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## ANTHROSOLS AND THE ANALYSIS OF ARCHAEOLOGICAL SITES IN A PLOWED CONTEXT: THE KING'S REACH SITE

Dennis J. Pogue

*Archaeologists working in the Chesapeake region have been particularly active in using plowzone-derived artifacts for interpreting historic-period sites. More recently, the analysis of patterns in certain plowzone soil chemicals has developed as a significant complementary source of data, and over the last decade several sites have been subjected to that type of study. An analysis of the distribution of soil chemicals at the King's Reach site (ca. 1690–1715) is presented as a case study in the use of the method. The pertinent literature on the subject is reviewed, and the King's Reach data are compared with those from several other similar sites. Taken together, the overall results support the viability of such analysis as an important interpretive tool at sites that have been subjected to plowing.*

*Les archéologues à l'oeuvre dans la région de Chesapeake se sont montrés particulièrement intéressés par l'utilisation des artefacts provenant de terres labourées pour assurer une meilleure connaissance des sites historiques. Récemment, l'analyse de la nature de certains éléments chimiques du sol de terres labourées en est venue à constituer une importante source complémentaire de données; au cours de la dernière décennie, plusieurs sites ont été soumis à ce genre d'étude. Une analyse de la distribution des éléments chimiques du sol du King's Reach site (v.1690–1715) est présentée à titre d'exemple d'utilisation de la méthode. Il est fait un examen de la bibliographie pertinente et les données de King's Reach sont comparées avec celles de plusieurs autres sites semblables. Il se dégage de l'ensemble des résultats que cette méthode d'analyse constitue un bon moyen d'étude des sites soumis au labourage.*

### Introduction

Over the last two decades, historical archaeologists in the Chesapeake region have been leaders in adapting and refining several techniques first developed by American and European prehistorians for the study of sites in plowed contexts. The techniques include systematic retrieval of artifacts via controlled surface collection and by plowzone excavation, with increasingly sophisticated, computer assisted manipulation of the recovered data. This technical sophistication has led to the kind of intensive, fine-grained spatial analyses that not too long ago were considered impossible, given the radical disturbance caused by plowing (cf. Keeler 1978; King 1988;

King and Miller 1987; Neiman 1980; Pogue 1988; Riordan 1988).

A third technique for investigating domestic sites that have been plowed has been developed, but has not been as widely adopted. This is the study of anthrosols, or soils that have been altered by human activity. Plowing is an agent that mechanically changes soils. In addition to mechanical transformation, the plowzone may exhibit increased levels of certain elements that may result from human occupation, and which survive to varying degrees depending on micro-environmental variables. This second, chemical, form of alteration will be considered in this paper, using the results of such analyses at one late

17th-century domestic site, King's Reach in Calvert County, Maryland, as a case study. In addition, those results will be compared with similar analyses of other plowed sites that are similar in type.

### Soil Chemical Analyses

The underlying concepts that gave rise to soil chemical analyses first appeared in print in Europe before the Second World War. American prehistorians began to utilize the evolving technique in the 1950s (cf. Dietz 1957; Lutz 1951). Cook and Heizer (1965) summarized those data for a later generation of American archaeologists more than two decades ago, and that summary remains the most often-cited source for all subsequent analyses. A limited number of methodological studies now supplement Cook and Heizer (Custer et al. 1986; Eidt 1985; Limbrey 1975), and the technique has come to be commonly used in prehistoric archaeology. The definitive study of anthrosols, combining the results of more than 30 years of fieldwork with a systematic examination of the hypothesized causal links, however, remains to be undertaken.

Interpretation of plowzone soil chemical patterns is based on assumptions similar to those underlying analyses of the distributions of plowzone-derived artifacts. That is, while plowing destroys the stratigraphic integrity of cultural deposits, the surviving artifacts retain their relative horizontal relationships. Therefore, even though what had been a surface sheet midden may have been virtually plowed away, the more durable

artifacts survive and their horizontal distributions reflect the original deposition. A number of domestic sites in the Chesapeake have been subjected to this type of study (e.g., Keeler 1978; King 1988; King and Miller 1987; Miller 1986; Neiman 1980; Riordan 1988). In each case extremely rewarding results were obtained. In addition, a number of experimental studies providing important corroborating evidence have been conducted over the last decade (e.g., Lewarch and O'Brien 1981).

Going a step further, the chemical residues deriving from a variety of types of material deposited in the midden also may survive in the plowzone, even in extreme cases when all material trace of the original matter from which the chemical derived may have "disappeared." Therefore, the analysis of patterns in the distributions of these chemicals should reflect depositional processes similar to those indicated by the artifact distributions, but might well provide additional data that otherwise may not be available. For instance, potassium is a major component of wood ash, and the patterns in its distribution at a site may be interpreted as indicating areas where fireplace ashes were deposited (Keeler 1978: 67), even though the ash itself may long since have been dispersed and is unrecoverable using traditional archaeological procedures.

In addition to potassium, three other chemicals have been identified as reflective of human activities: phosphorous, calcium, and magnesium. Historically, phosphorous was the first to be identified as resulting from human occupation and has been used as a

means of site identification based on its presence in high values (Cook and Heizer 1965: 1). The reason given for the correlation of phosphorous with humans is that the chemical is present in animal body tissue and in body waste, as well as in other organic materials. Thus, it is associated with a wide range of human activities (Eidt 1985: 181). Calcium also is linked with animal hard tissue (Cook and Heizer 1965: 19), and has been postulated as particularly indicative of shell and bone. Finally, the presence of magnesium has been rather vaguely linked with "intensive burning" (Konrad, Bonnicksen, and Clay 1983: 24).

Fortunately for archaeologists interested in soils analysis, these four elements may remain in the ground for long periods—phosphorous related to human occupation has been recorded at prehistoric sites dating back over 10,000 years (Konrad, Bonnicksen, and Clay 1983). Since these macro-nutrients are required in large amounts for healthy plant growth, testing for them is a standard procedure at virtually all large soil testing laboratories. The soils from the King's Reach Site were analyzed at the University of Maryland at College Park.

Unfortunately, the rather simplistic cause and effect relationships enumerated above are not discussed to any satisfying degree in any of the references cited. Instead, they are simply stated, with little if any supporting evidence provided. Generally, if a reference is given, it is Cook and Heizer (1965), even though that 25-year-old study treats the underlying bases for these claims in the most cursory manner. This is a

disturbing state of affairs, which suggests that a systematic study of the possible causes, both cultural and noncultural, of specific chemical anomalies in plowed environments has yet to be performed.

The author consulted with Martin Rabenhorst and Bruce James at the Agronomy Department of the University of Maryland in order to gain an additional expert perspective and source of comparison. They agreed to examine the distribution maps of the King's Reach Site soil chemicals and to discuss their possible causes. After a lengthy discussion, the author drew the following inferences:

- (1) Both phosphorous and calcium are relatively stable chemicals and very likely may survive for extremely long periods in the soil, but potassium and magnesium are relatively mobile and, therefore, their preservation is more dependent on micro-environmental conditions;
- (2) Because of its stability and its presence in both human waste and bone, phosphorous is considered to be the best indicator of human activity;
- (3) The agronomists were surprised that phosphorous from human excrement would remain in place over hundreds of years;
- (4) Calcium is a major component of both bone and shell;
- (5) Wood is composed of calcium and magnesium as well as potassium, but potassium is the most dominant element;
- (6) An area of "intense burning" was likely to be reflected by high values of calcium and potassium as well as of magnesium;
- (7) They cautioned that the standard test for phosphorous is not sufficient to differentiate the variety of types of the chemical that may be present, and which may reflect different causes; and finally,
- (8) The overall results may be greatly affected by a variety of factors, including the chemical composition of the underlying parent material, agricultural practices, sampling methods, and micro-environmental variables (Martin Rabenhorst and Bruce James, personal communication, 1988).

This consultation provided some reassurance on a number of points. The soils scientists supported most of the general correlations between the chemicals and cultural causes postulated by archaeologists. In particular, the correlations between the presence of phosphorous and human occupation in general, between calcium and the former presence of bone and shell, and between potassium and the former presence of wood ash, are all supported. They questioned the correlation between burning and magnesium, however, and cautioned that more than the standard test for phosphorous is needed to isolate all its forms.

One of the first attempts to adapt soil chemical analysis to an American historic period site was Keeler's (1978) study of the St. John's Site (ca. 1638–1720) at Historic St. Mary's City, Maryland. Keeler's pioneering study remains extremely valuable as a source of comparison. Initially, soils from a number of strata deriving from subsurface features were analyzed. The overall results, and particularly the comparison of results from two large features—one a privy and the other a refuse-filled pit—pointed to high values of phosphorous as an indicator of organic waste, especially human and animal excreta, with calcium correlating with trash deposits. Encouraged by this empirical evidence, Keeler tested soil samples from the plowzone across the site.

Concentrations of phosphorous were revealed at a number of locations just outside doorways, which Keeler interpreted as evidence of primary deposition of human waste, as well as the secondary deposition of "night

soils" from chamber pots. Animal enclosures also were indicated by heavy phosphorous concentrations within fenced areas. High values of calcium, on the other hand, correlated with a major surface midden and with a pathway and service yard, presumably as a result of concentrations of oyster shell and bone in those areas. Potassium levels also were tested, revealing several peaks interpreted as stemming from the dumping of fireplace ash. The distributions of magnesium did not form any pattern that could be associated with cultural activity, and were not included in the final report (Robert W. Keeler, personal communication, 1989). By plotting the soil chemical distributions and by comparing them with artifact patterns and with the evidence provided by analysis of the subsurface features, Keeler was able to differentiate activity areas within the St. John's homelot (Keeler 1978).

A more recent study of an 18th-century site at St. Mary's City, Clocker's Fancy, has applied Keeler's methods with similar results. In this study, Stone et al. (1987) point to the degree of correlation among all three chemicals studied (excluding magnesium) as a key to identifying different functional areas. The co-occurrence of all three elements is interpreted as evidence of trash dumps. Phosphorous concentrations alone are interpreted as representing animal pens, privies, and primary and/or secondary human waste deposits. Potassium by itself is interpreted as indicative of ash dumping; calcium alone is viewed as primarily indicating oyster shell middens (Stone et al. 1987).

### The King's Reach Site

The King's Reach site (18 Cv 83) is located at the Jefferson Patterson Park and Museum, in lower Calvert County, Maryland (FIG. 1). In 1984 and 1985, the Maryland Historical Trust/Jefferson Patterson Park and Museum conducted an intensive, research-oriented excavation at the site. As no documentary evidence so far has been linked with this site, interpretation of it is largely dependent on inferences derived from the archaeological record, combined with what is known of similar sites in the region from previous archaeological and historical research.

Systematic surface collection of artifacts from the plowed field surface in a 50 × 60-m (164 × 196.8-ft) area allowed delineation of the site boundaries and served as the basis for selecting areas to begin excavation. A total of 144 2 × 2-sq m (6.56 × 6.56 sq ft) plowzone quadrants were excavated during two summers, with 116 of those concentrated in the site core and the remaining 28 systematically distributed in the outlying zone (FIG. 2). The plowed stratum of each square was hand-screened through 3/8-in hardware cloth for uniform artifact recovery. Samples of the plowed soils were gathered from the center of each of the 144 quadrants. Selected subsurface features were excavated, with all of the major pits at least partially excavated.

The plantation core appears to have been completely exposed by excavation (see FIG. 3). This includes the remains of a relatively large post-supported frame dwelling measuring 9.14 m × 9.14 m (30 ft × 30 ft), and a smaller, 6.1 m × 3.09 m (20 ft × 10 ft) structure interpreted as a quarter. A

fenced foreyard connected the structures (FIG. 3). All evidence points to a short-term occupation dating to ca. 1690–1715.

The combination of the architectural and artifactual evidence suggests a relatively wealthy household. Based on probate inventory data, Main indicates that in Maryland for the period 1660–1719 those households with five rooms in the main house ranked in the 70–79th percentile according to wealth (1982: 152). The King's Reach main house had at least five rooms and could well have accommodated more. The analysis of the diverse and rich artifact assemblage, including numerous brass and pewter objects, fine table glass, and matched sets of ceramics, supports that interpretation.

Based on the comparison of the King's Reach evidence with results of previous archaeological and documentary research (cf. Carson et al. 1981; Main 1982), the structural spaces have been interpreted as consisting of a main house with a hall-parlor plan and two attached sheds, and a one-room quarter (FIG. 3 and Cover). The heated room served as the hall (kitchen), partitioned from the parlor, which may have been further divided into two smaller rooms. A shed, which may also have been partitioned, extended along the entire rear of the house. A second, smaller shed, attached to the hall gable, probably served as a milkhouse, or dairy, wherein dairy products were stored in a shallow, wood-lined pit. The other building was also a dwelling, most likely a quarter for indentured servants and/or slaves. It consisted of a single heated room over a cellar.

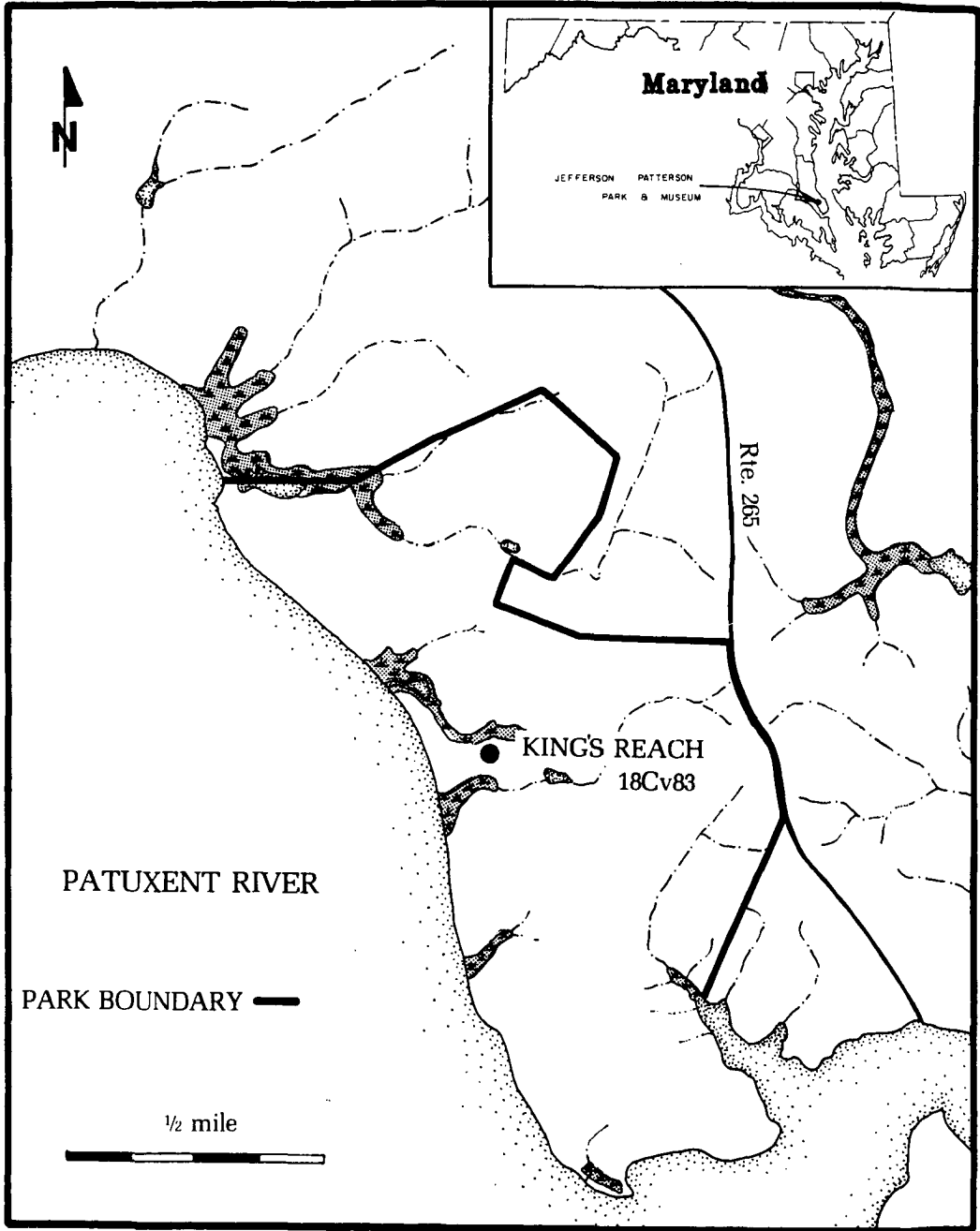


Figure 1. Location of the King's Reach Site (18 Cv 83), Calvert County, Maryland.

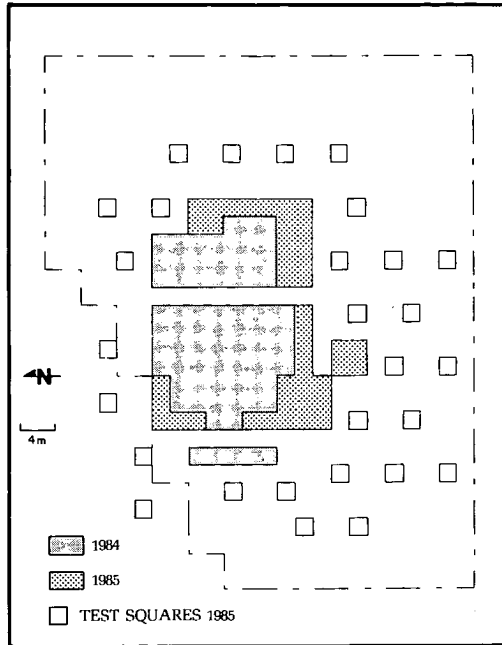


Figure 2. Placement of excavation units at the King's Reach Site.

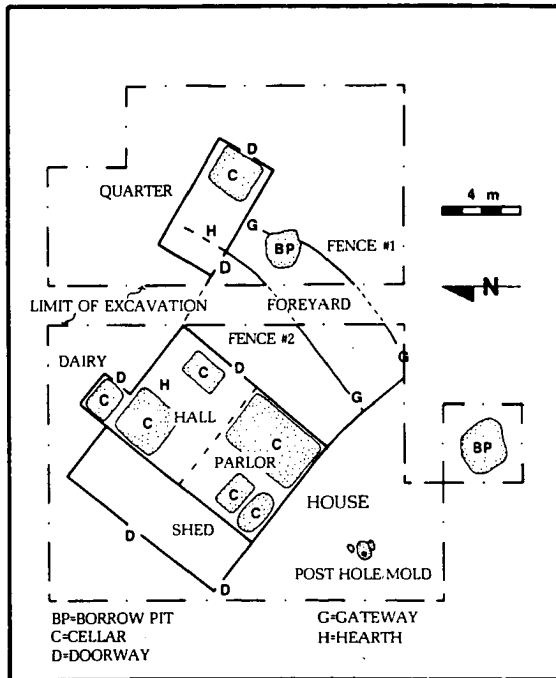


Figure 3. King's Reach Site plan.



### Artifact Distributions

Interpretation of the distributional patterns of plowzone-derived artifacts was a major tool used in interpreting the functional uses of space at the King's Reach homelot. Maps of the artifact and soil chemical distributions were computer-generated using a three-dimensional spline as the interpolation algorithm, with contour intervals reflecting percentiles of the frequency distribution of artifact counts (Tukey 1977). The maps included herein have contour lines indicating the third, fourth, and fifth quantiles. The phosphorous, calcium, bone, and pipe maps also include a contour at the second quantile. The maps of tobacco pipes and bones represent numbers of fragments while the shell distribution reflects volume and the soil maps measure the chemicals by pounds per acre.

Various artifact types were plotted, most notably tobacco pipestem fragments according to bore size, as well as ceramic wares, bottle glass, table glass, oyster shell, bone, and structural remains such as brick and nails (Pogue 1988). The distribution of total measurable pipestems demonstrates the general patterns of artifact distribution, which reflect the nature of the refuse disposal processes at the site. Three major concentrations of tobacco pipes occur: to the rear of the main house; centering on the house and extending to the south; and between the house and quarter (FIG. 4). Plotting of numerous other artifact types supports the interpretation that these concentrations represent the main areas of refuse disposal at the site. The rear concentration and the one between the house and quarter appear

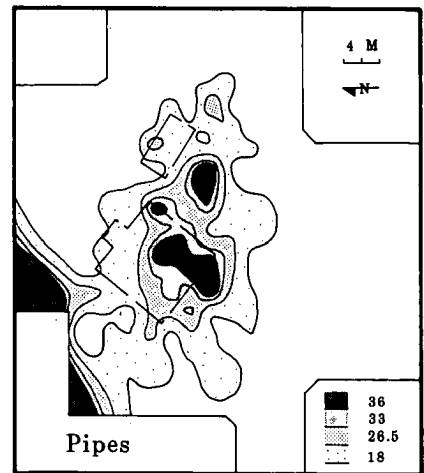


Figure 4. Distribution of total measurable pipe stems (by fragment).

to be extensive sheet middens. The concentration located within the house clearly is not, however, and seems to stem from the existence of the numerous large subsurface features located there. The house concentration appears to result from artifacts being plowed from the upper portions of those features, while the other two are the result of the plowing away of shallow surface middens. For a more detailed analysis of these data, see Pogue 1988.

### King's Reach Soil Chemicals

At King's Reach, the soils analysis complements and reinforces the plowzone artifact patterns, and supports certain aspects of the site interpretation. As at St. John's (Keeler 1978), the distributions of the different chemicals at King's Reach show remarkable differences between them, three of which may be associated with different types of refuse. Phosphorous levels are highest within the main

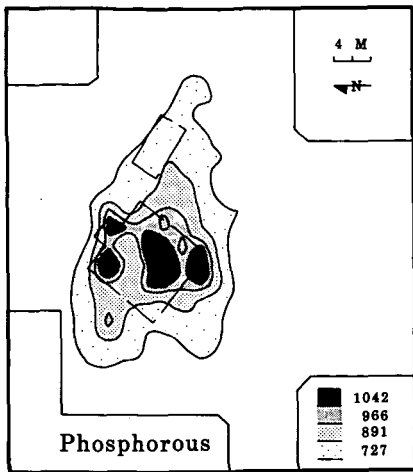


Figure 5. Distribution of phosphorous (by pounds per acre).

house, with less dense clusters in the foreyard and adjacent to several doorways (FIG. 5). The concentration within the house seems less likely to represent human waste than general organic refuse, apparently stemming from the cellars there. The small concentrations located adjacent to most of the doorways point to the deposition of human excreta. The absence of any major outlying concentrations is somewhat surprising and suggests that if animals were penned, that it must have been carried out beyond the area studied.

Calcium is also concentrated within the house, as well as behind the house and between the house and quarter (FIG. 6). Its distribution is generally similar to that of tobacco pipes (FIG. 4), and suggests that calcium also reflects the general pattern of refuse disposal at the site. The major calcium concentration over the hall and dairy is also remarkably similar to that of bone (FIG. 7), but the heavy concentration of bone over the quarter

is not mirrored by a similar density of calcium. While calcium distribution is not identical to bone in terms of relative density, however, the general distributions of calcium and bone are similar. At any rate, the calcium distribution is very different from that of oyster shell (FIG. 8)—suggesting that, at King's Reach, the presence of calcium serves as a more accurate reflection of bone than of shell.

The potassium distribution is almost completely the reverse of those of phosphorous and calcium, with virtually no occurrence within the house and major concentrations in an outlying band, just beyond the foreyard fence and at approximately the same distance all around the homelot (compare Figures 3 and 9). This pattern is interpreted as reflecting ash tipping and may, therefore, indicate the effective perimeter of the day-to-day use of the homelot. Clusters also appear just outside the dairy door, suggesting that it served as a primary avenue for dumping the hall fireplace sweepings; in the quarter, where a small ash-filled pit was located adjacent to the hearth; and adjacent to the quarter gable door.

Finally, the distribution of magnesium is puzzling, for it exhibits a different pattern from the potassium (FIG. 10). If magnesium does indeed indicate "intense heat," and potassium derives from ash, then some correlation between the two would seem likely. However, very little co-occurrence is indicated, with the lone exception being concentrations of both chemicals outside the dairy door. That co-occurrence may result from the dumping of hearth ashes there, but if so the noncorrelation elsewhere is puzzling. The major concentration to

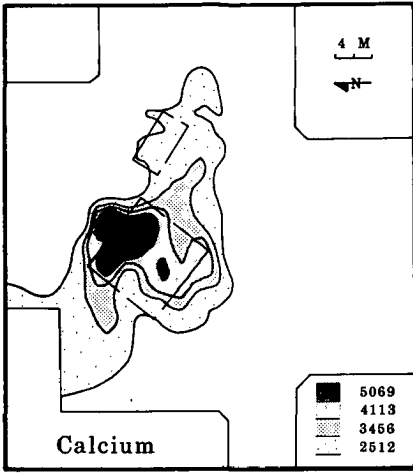


Figure 6. Distribution of calcium (by pounds per acre).

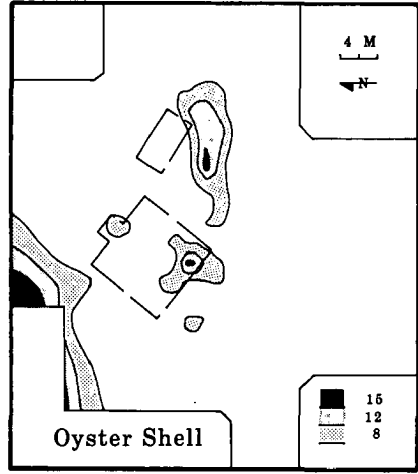


Figure 8. Distribution of oyster shell (by volume).

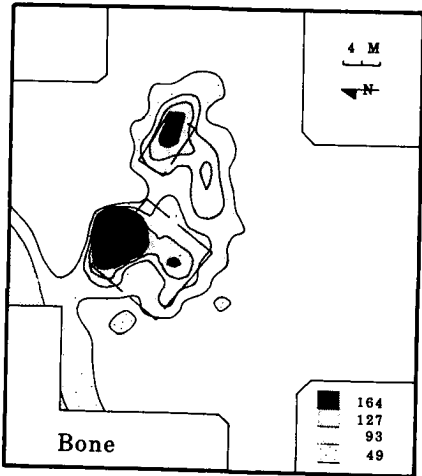


Figure 7. Distribution of bone (by fragment).

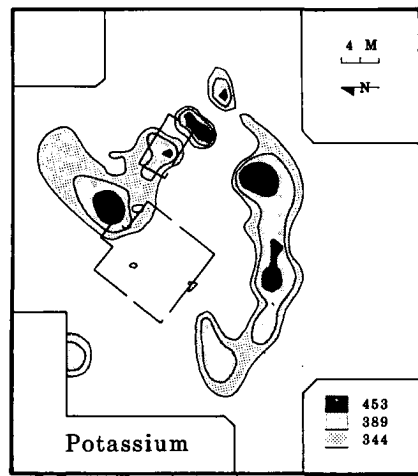


Figure 9. Distribution of potassium (by pounds per acre).

the rear of the house corresponds with an extensive midden indicated by concentrations there of virtually all types of artifacts (Pogue 1988), as well as calcium, but it does not occur in the other areas of heavy refuse disposal indicated by the calcium distribution.

The King's Reach chemical data are generally similar to those from St. John's, described earlier. Not only are the general patterns similar, but the distributions of specific chemicals seem to result from similar causes. While the methods of sampling at the sites varied somewhat, they both were carried out at a relatively close interval, which seems to have allowed very sensitive interpretation. The King's Reach soils were sampled at intervals of 2 m (6.56 ft) at 116 points across the core of the site, with an additional 28 samples taken systematically at intervals of approximately 4–6 m (13.12–19.69 ft) in the outlying area. In contrast, the author gathered soil samples at three other nearby 17th-century domestic sites, one at 4-m (13.12-ft) and two at 8-m (26.25-ft) intervals. The resulting analyses have proven useful in the interpretation of the sites, but also clearly reflect the greater sampling intervals. Distinctions within the larger distributional patterns are less well defined, suggesting that a more intensive sampling strategy would yield more useful results.

Soils analysis also was carried out at the Compton Site (ca. 1651–1684), a tobacco plantation located in lower Calvert County, Maryland, less than 10 miles south of the King's Reach Site. At this site, 162 test units, each measuring 0.76 m (2.5 sq ft), were excavated across the site at an interval of between 1.52 and 2.29 m (5 and 7.5

ft) (Outlaw et al. 1989: 19–20). The plowed soils from each unit were screened through 1/4-in hardware cloth, and the artifacts recovered were plotted according to type. In addition, a total of 57 plowzone soil samples were tested, at an interval of approximately 6.1 m (20 ft) (Outlaw et al. 1989: 52–53). The phosphorous distribution includes one major concentration located near a structure, that has been interpreted to indicate an animal barn and nearby pen. Numerous concentrations of potassium appear to correlate with subsurface pits containing large amounts of wood ash. Calcium concentrations appear to correlate with oyster shell. Finally, magnesium generally follows the other soil chemical distributions, with two major concentrations correlating with those of calcium (Outlaw et al. 1989: 53–58).

At the Whitten Road Site, a late 18th-century residence and associated homelot in New Castle County, Delaware, samples of soil were taken from plowzone at a 10-ft interval across the core of the site, with additional samples taken from 5 × 5-ft units located in the surrounding area. Those units were randomly placed, but were at intervals of no more than 3.05 m (10 ft) (Shaffer et al. 1988: 30–31, 133). The resulting computer-generated distribution maps were interpreted as indicating patterns similar to those observed at St. John's. Phosphorous concentrates near the structure interpreted as a dwelling; calcium concentrations were linked with oyster shell; potassium was concentrated in and around the dwelling, and was interpreted as resulting from the dumping of hearth

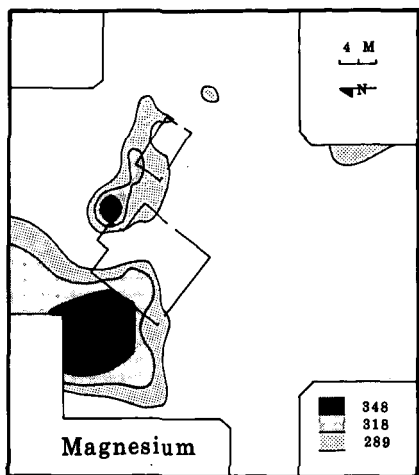


Figure 10. Distribution of magnesium (by pounds per acre).

ashes. Once again, the distribution of magnesium could not be linked with any activity associated with the component of the site being studied (Shaffer et al. 1988: 133-140).

### Conclusion

In this paper, a case study of the interpretation of patterns in soil chemical distributions at one intensively studied site has been combined with a comparison of similar studies at a number of other sites in comparable contexts. In addition, a review of the relevant literature pertaining to such analyses has provided the background necessary to interpret the King's Reach data. In general terms, the results at

King's Reach are remarkably similar to those from the St. John's Site. In both instances, the soils data were combined with an abundance of complementary distributional and structural evidence, which allowed for an extremely fine-grained interpretation of the two homelots.

Soils analyses carried out at two other plowed sites, Whitten Road in Delaware and Compton in Maryland, are also instructive sources of comparison. In those instances, areas of differing functions across the site also were interpreted based on the patterns in soil chemicals. Those interpretations, in turn, were supported by the patterns in the distributions of the artifacts recovered from plowzone. The combination of all these results suggest that the technique should be considered by any archaeologist conducting similar studies.

No systematic study of the validity of the postulated correlations between soil chemicals and certain cultural causes has been conducted to date. However, the results from interpreting the patterns at King's Reach and at St. John's, and to a lesser degree from the other sites mentioned above, seem to support several of those correlations. Phosphorous seems strongly correlated with the surface deposition of human waste and with substantial subsurface trash deposits. At King's Reach, calcium concentrates within the main house and generally correlates with the distribution of bone. This is different from the pattern at St. John's, where calcium seems to correspond more closely with oyster shell. At both King's Reach and St. John's the potassium distributions are markedly

different from calcium and phosphorous, concentrating adjacent to several doorways near hearths but also in outlying areas, suggesting the chemical's association with ash dumping. Finally, the distribution of magnesium is puzzling and cannot be tied to any specific cause.

In addition to adding an important complementary source of data for interpreting intensively excavated sites like King's Reach and St. John's, soil chemical analyses may be particularly useful in the interpretation of sites where logistical constraints limit the extent of subsurface testing. In combination with controlled collection of artifacts from the plowed field surface, and/or a program of plowzone artifact sampling, the soil chemical distribution patterns may allow for a relatively precise spatial analysis. Now that a number of sites have had soils analyses carried out in conjunction with systematic plowzone artifact sampling and with open area excavation, those results may serve as important comparative sources for interpretation of data from more limited investigations.

The soil chemical analyses carried out in connection with the interpretation of the three additional Calvert County sites served as an important component of their much less intensive, survey-level study and support its utility in that context. However, the increased sampling interval used at those sites clearly seems to have reduced the sensitivity of the resulting patterns, with a concomitant decrease in their interpretive power. The Compton Site distributional patterns also seem less conclusive, probably because of an

inadequate sample taken at too wide an interval. As with any spatial sampling program, the size of the interval between soil samples remains a crucial determinant of the validity of the results.

For many years the value of archaeological sites situated in agricultural contexts was regarded as having been greatly compromised because of the disturbance caused by plowing. Over the last two decades, however, a number of excavation and analytical techniques have been developed that have transformed plowzone artifact data into powerful interpretive tools especially useful in addressing spatial issues linked to interpretation of the homelot. The analysis of the distribution of plowzone soil chemicals deserves a place as an important source of complementary data in spatial studies of domestic sites.

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