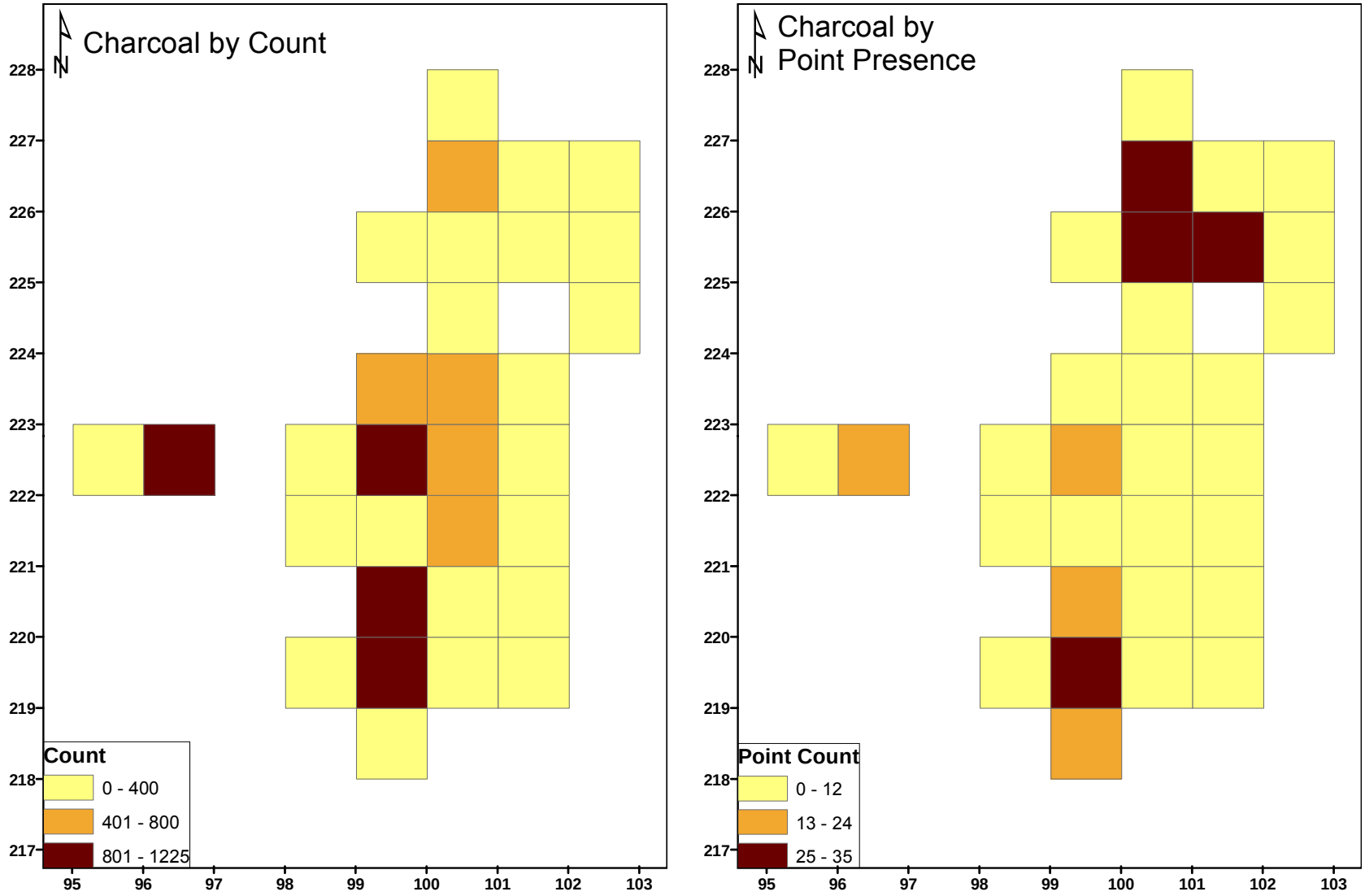

Figure 34. Distribution of charcoal within the main excavation block; the map on the left shown the distribution by raw count and the map on the right shows the distribution by collection point frequency within unit.

areas but the map displaying the raw count data shows concentrations that area heavily weighted the toward areas of the excavation block excavated in earlier years. In order to avoid this bias, the map using point frequencies will be used here to interpret the relative distribution of charcoal across the site.

As can be seen in the point frequency map in Figure 34, there are three areas with the highest collection frequency for charcoal. The area in the northern part of the excavation block coincides with the kiln/pit feature and the ash lenses observed in the profiles in this area. This alone cannot be taken as proof that the pit was used to fire ceramics, but does support the interpretation that activities involving intensive episodes of burning did take place in the feature, most likely prior to its use as a refuse pit.

The second area with a high collection frequency is the area near the south end of the block (Unit 219N 99E) that has been interpreted as a bone processing area and associated hearth. The presence of large amounts of charcoal and concentrations of small bone fragments in this location may indicate bone grease processing activities. During this process, certain high yield bone elements would be crushed and broken into small fragments and boiled over a fire in order to extract the grease. This area may have been distinct from other hearth areas where daily cooking and social activities took place and may not have been cleaned as frequently leading to an accumulation of bone processing debris in the area. The third area that shows a moderately high collection frequency of charcoal is within Unit 222N 96E, which is the area of the smaller trash-filled pit.

Interpretation of Spatial Autocorrelation

Due to the small scale of ceramic manufacturing within hunter-gatherer-horticultural societies, it is often a difficult activity to see archaeologically. Some of the evidence, such as burning, pit features and fire-altered rock, can also be interpreted as evidence for a multitude of other activities and their archaeological patterns can be the result of a number of other site formation processes. However, if the presence of all these lines of evidence, including fire altered rock, intensive burning, and evidence of poorly fired or failed ceramics converge within a feature that could represent a kiln functionally and structurally, the interpretation that ceramic firing may have taken place at the site will be much stronger than if those indicators are randomly scattered throughout space. One way to test the randomness of the distribution of those materials potentially related to or resulting from ceramic firing is through a cluster analysis. If the material correlates of ceramic firing cluster in space within the pit feature and are not present outside of the feature, it suggests that ceramic firing is much more likely to have taken place at the site and that the evidence is less likely to be the result of some other behavior or site formation process.

Results of Moran's Index Coefficient of Spatial Autocorrelation

In order to examine whether or not the most direct evidence of ceramic manufacturing at the King site is clustered or randomly distributed in space, the Global Moran's I statistic was applied to each type of ceramic firing failure recorded, all the failure types combined, and the presence of residue on the pots (predominantly on the exterior, as discussed above). The Global Moran's I is a common statistic used to determine spatial autocorrelation of a single variable. The variables used in this analysis

are the failure attributes recorded for the ceramic sample, which include exfoliation, spalling, and residue as an additional marker of potentially failed pots or sherds used as kiln props. The expectation is that ceramics with evidence of firing failure will be clustered in space. The Global Moran's I is only a measure of clustering or randomness in the distribution of a variable, it does not provide information concerning the spatial location of the clustering. In order to examine the spatial distribution of clustering, another statistic called a Local Indicator of Spatial Association (LISA) will be used.

As shown in Table 4, the results of the Moran's I analysis indicate that ceramics displaying both exfoliation and spall scars display a statistically significant clustered distributional pattern. The Moran's Index (MI) ranges from 1, indicating clustering to -1, indicating dispersal. The analysis generates an expected index value for random spatial

Table 4. Results of Global Moran's I Analysis.

Variable	Expected	Observed	z-score	p-value	Result
Spall Scar	-0.003003	0.049107	6.079505	0.000000	Clustered
Exfoliation	-0.003003	0.095512	11.071230	0.000000	Clustered
Combined	-0.003003	0.085267	9.907393	0.000000	Clustered
Residue	-0.003003	0.111660	12.852463	0.000000	Clustered

distribution that is then compared to the observed index value to generate the measures of statistical significance (p-value and z-score) of the difference between the two indices. The greater the difference between the expected and observed index values, the greater the z-score. The z-score represents the number of standard deviations the analyzed observations are from the mean of a normal distribution. Results showing a positive z-score higher than 1.65 indicate significant spatial clustering within the data. The high z-scores obtained for the two most common variables and the three variables combined indicate that there is a less than one percent likelihood the clustered pattern

could be the result of random chance. In other words, ceramics with failure attributes are clustered in space to a statistical confidence level of $p<0.01$.

In addition to looking at clustering for failure attributes, I also wanted to determine if ceramics bearing residue displayed spatial clustering. The location of the residue on a particular sherd may be an indicator of the source of the residue. It is reasonable to assume that cooking residues will accumulate on the interior surface of a pot. Pots with large amounts of interior residue may be clustered due to discard behavior, whereby they are disposed of in a specified refuse area after they are broken or deemed otherwise unusable and/or they may be clustered in areas of usage if they are not cleaned up and redeposited after breakage. As the residue on the pots at the King site is overwhelmingly located on the exterior surface of the sherds, some other explanation may be required to accommodate this pattern. One possible explanation is that residue on the exterior surfaces results from contact with fuel sources during the firing process indicating a failed pot that was never removed from the kiln and cleaned or a sherd that was used as a kiln prop/insulator. The results of the Moran's I analysis of residue bearing ceramics, 85% of which displayed residue on the exterior, indicate that they are also clustered to a statistical confidence level of $p<0.01$ (Table 4).

Results of the Local Indicator of Spatial Association

In order to determine the location of clustering within the ceramic sample, I used the Local Indicator of Spatial Association (LISA). The cluster codes produced by the analysis are interpreted as follows: HH indicates clusters of the variable of interest, LL indicates clusters where the variable is not present, HL represents an outlier where the variable of interest is present as an isolated feature surrounded by artifacts lacking the

variable, and LH indicates an outlier where there is an artifact lacking the variable that is surrounded by other artifacts displaying the variable. Features for which there is no autocorrelation based on that variable, either as part of a cluster or as an outlier, are displayed as not significant. The expectation is that the ceramics displaying attributes of firing failures will be clustered in the location where firing took place. The LISA analysis will help to determine whether or not the hypothesis that ceramic firing took place within the large pit feature is supported by the spatial distribution of sherds with firing failure attributes and heavy exterior residues.

Figure 35 shows the location of clusters of ceramics and outliers with spalling scars on their surface. It is clear that there is only one spot where there is a significant cluster of spalled ceramics. This cluster is located within Unit 224N 100E, which is within the kiln feature. Almost all other HH points and HL outlier points are also located within or immediately around the kiln. The results for exfoliated ceramics look roughly the same as those for spalled ceramics. Figure 36 shows that there is a cluster of exfoliated ceramics in the same location as spalled ceramics within Unit 224N 100E. Again most of the HL outliers are also located within the area of the kiln feature. The several HL outliers that are located in other parts of the excavation block outside of the pit are within the depth disturbed by plowing and thus may have been moved laterally away from the feature. The results for all firing failures combined show the same basic results as those for the analyses of the individual attributes. Figure 37 shows that the significant clustering occurs in Unit 224N 100E and most other HL outliers are also located within and around the kiln feature.

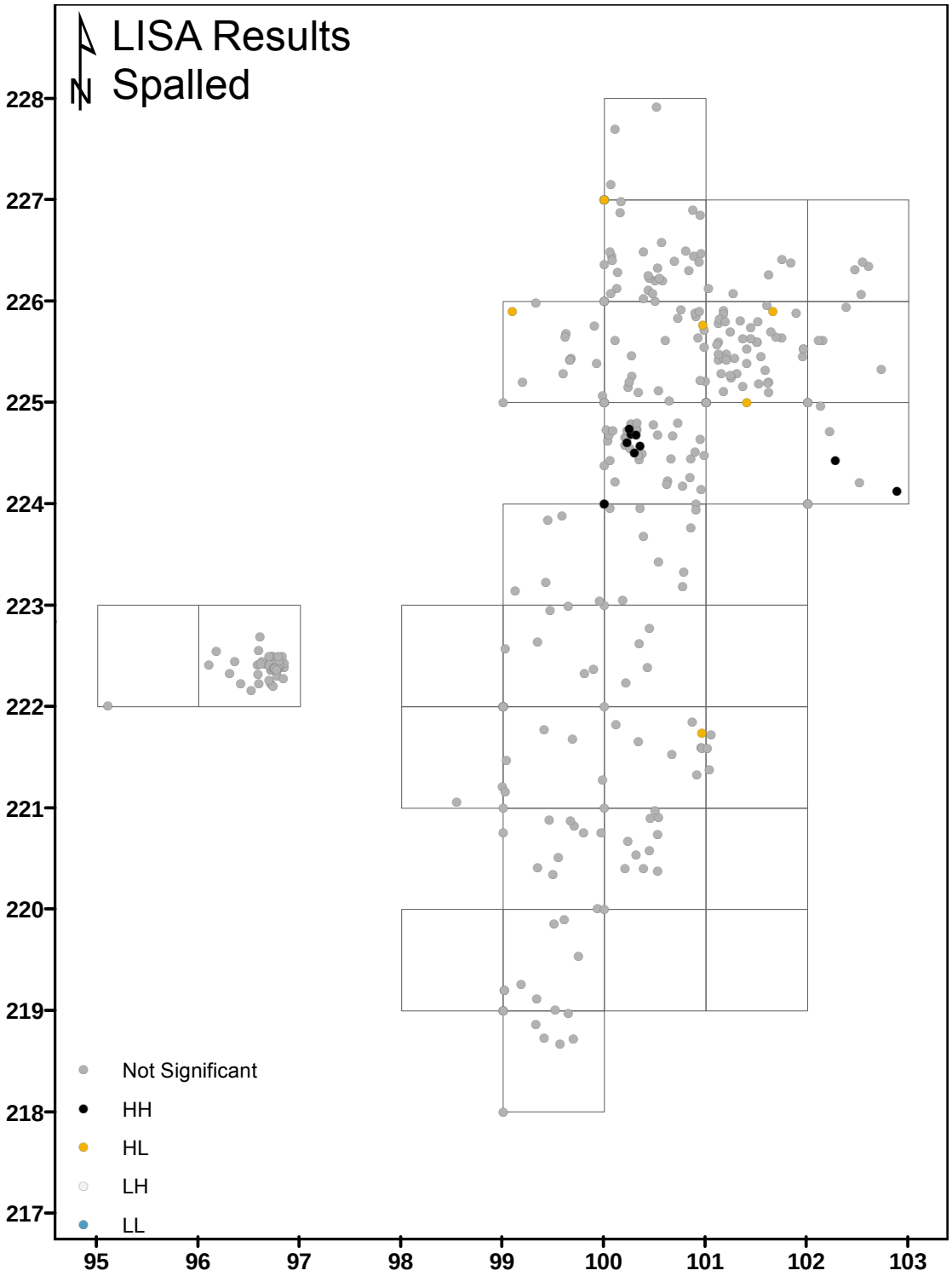

Figure 35. LISA results for spalled ceramics.

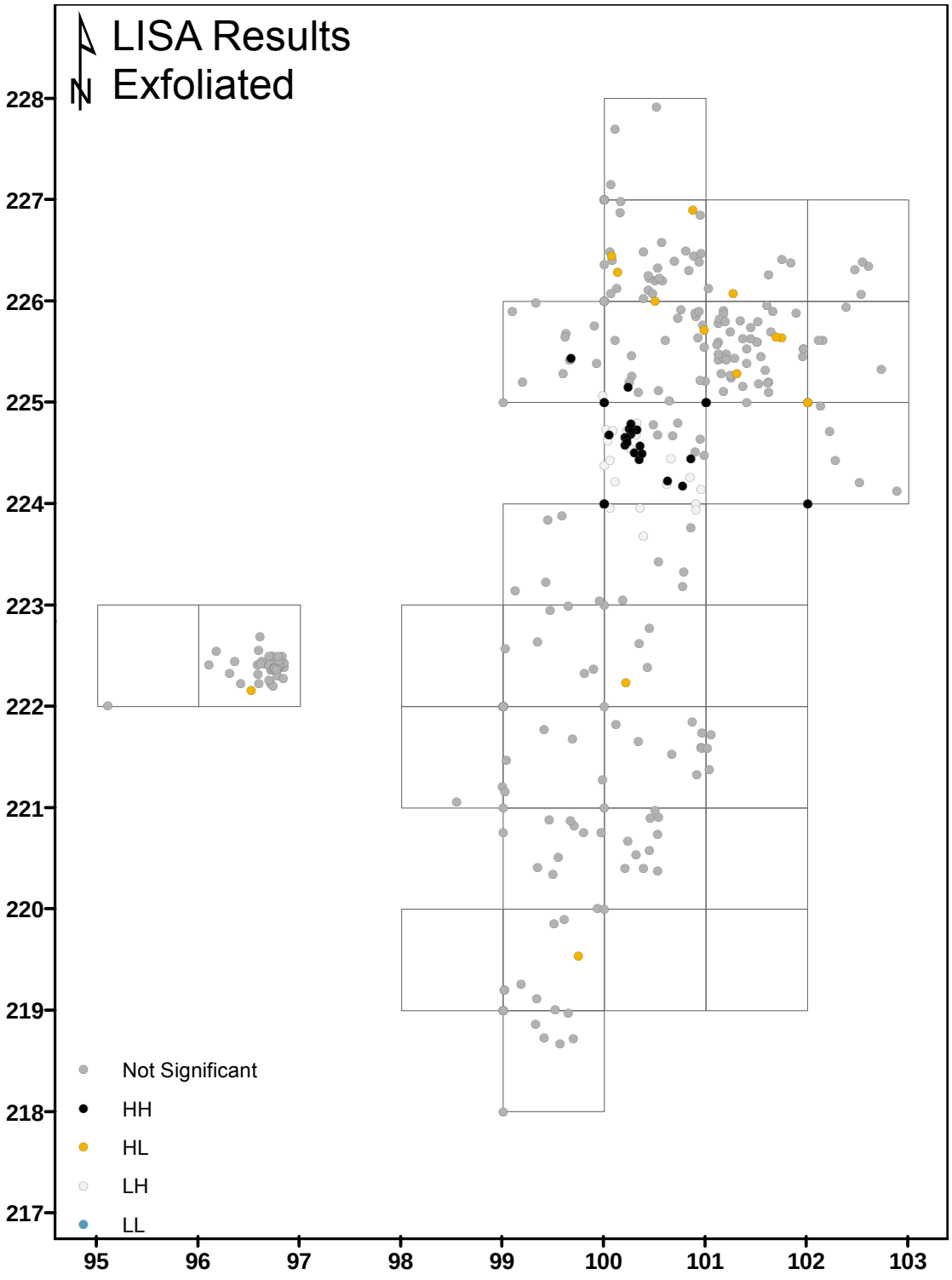

Figure 36. LISA results for exfoliated ceramics.

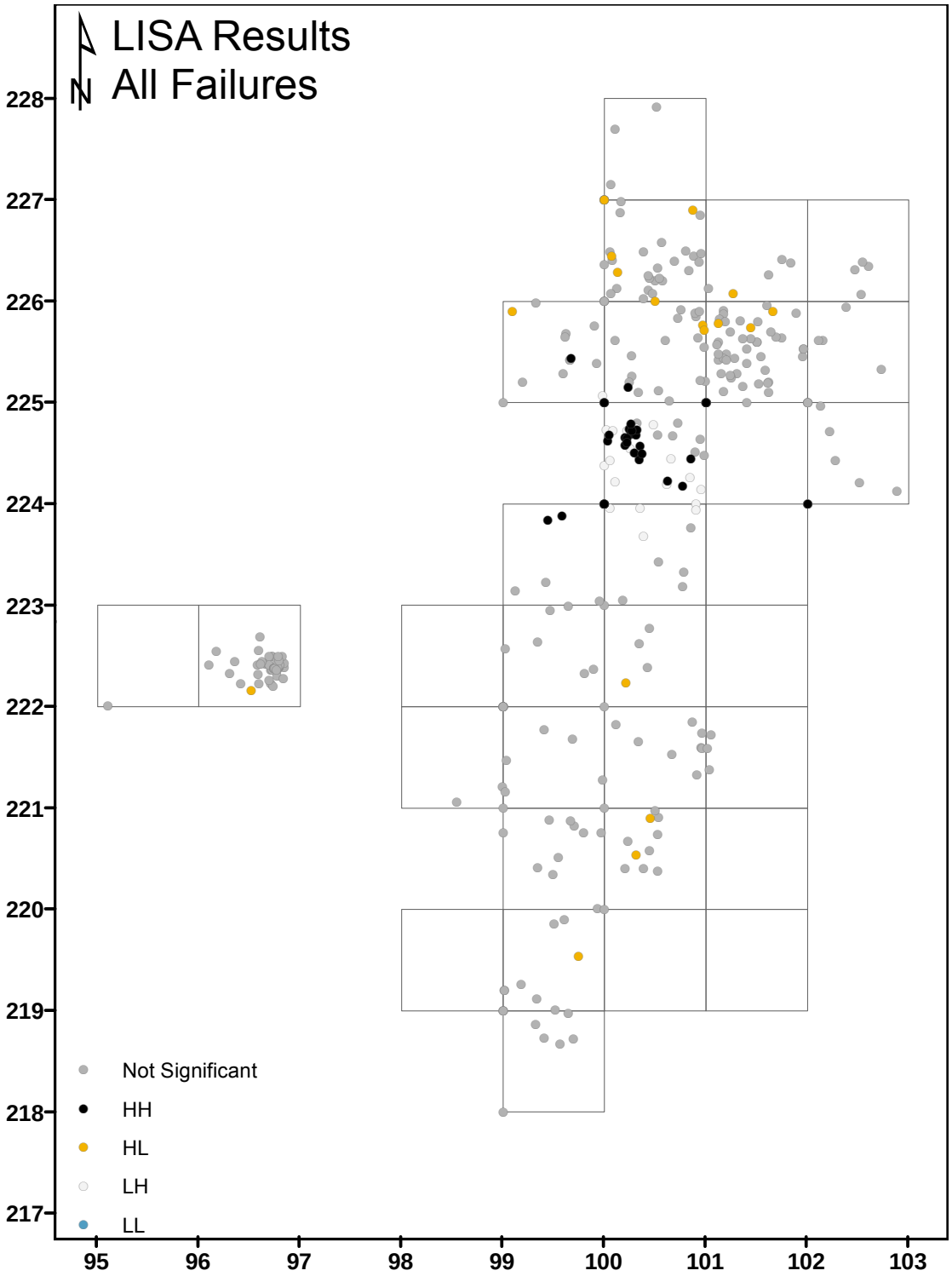

Figure 37. LISA results for all firing failure attributes combined.

The clustering detected for ceramics showing residue, potentially present on ceramic failures due to contact with fuel during ceramic firing, display some interesting results (Figure 38). There is significant clustering present within the area of the kiln feature. There are a few HL outliers located in other areas of the site that coincide with areas of high charcoal concentration. This pattern is expected in that some ceramics with residue are expected to be present in areas of use but the major concentration inthe large pit feature may be the result of a combination of failures, kiln props and some used discarded ceramics. Interestingly, there is only one HL outlier (residue-covered sherd) located in Unit 222N 96E, which is the location of another refuse-filled pit, despite the significant cluster of ceramics in this location. The general absence of residue-covered ceramics in the trash-filled pit at 222N 96E and the abundance of such sherds in the trash-filled pit at 224N 100E is suggestive that some process other than discard of used/broken pots is responsible for the distribution of residue bearing sherds. I suggest that the concentration of these items within the pit at 224N 100E is the result of accumulations of sherds from pots that failed during firing and/or were used as kiln props/insulators, both of which would have had direct contact with fuel sources during firing.

The LISA results conform to the expectation that the clustering of ceramics displaying failure attributes detected by the Global Moran's I analysis is, in fact, restricted in space to the pit feature at 224N 100E. If ceramics were being produced and fired at the King site, they were fired within this large pit feature. The clustering of ceramics that are covered in residue within this same feature is probably the result of

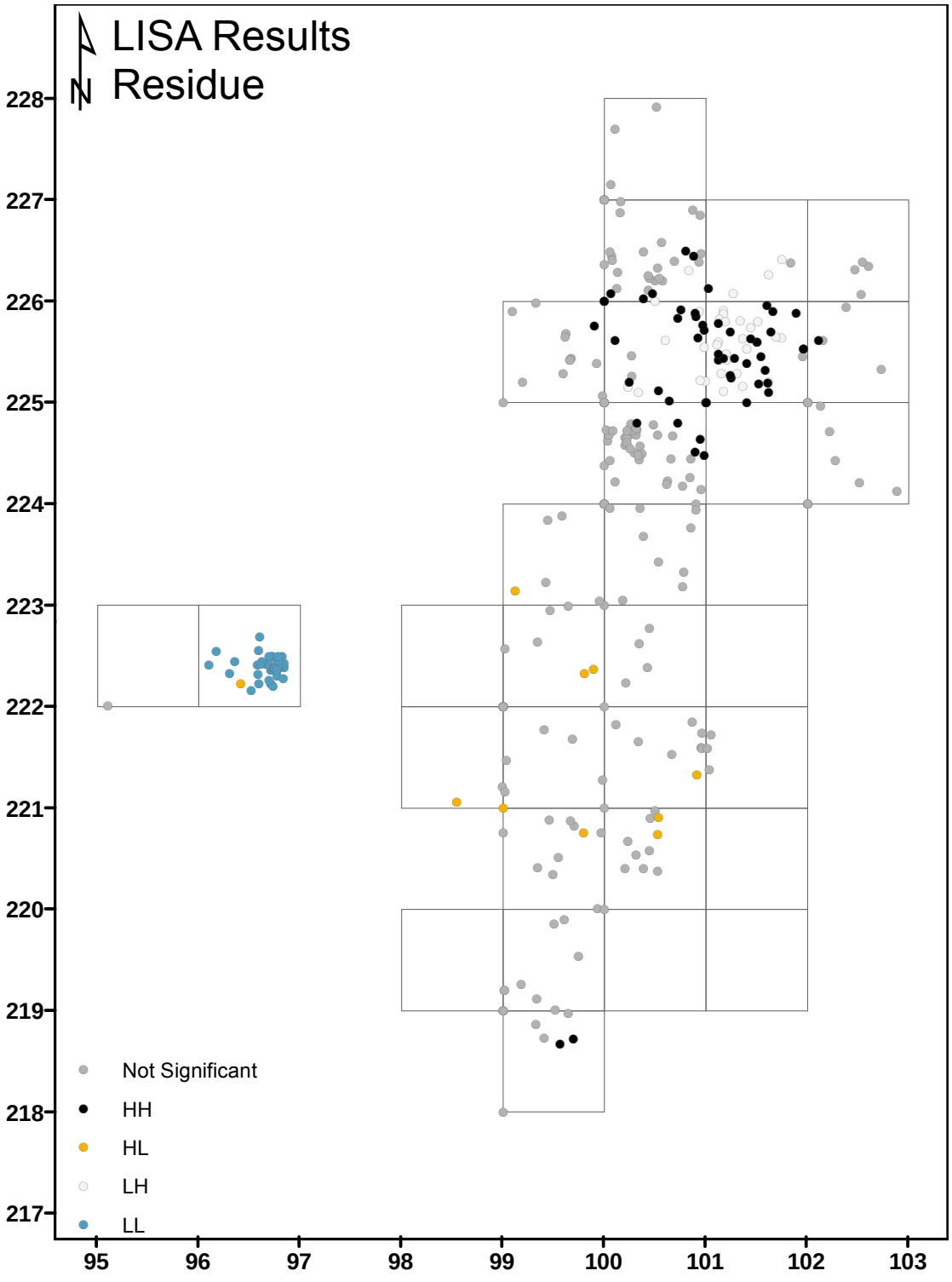

Figure 38. LISA results for ceramics with residue.

the pit having multiple functions both as a kiln and, later, for refuse disposal. The wider distribution of residue-bearing ceramics across the site than that for ceramics with failure attributes is also expected, as ceramics in use (some presumably with residue) will break and be incidentally deposited at their locations of use while ceramics that fail during firing and go unused will be restricted to the firing locale.

Interpretation of the Kernel Density Estimates

The Kernel Density Estimates are used here as a final visualization of the patterns that were demonstrated through the isopleth and frequency maps and the LISA analysis. Figure 39 shows the density analysis for the entire King site ceramic assemblage and the sample used in the analysis of firing failures. The areas with the densest concentrations of ceramics are the same as those shown by the frequency maps. These areas coincide with the trash-filled pit in Unit 222N 96E and with the pit kiln in Units 225N 99E and 224N 100E. The ceramic sample also shows a similar distribution to the total assemblage except that the highest density area is more restricted to Unit 224N 100E within the main excavation block.

The KDE results also show the pattern expected for ceramics displaying evidence of firing failures. Both exfoliated ceramics and ceramics with spall scars are concentrated within the kiln feature, specifically within Unit 224N 100E (Figure 40). The evidence for spalling and exfoliation on ceramics outside of this feature is minimal and may be related to the movement of materials due to post-depositional disturbance from plowing or may be the result of the actual use of some poorly fired but functional ceramics. It is nonetheless significant that the overwhelming majority of pots with evidence of under-firing and/or failure occur within the pit/kiln feature.

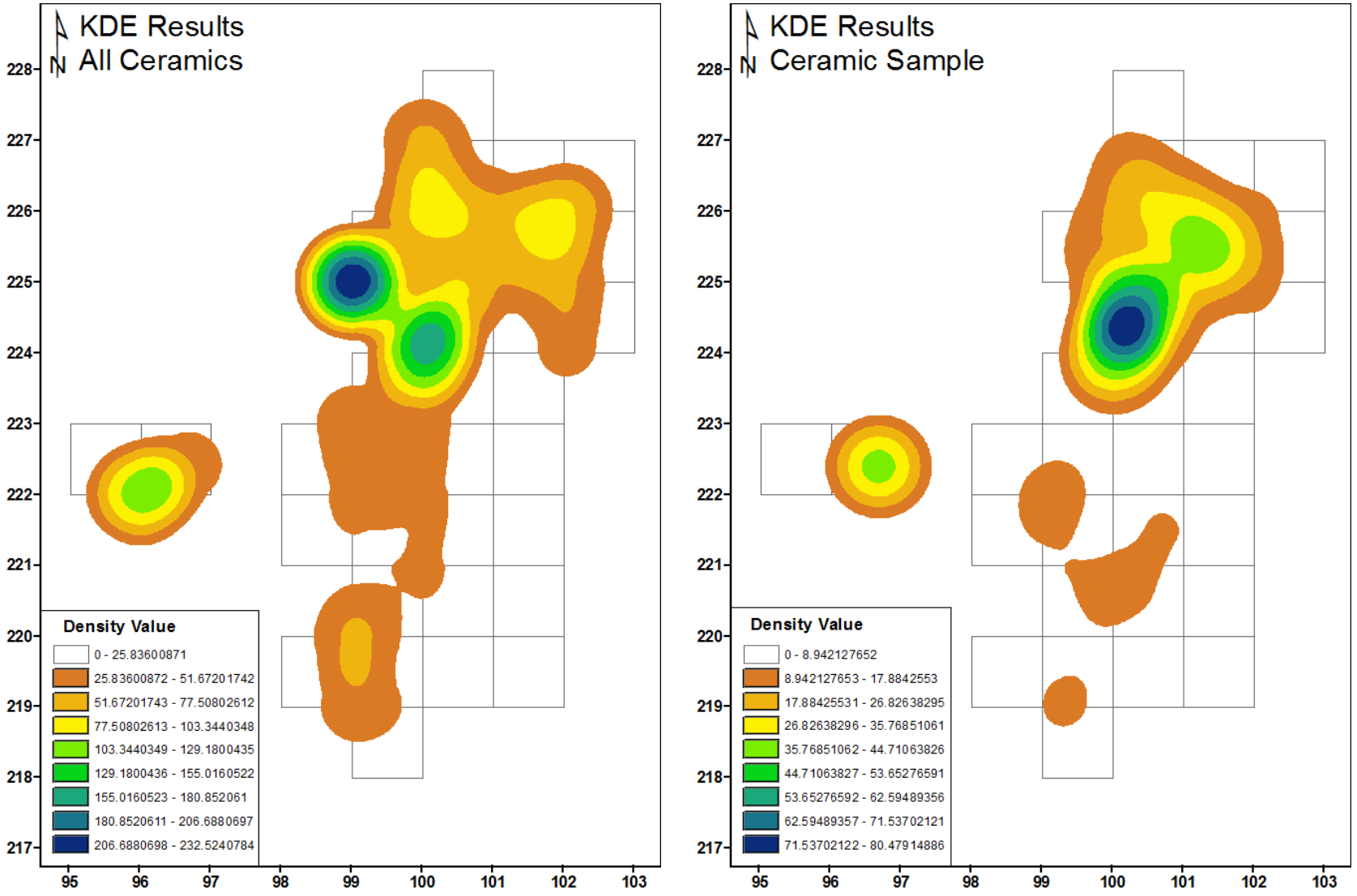

Figure 39. KDE results for all ceramics in the assemblage and for the ceramic sample used in the firing failure analysis.

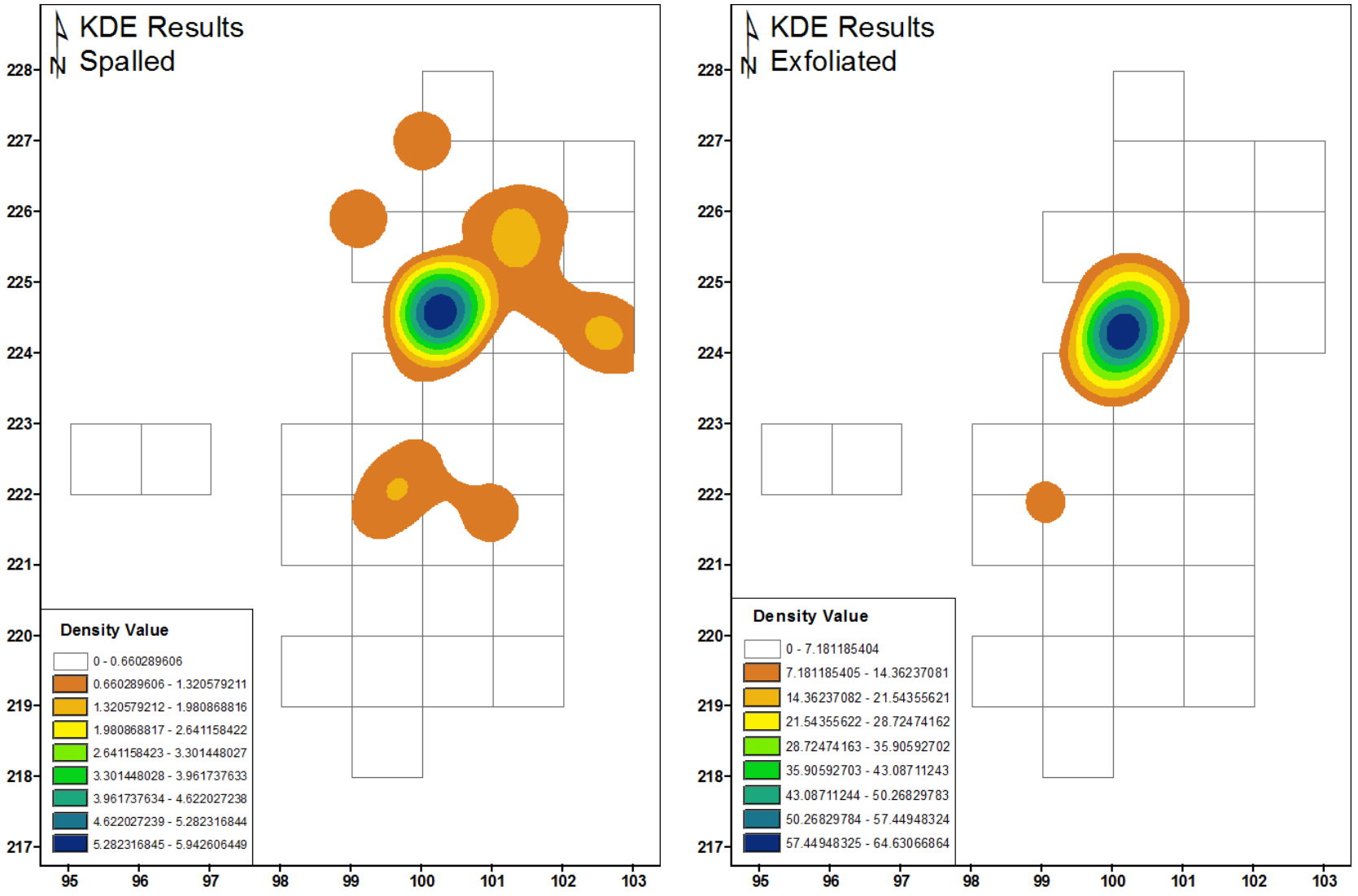

Figure 40. KDE results for ceramics with spall scars and exfoliation.

As shown in Figure 41, the density of fire cracked rock is highest within the kiln feature but there is also an area of lower concentration in the south-central area of the excavation block. As with the evidence for firing failures, these results are what are expected based on the functions determined for the two areas. The evidence for burning, related to ceramic firing, within the kiln would reasonably include rock as an insulator for heat retention within the pit. Similarly, fire cracked rock and other large stones would be expected in a bone grease processing area where extensive cooking/boiling activities took place.

The ceramics with surface residue show a similar pattern in that they are also concentrated within the kiln (Figure 41). A lower density scatter of ceramics with residue is present in the southern end of the excavation block, similar to the fire cracked rock, and is also most likely related to bone grease processing activities at that locale. The lack of ceramics bearing residue within the area of the trash pit at Unit 222N 96E may be explained by the reasoning that most residue-bearing ceramics recovered from the King site are the product of firing failures and/or use as kiln props and their distribution is not heavily patterned by discard and secondary refuse processes. The restriction of ceramics with residue mainly to the large pit feature at the north end of the excavation block is here viewed as another line of evidence that strengthens the interpretation of its use as a ceramic firing pit.

The Kernel Density Estimates support the expectation proposed in this thesis that if ceramic firing took place at the site, it most likely occurred within the pit feature in the northern end of the excavation block. The vast majority of the firing failures, and fire

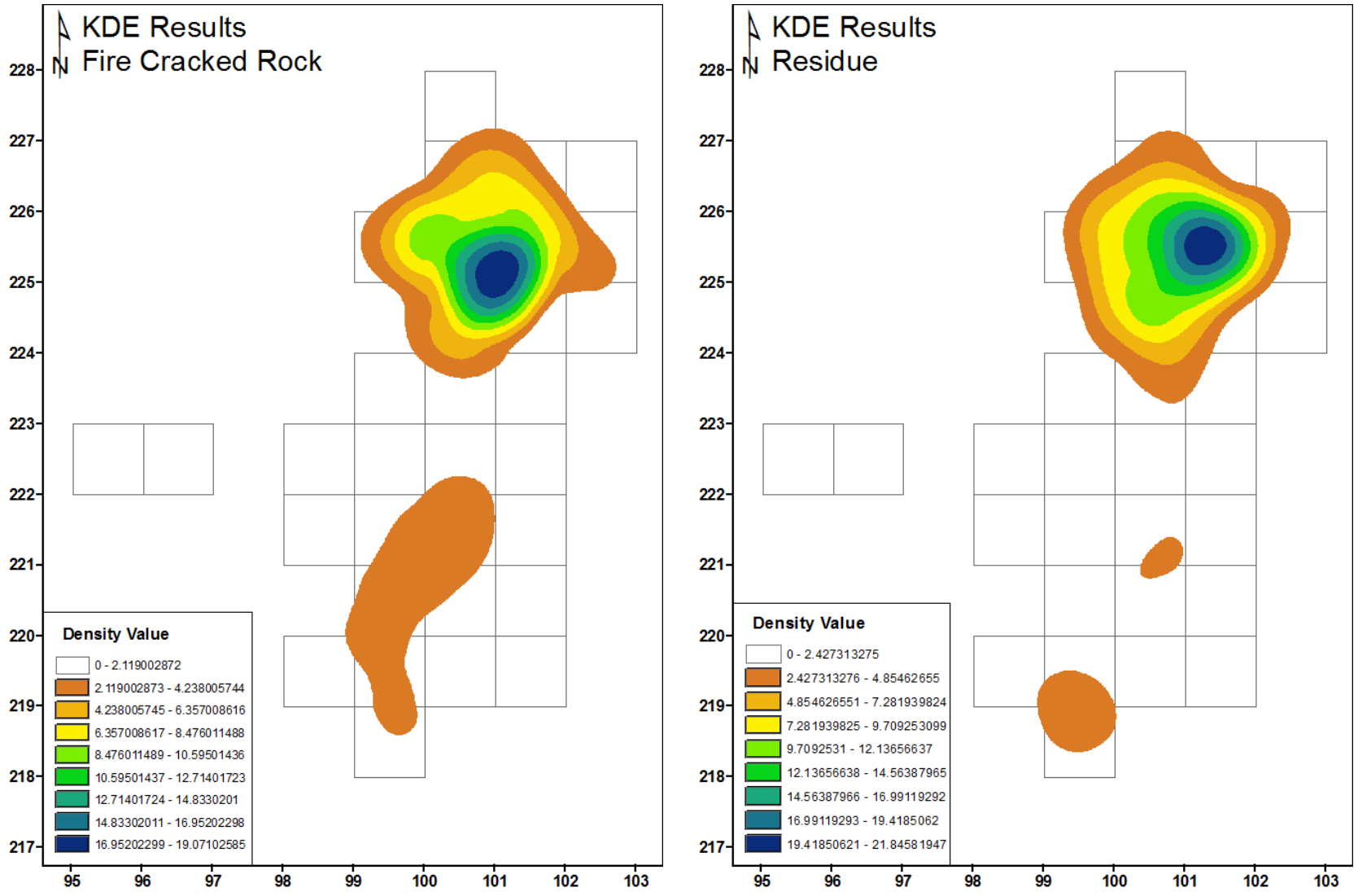

Figure 41. KDE results for fire cracked rock and for ceramics with residue.

cracked rock, as well as ceramics with heavy exterior surface residues and dense concentrations of charcoal indicating extensive burning, are all located within this feature. The concentrations of large bone remains and other ceramics within this feature also suggest that the pit was likely dual purpose, serving initially as a firing pit and then as a convenient area for refuse disposal.

Chapter 7: Discussion and Conclusion

The goals of the analyses conducted for this thesis were fourfold. First, the ceramics were examined for stylistic and formal attributes that could be used to identify the cultural affiliation of the site within current taxonomic schemes. Second, the vertical distribution of materials was examined in light of post-depositional disturbances in order to identify the number of occupations present at the site and the duration of occupation. Third, spatial analyses were used to identify the duration of occupation, potential activity areas, and the general range of activities conducted at the site to shed light on the possible site functions. Fourth, the analysis of the spatial distribution of the evidence for ceramic firing indicates that the occupants of the site were producing pottery. Pottery production locales have rarely been identified within the Central or High Plains and the evidence from the King site suggests that there are several reasons why this activity is difficult to recognize.

Discussion

Based on the proportions of certain rim forms and the type and location of decorative elements, the King site can be identified as an Itskari occupation (ca. AD 1100-1350), which is one of the CPt phases that persisted slightly later than some other phases in the northern regions of the Central Plains and the High Plains. The vertical distribution of the materials from the King site indicate that the occupation was most likely a single event. The distribution of materials across the site show distinctive areas of activity that become increasingly discrete in the deeper levels below the disturbed plow zone, thus indicating a relatively short-term occupation. The occupation surface was most likely at the contact between the two natural strata identified at approximately 40 cmbd. The

presence of materials above this is the result of pocket gopher burrowing and the material below this level is the result of a concentration of materials within the pit kiln as well as ongoing rodent activity since the time of occupation. There is also a Woodland period occupation in the deepest excavated levels of the site but the horizontal extent of this deposit has not been determined at this point.

The distinctive debris patterns at the King site indicate that a range of activities were performed at specific locations within the site area. Some of the material (bone, for example) appear to be widely distributed across the majority of the site, whereas other material types, such as ceramics and fire cracked rock, appear more restricted in their distribution. The high concentration of bone materials and their distribution across much of the site indicate that game processing was among the activities conducted at the King site. There are high concentrations of faunal remains at the southern end of the site area as well as within the pit kiln feature. The extremely fragmented nature of the remains suggests extensive processing such as that which results from bone grease extraction (Scheiber and Reher 2007; Vehik 1977). Some of the fragmentation of the bone may also have resulted from the use of bone for fuel in cooking and/or pottery firing activities, but this cannot be demonstrated with certainty at this point. The concentration of very small-sized remains at the southern end of the site combined with the presence of dense concentrations of charcoal and small-sized chipped stone debitage suggest that this was a bone processing locale. Some degree of game butchering may have taken place at this location, requiring the re-sharpening of stone tools and then the defleshed bones were likely crushed and boiled for grease extraction.

The area just west of the main excavation block, around Unit 222N 96E, also showed a high concentration of charcoal, small-sized chipped stone debris, and ceramic material. This area has been interpreted as a trash-filled pit, the outline of which was visible during excavation, albeit blurred by faunalturbation. The absence of ceramic material bearing residue in this trash-filled pit when considered against the concentration of residue-covered ceramics in the pit kiln indicates that the distribution of residue-bearing ceramics is patterned by factors other than discard and refuse disposal and that the source of much of this residue is from kiln-related processes rather than cooking.

Finally, the pit kiln located in the northern end of the excavation block was most likely multi-functional. The convergence of evidence for pottery firing in this area indicates that ceramic firing did take place within the pit. This evidence includes a dense concentration of charcoal and ash between 66-70 cmbd, a concentration of fire cracked rock and larger unmodified rocks, dense concentrations of broken ceramics, a concentration of ceramics that show signs of failure during firing, and the concentration of ceramics with reside caked mostly on the exterior surfaces. The ceramics show evidence of failure mainly in the form of spalling and exfoliation, cracking on the surfaces of some pots, as well as the remnants of one pot that appears as if it failed and was left in place at the base of the kiln. The cluster analyses conducted show that the ceramics with attributes of failure are significantly spatially clustered within the kiln feature. The combination of these correlates of ceramic firing taken with the restriction of failed pots to within, or immediately adjacent to, the pit feature strongly support the

interpretation that the inhabitants of the King site were making at least some of their pottery locally rather than transporting or importing it from the eastern lodge sites.

Despite the strong evidence that ceramic firing took place at the site, the location of a production area is not so clear. A few tools were recovered that could easily be interpreted as pottery fabrication tools, including three bone awls that may have been used for punctuating/ incising clay, a semi-circular bone tool that could have been used as a clay scraping tool, and a single potsherd that displays heavily rounded and smoothed edges that may also have been used as a scraping tool. There are several explanations that could be proposed for the minimal evidence of clear fabrication tools. It is possible that the manufacturing of pots took place in a portion of the site that has not been excavated. Another possible explanation is that other tools used to make pots were of a more expedient or general utility nature and thus more difficult to identify. The third explanation is that perhaps the fabricating tools were still functional and were transported away from the site when the occupants abandoned it. Whatever the explanation for the low number of clear fabricating tools or an obvious manufacturing area, there is strong evidence that ceramic firing did occur at the site and, based on the literature reviewed in this thesis, it is not unusual for only a portion of the ceramic production process to be evident at a given site.

The secondary function of the pit kiln is as a refuse disposal area. The presence of all material types and material size classes within the kiln indicate its use as a trash pit. Even more significantly is the fact that almost all of the size class 3 materials from the site, with the exception of a few ceramic sherds, are restricted to this area. This pattern is probably the result of site maintenance activities whereby large, obtrusive or

hazardous refuse was periodically cleared away from other areas of the site and deposited in convenient areas, such as this large open pit. Also supporting this interpretation is the fact that during excavation the material within the pit fill was found oriented both horizontally, as if deposited on a flat surface, as well as piled up and at various angles, as if gathered up and deposited collectively.

In general, the high degree of fragmentation of the bone remains suggests that the occupants of the King site were processing the bone for grease extraction. Sites with similar evidence are well known within the High Plains (Scheiber and Reher 2007) and bone grease was commonly used as a component in pemmican or to make broth (Vehik 1977:169). In addition to large amounts of highly fractured unburned bone, other evidence of bone grease extraction should include ceramics or boiling pits, fire pits, fire altered rock, large hammer stones, and anvils. There should also be a lack of evidence for high yield elements like legs, feet, ribs and vertebrae (Vehik 1977). The evidence from the King site includes many of these markers including ceramics, fire altered rock, some larger stones that may have functioned as anvils and hammerstones, and hearth areas. The presence of projectile points as the dominant formal tool type indicates that hunting was conducted nearby and the site was probably a base camp to which game were returned for further processing.

The length and season of occupation are unclear at this point but no evidence of a house structure has been located to date, which suggests a warm-season habitation. The firing of ceramics would have been a warm season activity due to the necessity of maintaining high temperatures within the pit in a relatively fuel scarce area, logistical constraints on collecting clay in frozen ground conditions, and the difficulty of drying

pots in the more humid conditions that prevail in late fall, winter or spring. Ceramic production activities would necessitate an occupation long enough to facilitate production and drying, which could arguably take up to several months from start to finish. It is difficult to assess whether the production of ceramics at the King site was a specialized function of the site or a by-product of need, but the pit feature in which they were fired is large enough to accommodate a considerable number of pots and much larger than what would be necessary to fire just a few replacements. Thus, the amount and kinds of debris recovered from the site and the investment in such a large feature for pottery firing indicate that the occupation of the King site may have lasted for an entire season. The occupants could have been as tethered, if not more so, to this particular locale by the demands of ceramic manufacturing as by those associated with hunting activities.

Conclusion

There are numerous avenues of research into the King site that are yet to be pursued. Further analysis of the floral and faunal remains will likely verify the seasonality of the occupation. Additional faunal analyses will also further elucidate the function of the site as either a broad-spectrum hunting camp or a specialized bison processing site. Formal lithic analysis should determine if expedient utilized flakes are in fact a primary tool type, as well as answer questions concerning whether the raw materials utilized are local to the area. Residue analyses on the ceramic sherds can directly identify the sources of the different types of residue and conclusively determine which are food related and which are related to fuel sources in the kiln. Finally, sourcing analyses of the ceramics may be able to determine if the clay used to make the pots is

chemically homogenous or from several different sources. Comparing the chemical composition of the pottery to local clay sources will obviously provide a very direct line of evidence concerning the local manufacture of the pottery.

Evidence of production, like that found at the King site, will increase our knowledge concerning the scale of pottery production within the Central and High Plains regions and may serve as an indicator of the group sizes occupying different sites. The provisioning practices of potters and ceramic manufacturing within the context of a nomadic settlement pattern are also issues that deserve further attention. Studies of settlement patterns have always recognized the proximity to a range of resources (water, lithic sources, arable land, etc.) as decisive to settlement location. While clay sources have been implicitly considered important, they haven't been viewed with the same primary importance as other types of resources. Pottery manufacturing requires a substantial amount of time and planning to execute, such that provisioning for this activity may have been more important to the settlement patterning we see in the High Plains than has been previously acknowledged.

Finally, while sourcing analyses (INAA, Laser Ablation ICP-MS, petrography) are an important direct means of determining local or non-local production, being able to identify production signatures in the absence of this data is important too. Sourcing analyses are not always feasible or as conclusive as we would like and they don't necessarily answer questions concerning the organization of craft production as readily as identifying production areas will. The methods outlined in this study are another way to see potential connections or variations between the way different groups occupied the High Plains. Perhaps, as Roper (1990) suggests some groups were occupying the

region for more extended periods while others were more transient. Such differences in residential permanency would certainly show up in the record of pottery production, whereby some groups may be practicing local production while others are transporting or trading pots in. There may also be considerable regional variability in the occupation of the High Plains, as suggested by Page (2009), and looking for the right material production signatures in the archaeological record is a necessary step in identifying such variability. This thesis demonstrates that, if the various lines of evidence are treated carefully and collectively, the identification of ceramic production activities is feasible within the archaeological record of the High Plains.

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