THERMALLY ALTERED STONE AS A RECORD OF BEHAVIOR AND TRANSFORMATION

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INTRODUCTION

Archaeological sites often contain features with varying arrangements and densities of thermally altered stone, which may include pieces that are cracked and broken (i.e., fire-cracked rock) or discolored or crazed. While thermally altered stone is the most common artifact class in many archaeological sites, much research remains to be conducted to precisely identify the multitude of processes that may contribute to the formation of clusters and scatters of these artifacts. Indeed, more rigorous archaeological analysis is warranted given that thermally altered stone distributions provide extremely important functional and depositional information, often unobtainable from other data sources.

This article focuses on thermally altered stone distributions that may be expected in prehistoric archaeological sites. Based on analogies derived from ethnographic observations and feature patterns derived from excavations, several hypothetical models are advanced concerning the types of fire-related features researchers might expect to identify from archaeological contexts. These hypothetical expectations are tested against sites located in the Middle Atlantic region of the Eastern United States, all contexts from which thermally altered stone distributions have been retrieved. The techniques and analyses that archaeologists may generally use to infer the cultural and natural processes responsible for the formation of fire-altered features and spatial distributions are then discussed.

In any study of intra-site patterns, archaeologists attempt to understand how assemblage distributions were formed. Archaeologists wish to know the degree to which patterns are the consequence of human activities and natural postdepositional processes. While it is recognized that the archaeological record is often an amalgam of many formational processes (e.g., Goldberg et al. 1993; Wandsnider 1996), it may be useful to consider thermally altered stone in light of these two main, but somewhat simplistic, processes: activity functions and non-cultural transformation processes.

ACTIVITY FUNCTIONS

With respect to functional variables, archaeologists may envision that a variety of feature types with thermally altered stone may be created by activities occurring during site occupation. Archaeologists have attempted to capture this variation through morphological studies of feature types. Central to any interpretation of the function of features is the relative abundance and size of thermally altered stone and the relative presence of charcoal. Using these criteria as a basis for describing morphology, two feature types are considered: evident and latent (see Leroi-Gourhan 1972). As used here, evident features bear clear morphology and are easily recognizable during excavation. Latent features may be described as distributions of features that are not easily detectable or particularly obvious during excavation. Latent features may derive from repeated site activities that tend to alter original distributions (i.e., through re-use of occupation surfaces and features, trampling), resulting in relatively non-distinct archaeological signatures.

Evident Features

Evident features are those that retain form after use and site abandonment (Figure 1). Many ethnoarchaeological studies are able to nicely delimit and map evident features, since these are often single-use episodes that have not been subject to alteration by multiple activities or non-cultural influences (e.g., Yellen 1977; Binford 1978; Bartram et al. 1991). Among identifiable characteristics that may be viewed in archaeological contexts are well-defined feature boundaries, often in combination with artifactual contents and eco-facts which can easily be separated from surrounding sediment matrices and artifact distributions. Indeed, certain fire-related features may be relatively easy to identify since they contain an abundance of thermally altered stone and charcoal.

Evident features vary with respect to their functions and use life histories, and thus they may be arbitrarily subdivided according to this degree of variation, consisting of single-state and multi-state categories. Single-state features are those where the original, discrete activity event or events may be recognized or inferred, such as with the construction of a ring-hearth. In contrast, multi-state features are those that have been used for several purposes, other than a single or a few original activity events. In the multi-state case, fire-altered stones and other artifacts may become incorporated in the feature as a result of behavior unconnected with an original event. An example of a multi-state feature would be a situation where site inhabitants use an empty storage pit for the discard of refuse. Thus, the feature use history becomes more complex and there is no discrete relationship between the original function of the pit and the thermally altered stone and artifacts which may be in the refuse. Dumping behavior such as this may be identified based on morphological assessment of the pit, the range and size of the thermally altered stone, and the lack of in situ burning, thereby suggesting the burned rock was a product of secondary deposition.

Latent Features

In contrast to discernable evident features, archaeologists may also identify latent features from archaeological patterns (Figure 2). Latent features are also constructions by a site's inhabitants, but these are not readily apparent to the archaeologist in the field as they do not show clearly detectable boundaries nor clear artifact associations representative of single- or multi-state activity events. Latent features are those that may result from cultural sorting behaviors, such as increased length of site occupation on a surface and re-occupations on the same surface, where re-use of features or processes such as trampling have an effect on patterns. These type of repetitive processes tend to alter artifact positions forming deposits which are overlapping accumulations of site activities (e.g., Gregg et al. 1991; Stevenson 1991). As an example, thermally altered stone may be dispersed as a result of trampling if it remains on the surface of an active, re-occupied site. Alternatively, stone from a disused feature may be recycled or scavenged, removed from its original location and incorporated in another thermal feature.

Latent features may be recognized as a result of detailed or more sensitive intra-site examinations, which combine qualitative and quantitative analysis (e.g., Rigaud and Simek 1991; Petraglia 1993). For instance, cluster analysis of assemblage distributions may identify intra-site spatial patterning not readily apparent in the field. Refitting is another useful analytical technique, where conjoins of fire-cracked rock may reveal patterns which help to identify spatial clustering and implied activity sets that are not obvious in the raw data.

NON-CULTURAL TRANSFORMATIONS

Thermally altered stones and features may be redistributed by a number of natural processes. Prior to burial, thermally altered stone may become disturbed by a variety of environmental agents such as flowing water and gravity. After burial, artifact distributions may be influenced by tree root action or burrowing animals. In addition to these natural agents, archaeological sites are often the subject of transformation by historic or modern plowing. In any of these scenarios thermally altered stone concentrations or features may no longer exhibit the discrete spatial structure of the original cultural context. Thermally altered stone may thus become redistributed horizontally across surfaces or vertically separated in buried contexts. As in the initial identification of features, cluster analysis of assemblage composition and artifact refitting are techniques that may prove useful for assessing the relative degree of transformation to which thermally altered stone features or distributions have been subject.

ARCHAEOLOGICAL SITE CASE STUDIES

The goal of this section is to compare the utility of the hypothetical sub-divisions of thermally altered stone features presented above against archaeological data sets from the Eastern United States. These prehistoric sites often contain features with thermally altered stone (e.g., Kinsey 1972; Ritchie and Funk 1973). Archaeologists working in the region have taken different approaches to understanding the function of these features, through descriptive, morphological, and experimental studies (e.g., Stewart 1977; Hatch and Stevenson 1980; Cavallo 1984; Pagoulatos 1992). What is often lacking is an examination of the relationships between morphology, contents, and formation processes, however.

The case examples employed in this article are from the Middle Atlantic region of the Eastern United States, and include prehistoric sites located in Pennsylvania and Delaware (Figure 3). The sites are primarily Late Archaic to Middle Woodland in age, dating from about 3000 B.C. to A.D. 1000. The sites are relatively short-term, semi-sedentary localities, as opposed to continually occupied, sedentary village locales. Due to the relatively high level of settlement mobility implied by the sites and their potential for re-occupation on the same surfaces, thermally altered stone features may be expected to be more ephemeral or not as well constructed as those at sedentary locales.

The Pennsylvania and Delaware sites were located in a deciduous vegetative zone, and relatively thin stratigraphic profiles have developed as a result of colluvial and aeolian contributions, and erosion on floodplain settings. The Connoquenessing site was located in western Pennsylvania, in the Upper Ohio Valley (Knepper and Petraglia 1996). The archaeological assemblages at the site were found on a broad alluvial terrace, in an open agricultural field. A number of sub-plow zone features were identified in the field. The Kettle Creek site was located in north central Pennsylvania, along the western fringes of the Appalachian Mountains (Petraglia et al. 1998a). The site was situated on a broad alluvial terrace, and archaeological assemblages were identified in plow zone and subsurface contexts. The Lums Pond site was located in northern Delaware, situated in the High Coastal Plain (Petraglia et al. 1998b). The assemblages were identified in plow zone and sub-plow zone contexts, as well as in buried contexts on the floodplain of a small stream.

Evident Features

The Pennsylvania and Delaware sites contained evident features. The Connoquenessing and Kettle Creek sites contained single-state evident types, which were the most common type of thermally altered stone feature encountered. Multi-state evident types were identified at the Connoquenessing site and at Lums Pond.

Single-State Evident Features

At the Connoquenessing site, well-delimited hearths with fire-cracked rock were preserved. In one example, there was a hearth which retained its original morphology and contents, along with reddened subsoil, indicative of in situ heating (Figure 4). Charcoal was concentrated within the feature, and heated rock was found in abundance. Multiple refits among the fire-cracked rock further indicated the primary cultural nature of the feature.

In the Kettle Creek site, there was a wide range of evident types. A large group of features were classed as hearths, so defined from their shallow basin shape and the amount of fire-cracked rock associated with them. One hearth feature unique to the site was a large, shallow basin filled with densely packed fire-cracked rock (Figure 5). The fire-cracked rock was brittle, as if heavily or repeatedly burned, and many pieces were fractured in place. A dark, charcoal laden soil surrounded the thermally altered stone. The stone lay atop a layer of charcoal and ash, which was dark greyish brown and black in color. Another feature that retained its original shape (Figure 6) contained fire-cracked rock that was generally angular and displayed low weights. This suggested repeated heating and rapid cooling of the material, perhaps associated with stone boiling. The feature contained reddened and fire-hardened sediment with a collection of thermally altered stone lying adjacent. A similar configuration has been described in ethnoarchaeological settings for stone boiling features where stones were laid beside the hearth to dry out prior to reheating.

Multi-State Evident Features

The sites also preserved thermally altered stone in evident features that may be viewed as in multi-state cultural contexts. In the Connoquenessing site, features retained lenses of charcoal and cultural fill (Figure 7). There was no evidence of in situ heating. The thermally altered stone was likely dumped in the feature since there were only a few pieces of thermally altered stone and these often times did not refit. In other cases, association of fire-cracked rock may have been incidental. For example, one feature showed evidence of infilling during the normal course of site activity and not as a result of purposeful maintenance activity (Figure 8). The end-result was the same: a pit with scattered pieces of thermally altered rock and no evidence for in situ burning.

In the Lums Pond site in Delaware, a series of large, deep, rounded pits were fully exposed. These pits were often considered to be storage features based on their size and shape parameters and ethnographic parallels. Archaeological support for this interpretation came from the lack of evidence of fire alterations and evidence for secondary infilling. In at least one case, the fill appeared to be derived from intentional and rapid refuse disposal, resulting in distinct charcoal lenses and a number of pieces of fire-altered rock (Figure 9). In others pits, the fill appeared to be the result of slower cultural processes occurring during site occupations. In either case, the pits may be classified as multi-state evident features, containing variable densities of thermally altered stone deposited as secondary refuse.

Latent Features

Latent features were identified in the Lums Pond site. As indicated earlier, latent features are features which may not have been readily visible in archaeological context. This was the case for fire-cracked rock distributions buried in alluvium. During excavations, scatters of fire-cracked rock were noticed in a buried A-horizon (Figure 10). Once this floor was mapped and contoured, it was noted that certain zones contained higher concentrations of fire-cracked rock. There were no strict boundaries, but some degree of clustering was observed. As a consequence, it was surmised that the clustering was cultural in origin. To help address this issue, refitting of the fire-cracked rock was performed. While fire-cracked rock fragments were shown to refit across several excavation units, refits were discovered within a concentration highlighted by cluster analysis. Refits of heated and non-heated chipped stone also suggested re-use of this surface. The contour plotting and the refitting suggested that the remnants of a scattered hearth was identified.

Non-cultural Transformations

Fire-cracked rock was shown to be of great use for helping to identify transformations of original cultural patterns by postdepositional processes. At the Lums Pond site, refitting of the fire-cracked rock showed the effects of natural processes on feature and site distributions. The vertical disturbances of fire-cracked rock appeared to be caused by natural processes which occurred after burial, moving fragments upward and downward in the profile (Figure 11). Interestingly, size sorting was observed as the fire-cracked rock, being larger and heavier, was not as vertically separated as the smaller chipped stone assemblage.

Fire-cracked rock distributions can play an important role in the search for cultural patterning, and in particular, feature identification in plow zone contexts. In the Lums Pond site, spatial plotting procedures were conducted on the thermally altered stone in the plow zone as a means of locating remnant features (Figure 12). In an area where subsurface pit features were preserved, there were indeed fire-cracked rock clusters retained in the plow zone. This suggested that while the plow had redistributed the artifacts, some of the original spatial patterning was preserved. Moreover, associations between the thermally altered stone and the subsurface features were often implied by the distributions, with hearths situated adjacent to the pits. In other cases, however, when plots were constructed, as is in the case from Lums Pond, wide spreads of thermally altered pieces were observed, as if mechanical plowing has irreparably harmed some original patterning.

DISCUSSION

An attempt has been made to demonstrate the value of targeted analysis of an important artifact type: thermally altered stone. Thermally altered stone has an important role to play in understanding the formation of sites. As a result, archaeologists should make a concerted effort to examine the various cultural and natural processes involved in forming distributions of thermally altered stone. The results of the presented case studies suggest that there is value in the analytical approach taken here. It should be anticipated that there will be recurrent patterns in thermally altered stone features, and that distinctions can be made among original, functional patterns and transformed distributions. It is recognized, however, that the relationships are complex, and certainly not straightforward. The entire spectrum of formation processes, from initial feature construction and use to alterations resulting from later cultural and natural processes, can be extensive. Thus it is necessary to treat thermally altered stone and related features explicitly in some level of analytical detail, rather than simply counting, or worse, discarding the stones after excavation. Analysts will then be in a special position to gather a far greater amount of interpretive information about the processes leading to observed spatial configurations and preservation conditions of these features in archaeological context.

Acknowledgements

The archaeological excavations conducted in Pennsylvania were carried out on behalf of the CNG Transmission Corporation. Many individuals at CNG and the Pennsylvania Bureau for Historic Preservation assisted the authors during these excavations. The excavations at Lums Pond were performed for the Delaware Department of Transportation. Kevin Cunningham, DelDOT archaeologist, provided constant support and encouraged research on site formation. Fellow archaeologists at Parsons Engineering Science provided their services in the field, laboratory, and office, especially John Rutherford, Carter Shields, and Sulah Lee. More than 100 field crew members were responsible for carefully documenting the thermal patterns found in the Pennsylvania and Delaware sites, and to them we owe our thanks.

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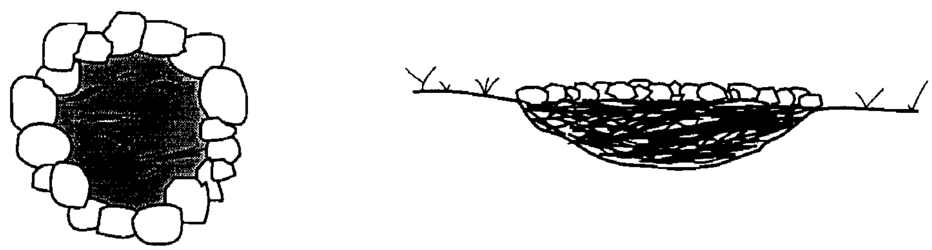
LIST OF FIGURES

Figure 11. Vertical transformations shown in a Lums Pond profile, demonstrated by artifact refitting. The vertical distances of refit core/flake and fire-cracked rock was likely caused by natural processes after burial, moving artifacts upward and downward in the profile. Note that the larger, and heavier fire-cracked rocks were not as vertically disturbed as the smaller core/flake refits, indicative of size-sorting.

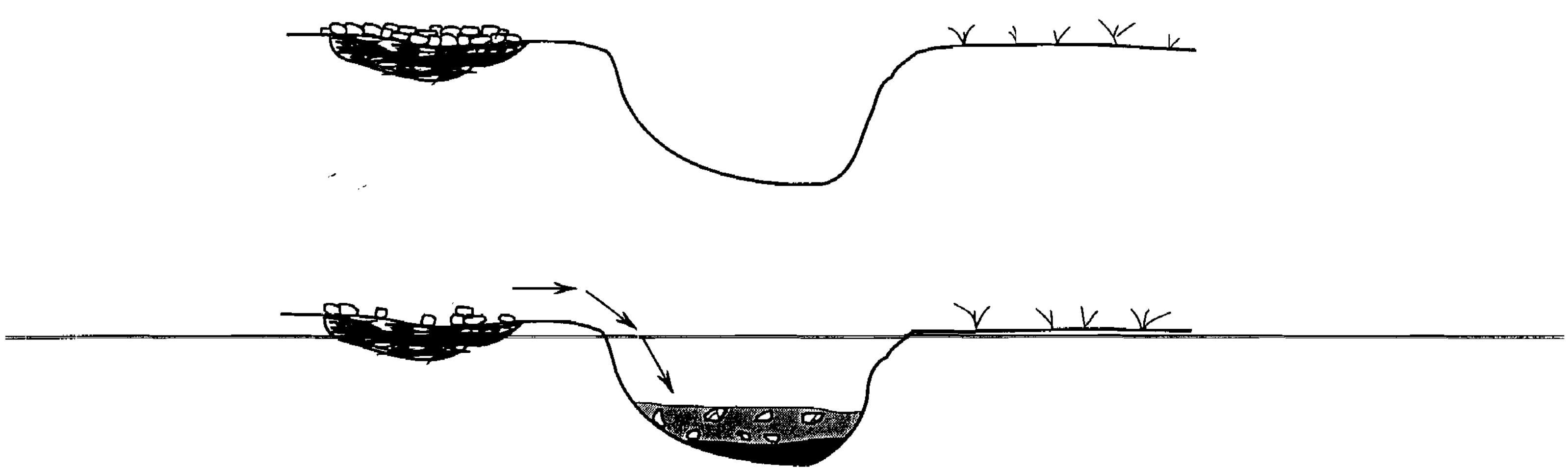
Figure 12. Horizontal plow zone transformations, Lums Pond. The plow disturbed artifacts across the occupation surface, and truncated the top of the pits. Spatial plotting showed that thermally altered stone clusters occurred in the plow zone, indicating that hearths may have been adjacent to the pits.

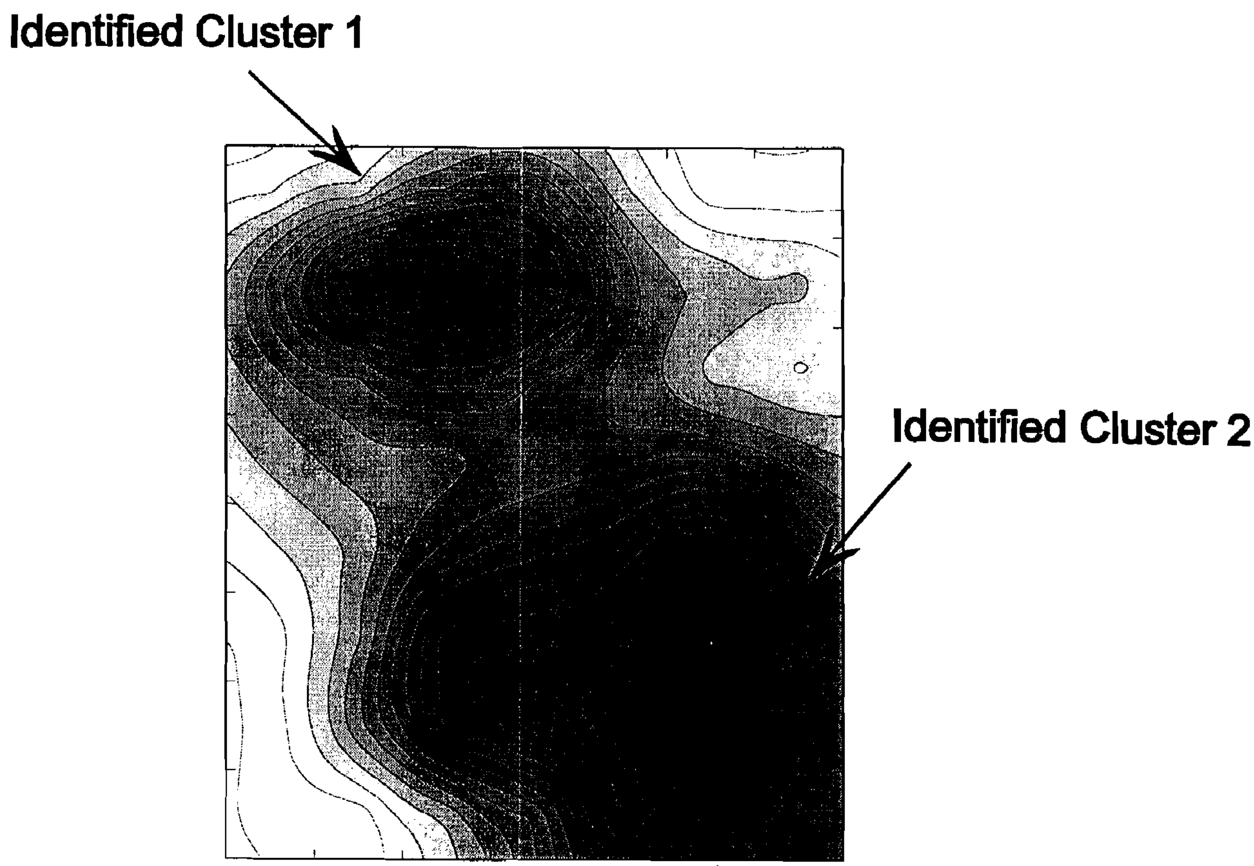
A. Single State

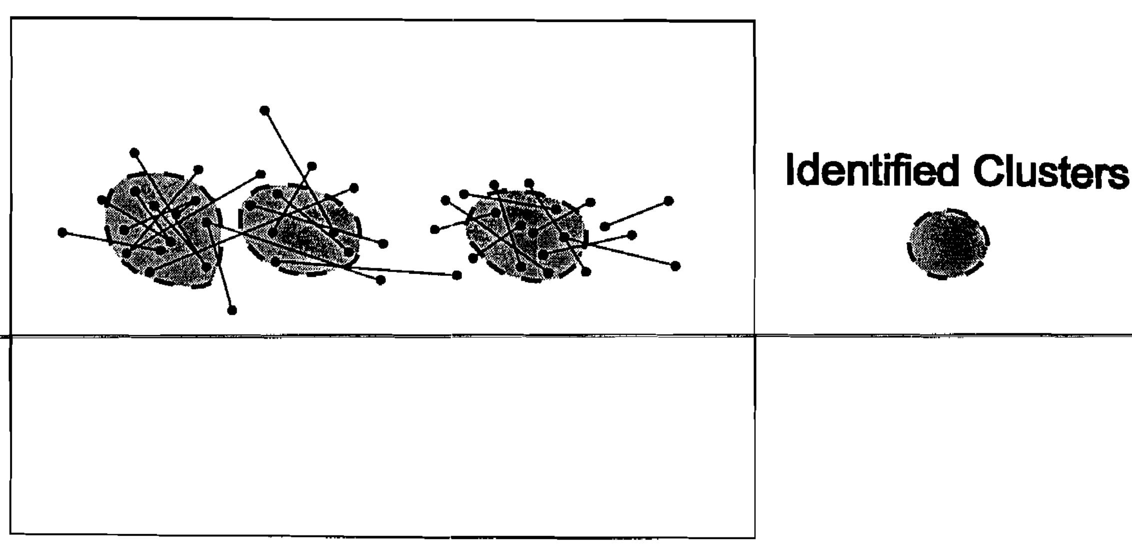
Plan | Profile

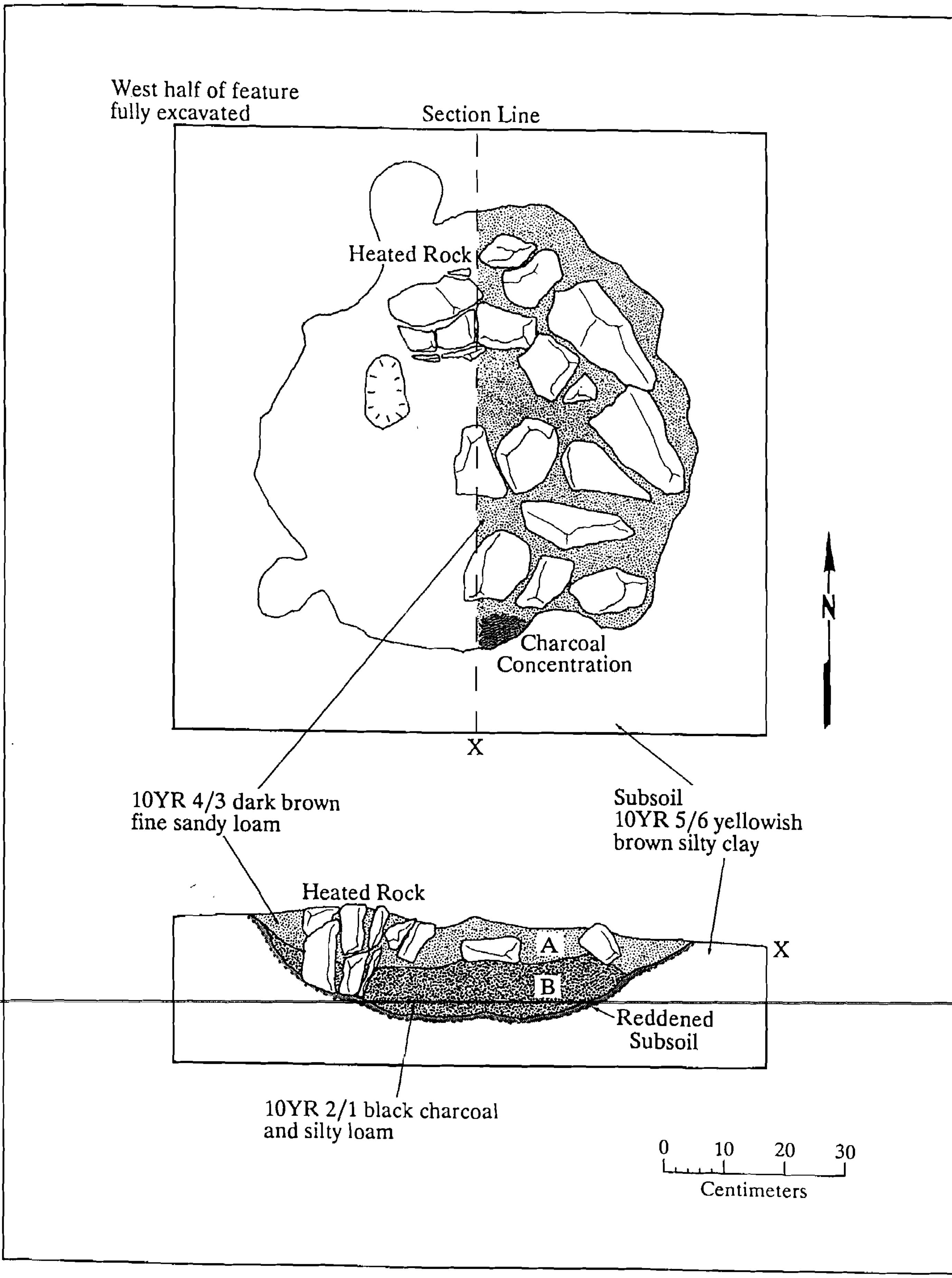


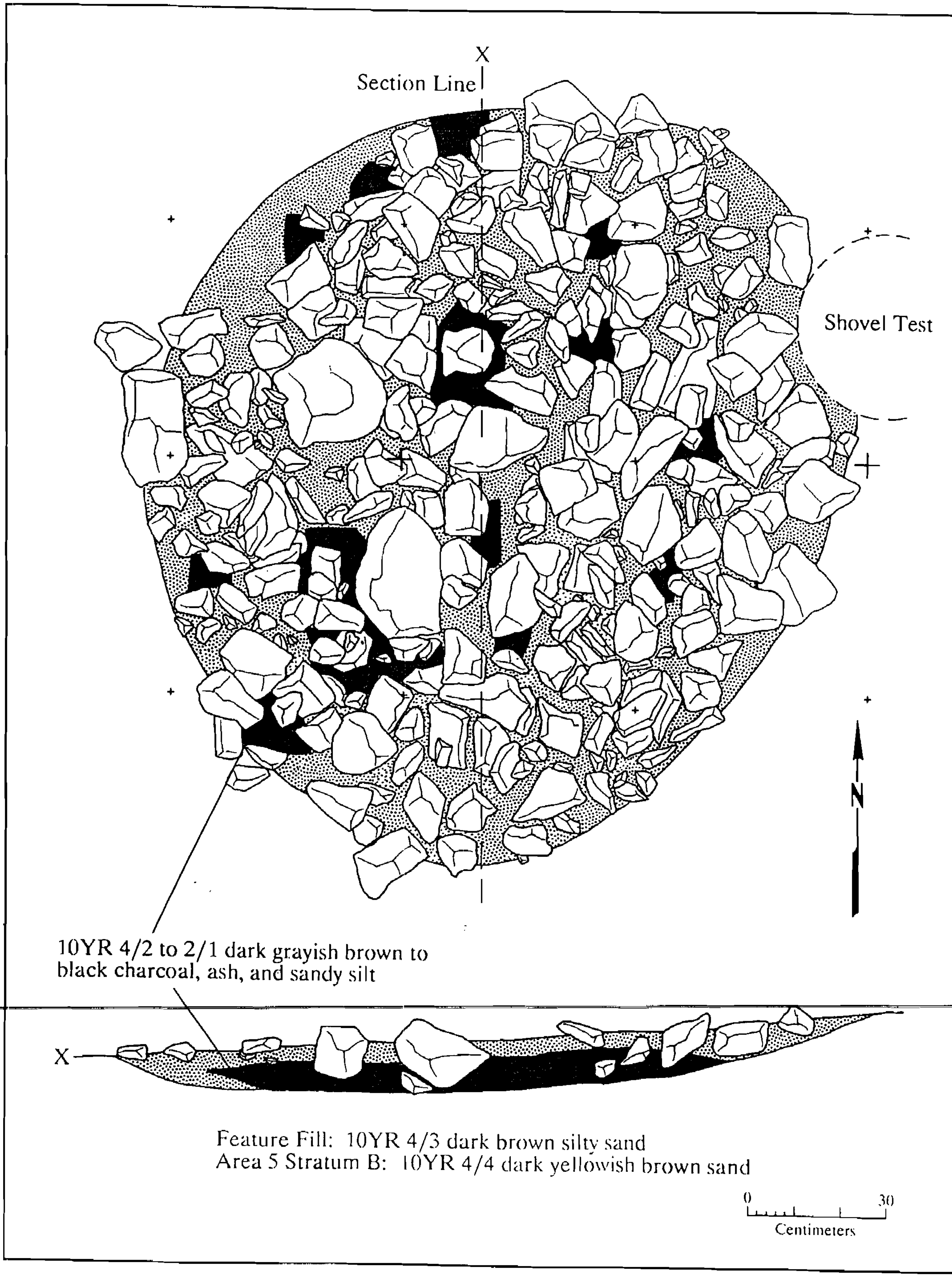
B. Multi-State

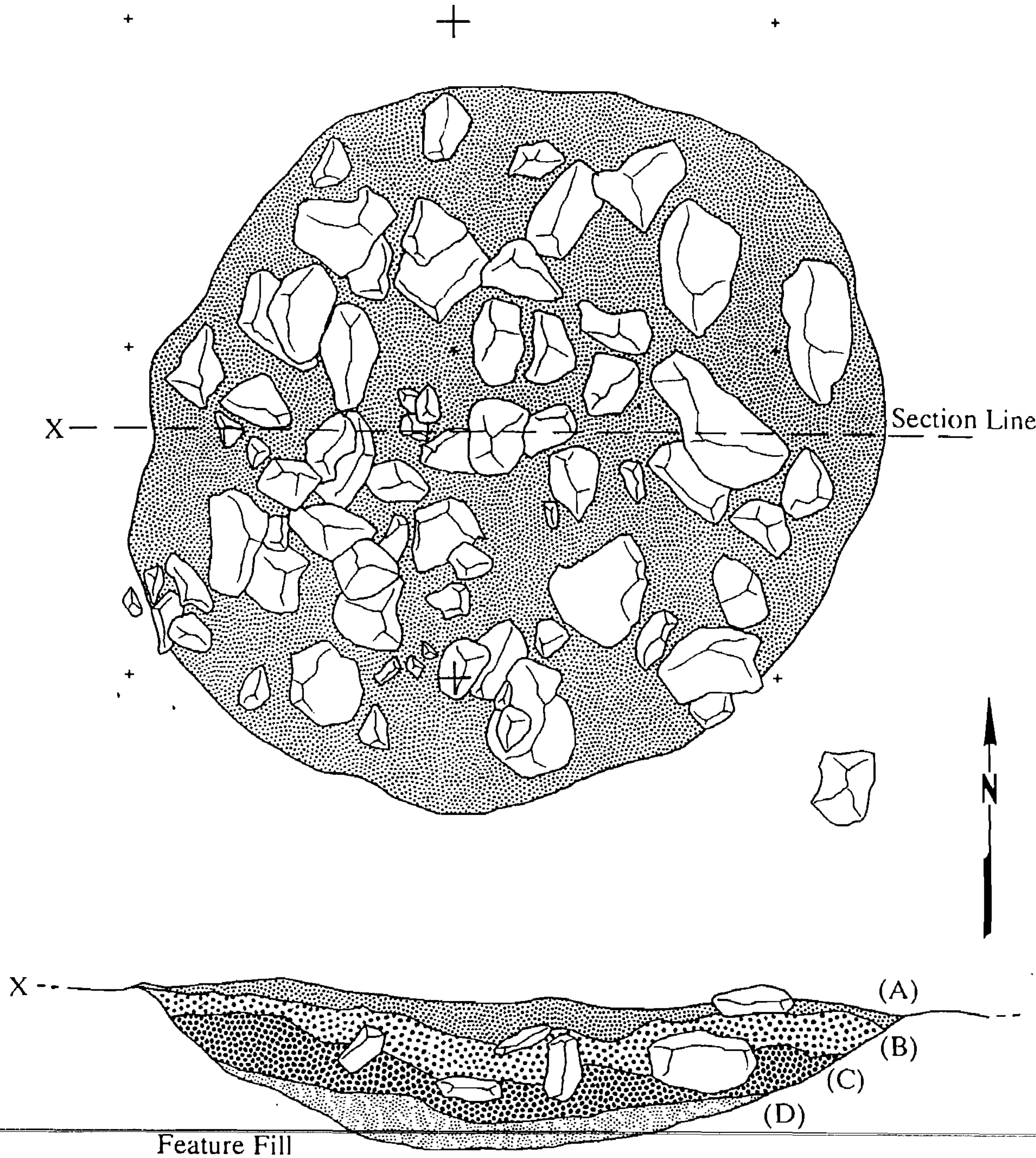



Identified Cluster 1
Identified Cluster 2


Identified Clusters


West half of feature
fully excavated
Section Line
Heated Rock
Charcoal
Concentration
X
N
10YR 4/3 dark brown
fine sandy loam
Subsoil
10YR 5/6 yellowish
brown silty clay
Heated Rock
A
B
X
Reddened
Subsoil
10YR 2/1 black charcoal
and silty loam
0
10
20
30
Centimeters

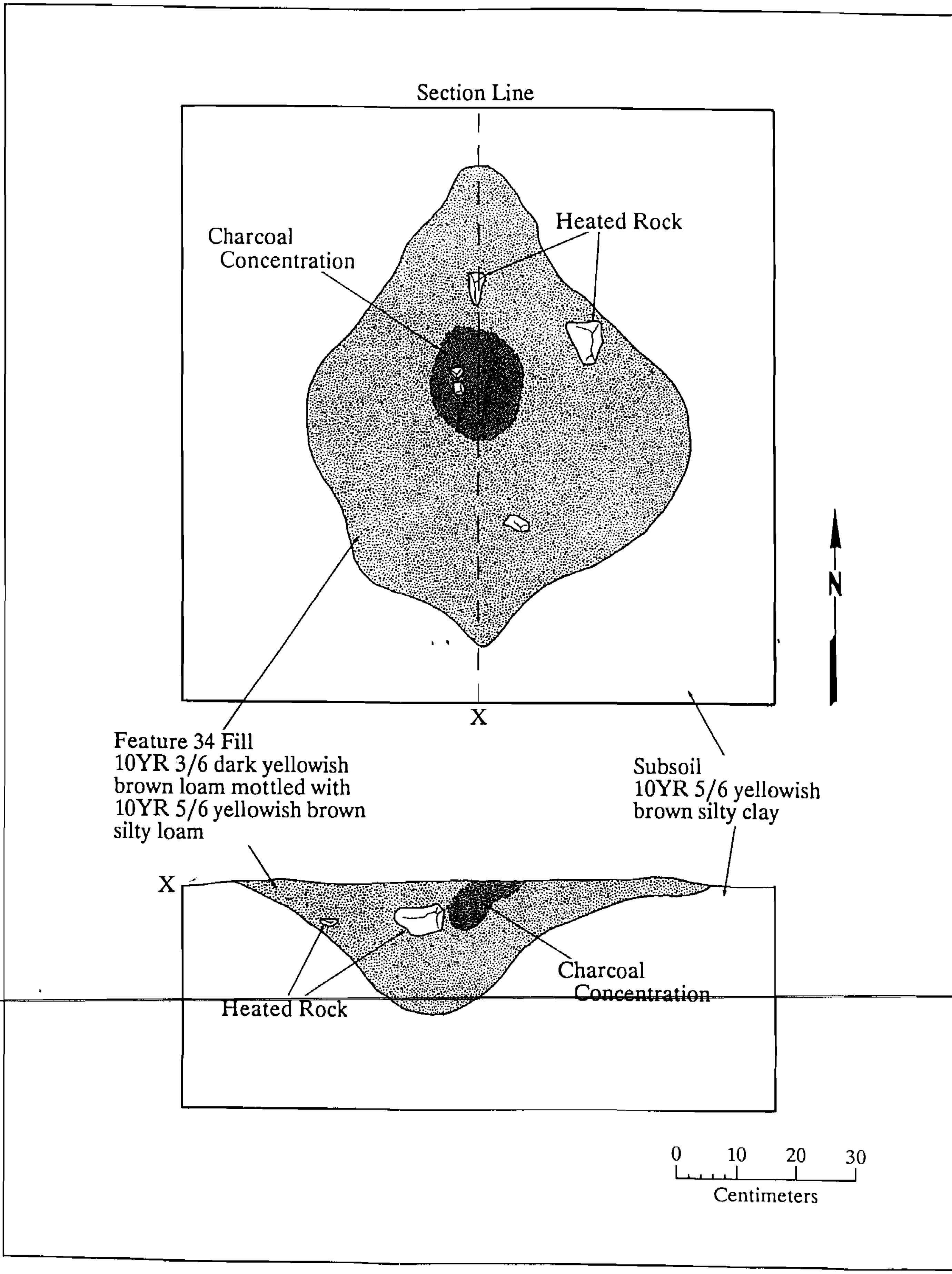

X
Section Line
Shovel Test
N
10YR 4/2 to 2/1 dark grayish brown to black charcoal, ash, and sandy silt
X
Feature Fill: 10YR 4/3 dark brown silty sand
Area 5 Stratum B: 10YR 4/4 dark yellowish brown sand
0
30
Centimeters



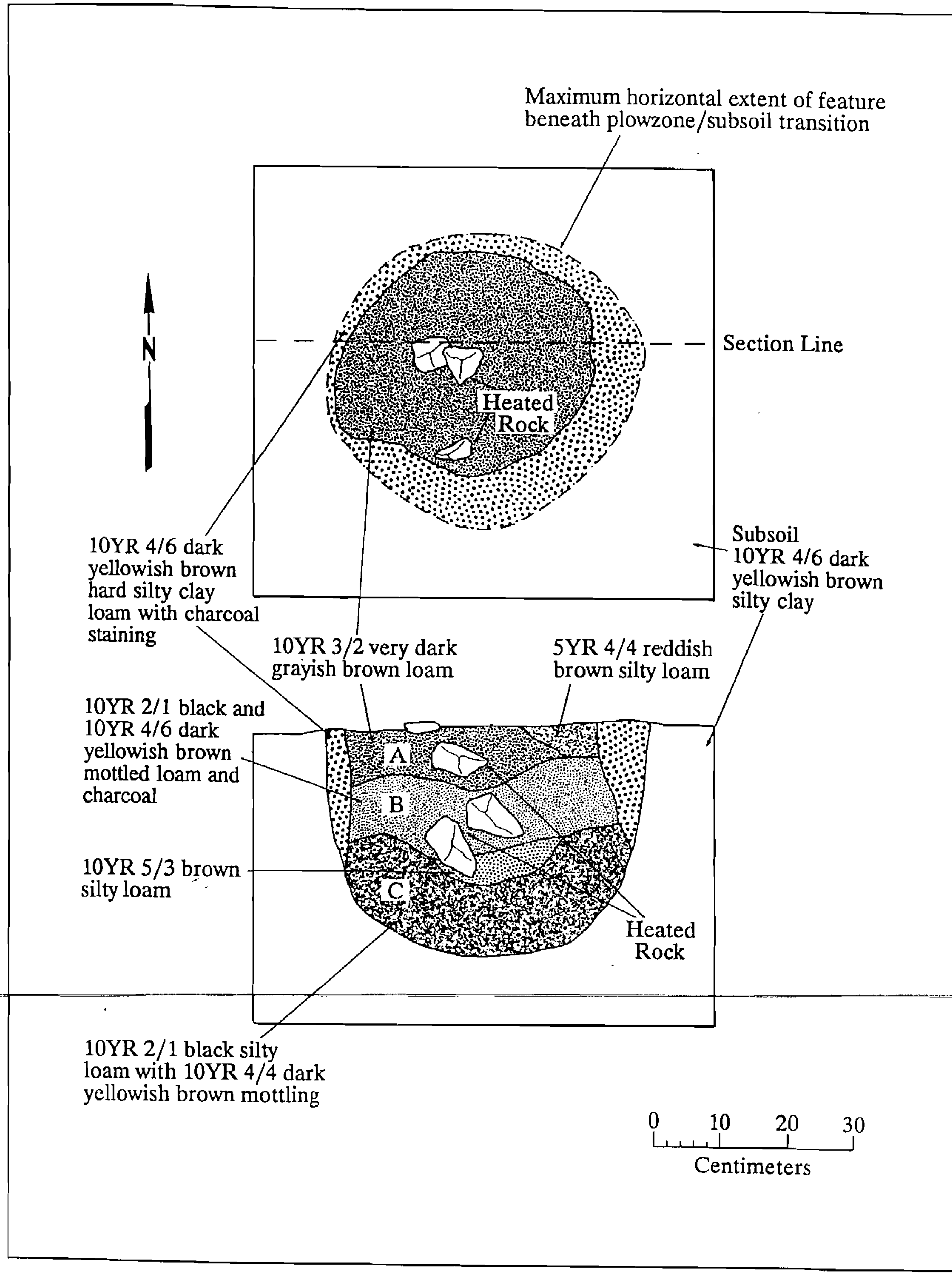
Feature Fill
Feature Stratum A: 7.5YR 4/4 dark brown silty sand
Feature Stratum B: 5YR 4/2 dark reddish gray silty sand
Feature Stratum C: 7.5YR 2/0 black silty sand
Feature Stratum D: 7.5YR 4/4 brown/dark brown mottled with
7.5YR 5/3 brown and 10YR 3/1 very dark gray silty sand

Area 6 Stratum B: 7.5YR 4/6 strong brown silty sand

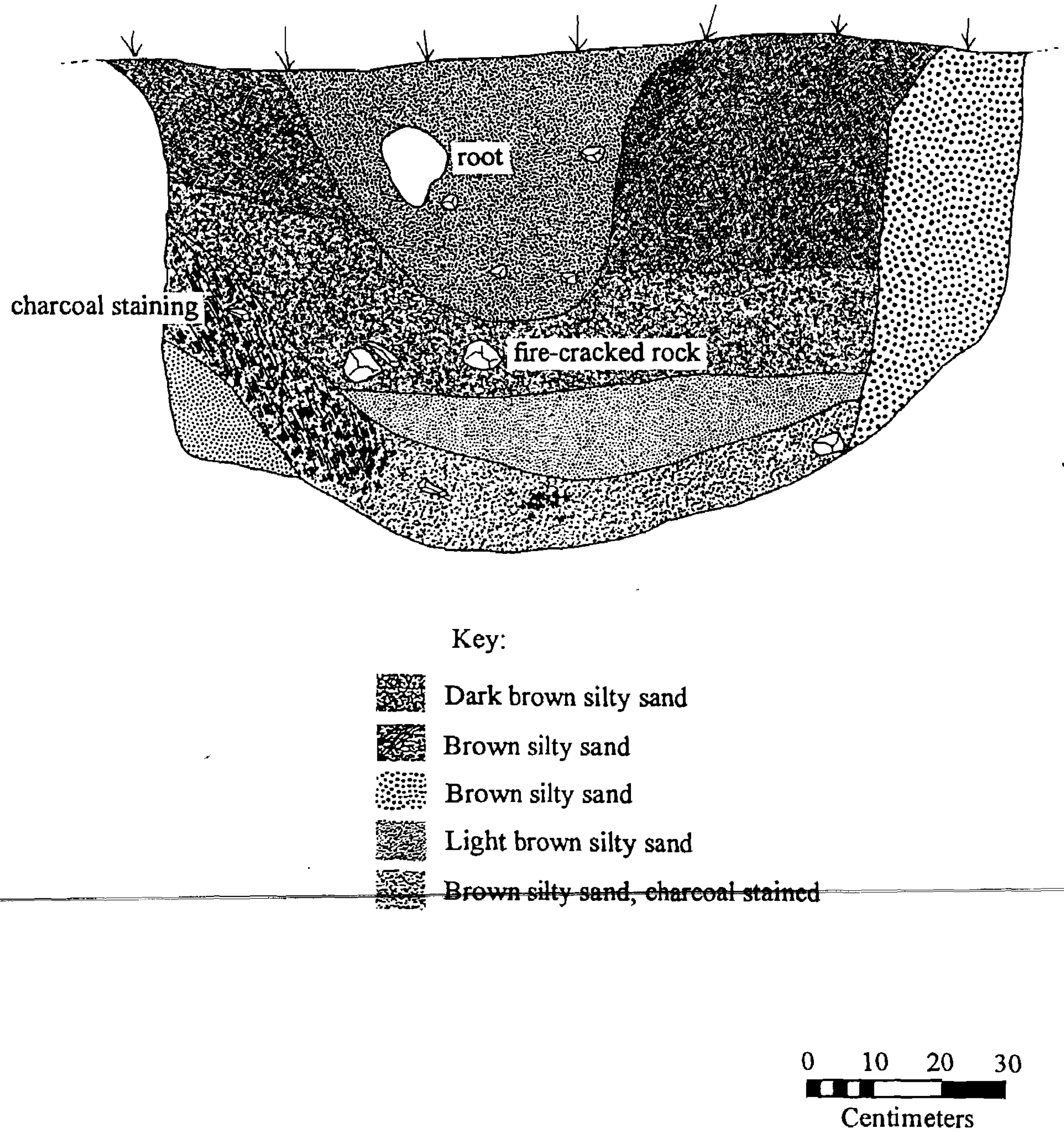
0 30
Centimeters



Section Line
Heated Rock
Charcoal Concentration
N
X
Feature 34 Fill
10YR 3/6 dark yellowish brown loam mottled with 10YR 5/6 yellowish brown silty loam
Subsoil
10YR 5/6 yellowish brown silty clay
X
Charcoal Concentration
Heated Rock
0 10 20 30
Centimeters

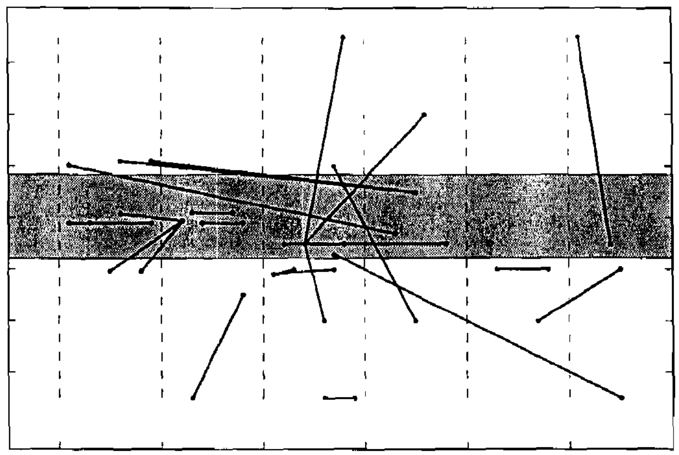


Maximum horizontal extent of feature beneath plowzone/subsoil transition
N
Section Line
Heated Rock
Subsoil 10YR 4/6 dark yellowish brown silty clay
10YR 4/6 dark yellowish brown hard silty clay loam with charcoal staining
10YR 3/2 very dark grayish brown loam
5YR 4/4 reddish brown silty loam
10YR 2/1 black and 10YR 4/6 dark yellowish brown mottled loam and charcoal
A
B
C
10YR 5/3 brown silty loam
Heated Rock
10YR 2/1 black silty loam with 10YR 4/4 dark yellowish brown mottling
0 10 20 30
Centimeters


root
charcoal staining
fire-cracked rock
Key:
Dark brown silty sand
Brown silty sand
Brown silty sand
Light brown silty sand
Brown silty sand, charcoal stained
0 10 20 30
Centimeters

A. Core/Flake Refits

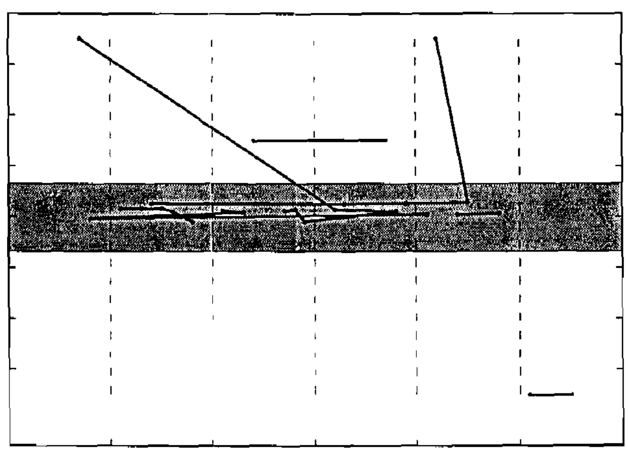
10 cm levels



1 m units

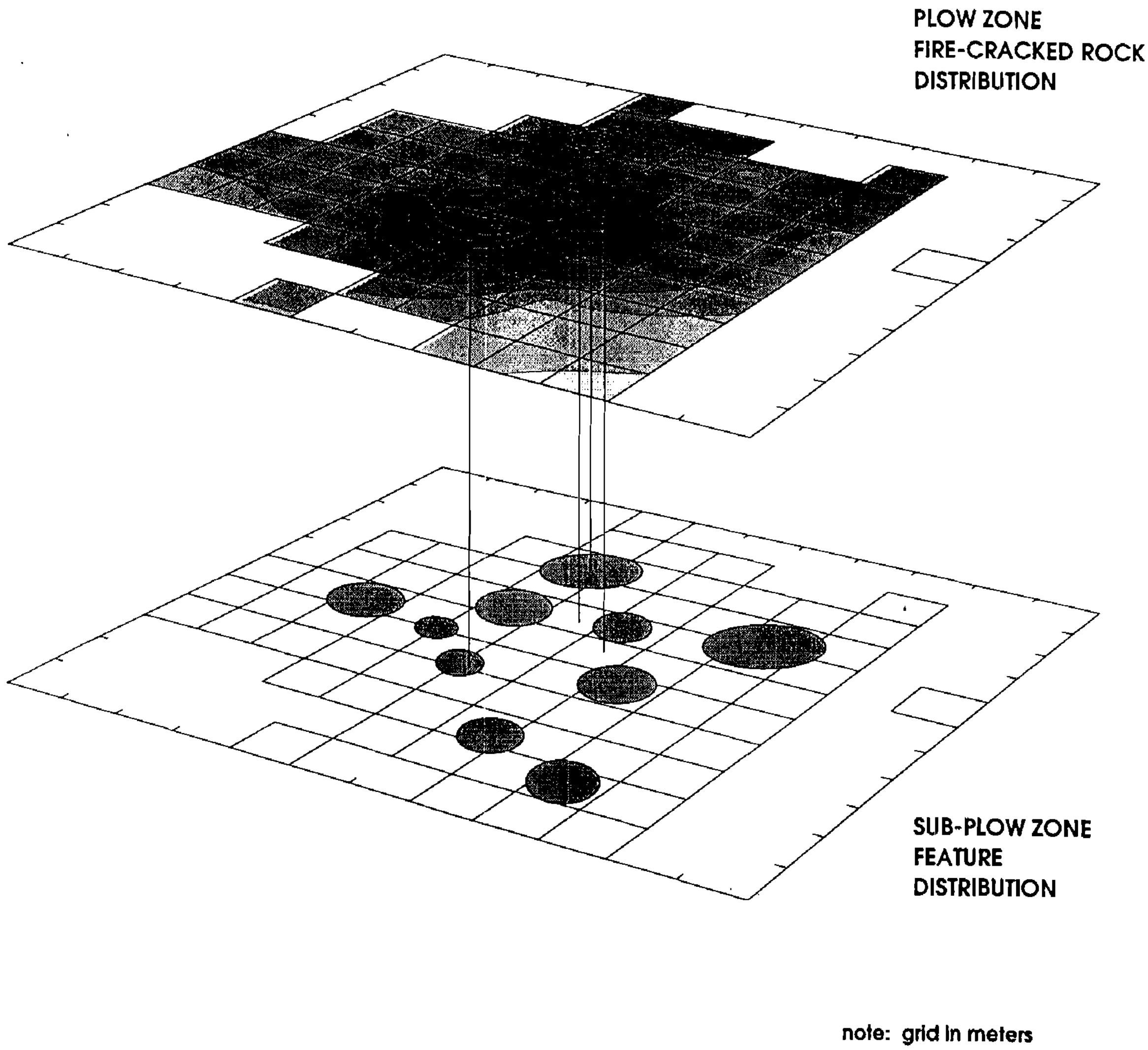
B. Fire-Cracked Rock Refits

10 cm levels



1 m units

note: shaded areas show approximate level of original deposition


PLOW ZONE
FIRE-CRACKED ROCK
DISTRIBUTION
SUB-PLOW ZONE
FEATURE
DISTRIBUTION
note: grid in meters