Site Formation Processes at the Spring Valley Site (23CT389), Ozark National Scenic Riverways, Missouri

By

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Submitted to the graduate degree program in Anthropology and the Graduate Faculty of the University of Kansas in partial fulfillment of the requirements for the degree of Master of Arts.

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Date Defended: July 11, 2018

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Date Approved: July 24, 2018

ABSTRACT

The Spring Valley site (23CT389) is stratified, multicomponent site associated with a co-alluvial fan in Ozark National Scenic Riverways, Carter County, Missouri. Recorded prehistoric occupations range from Middle Paleoindian to Middle Archaic. My study focused on site formation processes at 23CT389 and included (1) description of soils and sediments; (2) particle-size analysis; (3) coefficient of linear extensibility; (4) radiocarbon dating; (5) limited refit analysis; (6) limited debitage analysis; and (7) three-dimensional spatial analysis of piece-plotted artifacts. Results indicate that the site has undergone some mixing of artifacts, particularly size-sorting with depth of artifacts such as debitage under ½”. Larger artifacts such as bifaces, however, have largely maintained vertical and horizontal integrity. Of significance, a Dalton occupation surface has been defined, and an Early Archaic occupation has significant integrity.

ACKNOWLEDGEMENTS

No one would ever say writing a thesis is easy, but the individuals listed here certainly tried to make it more so. Without their help, this project would never have been realized.

First, I want to thank my committee chair, Dr. Rolfe Mandel. He has sacrificed time and patience to help guide me through the MA program and thesis. He has taught me more than I thought possible about geoarchaeology during our class time, but moreover in our countless conversations. I also want to thank him for encouraging me when I first discovered an interest in geoarchaeology. Without those phone calls and emails during my time in Arizona, I doubt I would have found myself working in this field. I am truly indebted to him.

I also would like to thank my committee members, Dr. Jack Hofman and Dr. Daniel Hirmas. The two of them have been amazing over the last few years. Thank you both for your advice, critiques, and support.

Dr. Mary Adair provided a steady source of support and guidance over the last few years. She helped me not only by providing employment, but also acted as a friend and mentor. I will be forever grateful for her help.

Without the aid of Randy Cooper, I would never have completed my spatial analysis. He devoted his expertise and time in helping me address the problematic data, and I will always be thankful for his help.

I appreciate the efforts of the numerous people who helped in the 2017 testing at Spring Valley, and especially to Jack Ray who led the excavation. This project would have been impossible without your collective hard work.

Thanks to the National Park Service and the staff at Ozark National Scenic Riverways. Without the help of these individuals, we would never have an opportunity to explore an amazing site. On that note, thanks to the Odyssey Archaeological Research Fund for providing funding for this work.

Caroline, thank you for putting up with my complaining and stress over the last year or so. Thanks too to Sally for being a good girl and the sweetest dog I have ever met. Finally, I want to say thank you to my amazing family. Without their unwavering support and inspiration, I never would have made it through this process. Thank you all so, so much.

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CHAPTER 1

INTRODUCTION

The Dalton archaeological tradition, first identified by Chapman (1948), has been documented throughout the Eastern United States (e.g., Anderson and Sassaman 1996; Ballenger 2001; Craib 2016; Chapman 1948, 1975; Lopinot and Ray 2010; O'Brien and Wood 1998; Ray 1998, 2016; Sherwood et al. 2004). Archaeologists have recorded Dalton components in open-air, rockshelter, and cave sites. While professional and avocational archaeologists have recovered thousands of Dalton hafted bifaces from surface collection and excavation, relatively few well-stratified Dalton occupation sites, such as Rodgers Shelter (Wood and McMillan 1976), Graham Cave (Klippel 1971; Logan 1952), Big Eddy (Lopinot and Ray 2010, Ray 1998), and the Arnold Research Cave (Shippee 1966), have been excavated (McMillan and Klippel 1981; O'Brien and Wood 1998). Therefore the 2017 excavation of the Spring Valley site (23CT389), a multicomponent site with a large Dalton component, has potential to provide valuable new insights into the Dalton tradition, but that potential relies on the integrity of its archaeological materials.

In the summer of 2017, the University of Kansas Odyssey Research Team conducted testing at 23CT389 in Carter County, Missouri (Figure 1 and Figure 2). The site is located on a co-alluvial fan at the mouth of Spring Valley Branch, near the confluence of Big Spring's outflow and the Current River within the Ozark National Scenic Riverways (ONSR).

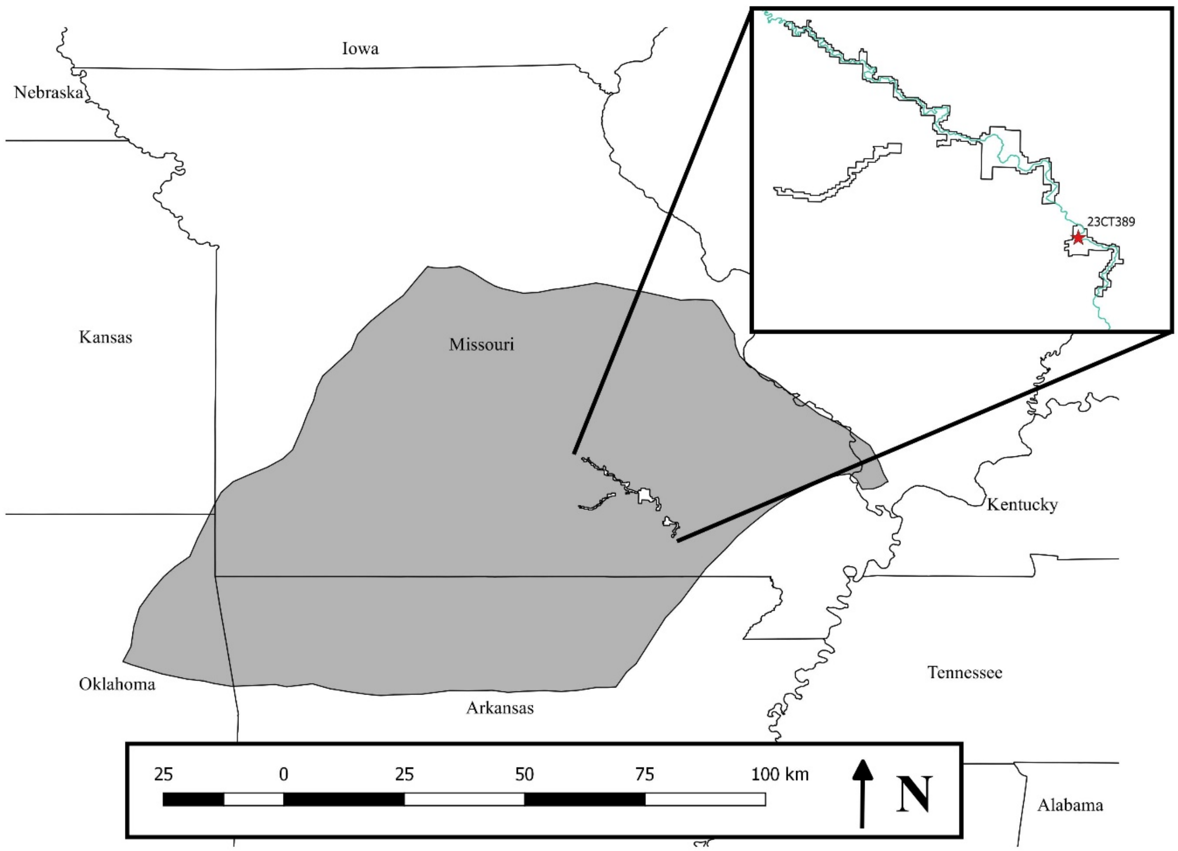

Figure 1. Map of Missouri showing the location of the Ozark Plateau physiographic province (shaded area) and the Ozark National Scenic Riverways (ONSR). Inset shows the location of the Spring Valley site (23CT389) within the boundaries of ONSR.

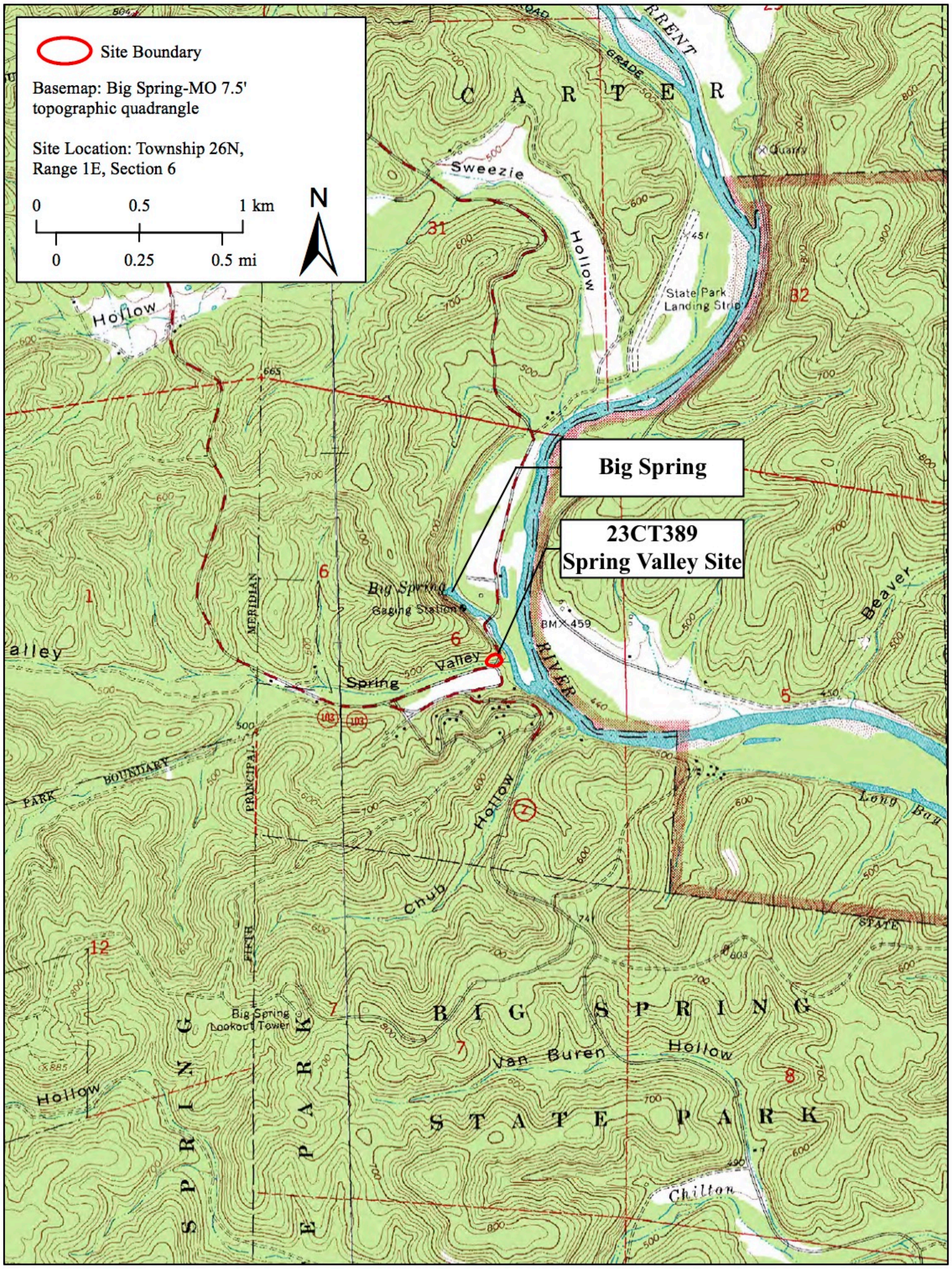

Figure 2. Location of the Spring Valley site (23CT389) and Big Spring.

Dr. James E. Price of the Southeast Missouri Archaeological Resource Center first recorded 23CT389 in 1994 when the National Park Service installed a water line to a Civilian Conservation Corps (CCC) bathhouse (HS-423). Dr. Price examined the back-dirt pile from the construction and noted the presence of Dalton and Archaic hafted bifaces, non-hafted bifaces, biface fragments, and debitage (Price 1993). The site was recorded, given a state site number (23CT389), and covered. The site remained untouched until 2016 when the Odyssey team placed two auger tests on 23CT389 to determine the depth of deposits, and in 2017 the team returned for testing.

It is likely that much of the archaeological record at 23CT389 was obliterated in 1935 with the construction of the bathhouse (Figure 3). At that time, CCC employees removed an indeterminate amount of soil from the surface of the co-alluvial fan to level the land. Next, they constructed the bathhouse and a stone retaining wall, and dry-laid abutments against the embankment (Figure 4) (Bishop 2015). CCC employees also may have widened the channel of Spring Valley Branch as it is ca. 15 m wide and 4 m deep beside the site, but slightly upstream is only 5 m wide and 1 m deep (Ray and Mandel 2017). During these construction processes, it is likely that archaeological materials were removed along with the soil. Hence, there is a truncated archaeological record at Spring Valley.

The primary objective of the Odyssey excavations at 23CT389 was to determine if Early Paleoindian and/or pre-Clovis cultural deposits are present. Between 50 cm and 1 m of modern disturbed fill was removed to reach undisturbed sediments. In some excavation units, the modern fill was more than 1 m thick. Despite the magnitude and depth of disturbance related to the construction of the bathhouse, the 2017 testing effort revealed that the site has a significant

Figure 3. HS-423 is a historic CCC-era bathhouse. Construction of HS-423 lead to the removal of soil from the landform, likely removing post-Early Archaic archaeological components. View is to the northwest.

Figure 4. HS-423 after construction. A stone retaining wall and abutments were dry laid against the embankment, date unknown. View is to the north (Bishop 2015: Figure 2-60).

Dalton occupation (10,500-9,800 ^{14}C yr B.P.), ephemeral Middle Archaic components (7,000-4,500^{14}C yr B.P, respectively), multiple Early Archaic (9,800-7,000 ^{14}C yr B.P.) components, and a possible Middle Paleoindian component (10,800-10,500 ^{14}C yr B.P.). None of these components had been affected by land leveling.

Having yielded a thick Dalton component, the Spring Valley site thus has potential to contribute to our collective knowledge of the Dalton tradition. That potential, however, depends on the stratigraphic integrity of the site and the spatial integrity of cultural materials. Dalton diagnostics were recovered throughout 1.3 vertical meters of soil. However, due to the clay-rich nature of the soil as well as the numerous krotovinas 2-4 cm in diameter encountered during excavation, it seems likely that there has been significant mixing at the site from the combined processes of argilliturbation and bioturbation.

Site formation processes include both natural and anthropogenic processes that operate in various depositional environments and can cause post-depositional disturbances, affecting the spatial integrity of the cultural record (Mandel et al. 2017). Such processes transform the archaeological record from the moment of initial deposition (Schiffer 1976, 1987). Moreover, artifacts located in the same geologic strata often are assumed to be part of a single assemblage representing a discrete cultural entity (Bruner 2003). Grouping these artifacts often results in misinterpretations of the record and establishes a limit on the temporal and spatial resolution with which these analyses may be applied to the study of the past. Bruner (2003:41) notes:

> Experimental research and specific case studies have demonstrated that artifacts routinely migrate both vertically and laterally as a result of post-depositional processes…The potential for artifacts to migrate across stratigraphic breaks has significant implications for the cohesion of assemblages collected using geological boundaries as cultural dividers…[interpretation] is problematic when the palimpsest nature of the archaeological record and the material evidence of the routine migration of artifacts from their location of deposit are taken into consideration.

Therefore, any analysis of past human behavior at the site must take into consideration the stratigraphic integrity of the site, and identify cultural or natural processes that may have affected the vertical and horizontal context of cultural deposits. As Hofman (1992b:129) noted, "Unknowingly treating mixed assemblages as representing the discard of a single group or occupation will lead to spurious conclusions".

To examine the stratigraphic integrity of the Spring Valley site, I addressed the following research questions:

1. How did the site form and what post-depositional processes have occurred?
2. How did post-depositional processes affect the archaeological record?
3. Is it possible to identify discrete occupations at 23CT389?

My hypotheses were as follows:

1. The landform aggraded rapidly due to complex interactions between alluvial and colluvial processes.
2. Rapid aggradation resulted in rapid burial of archaeological occupations.
3. Post-depositional processes such as argilliturbation and bioturbation have differentially translocated artifacts from their original depositional locations depending on the size of the artifacts.
4. Because of post-depositional disturbance, the ability to identify the number of occupations is limited to diagnostic material types.

The first stage of analysis was determining the geomorphic and stratigraphic context of the site, followed by a limited refit and spatial analysis to determine the extent of movement of the artifact assemblage within the site. The final stage of analysis consisted of closely examining spatial relationships between in situ cultural materials to determine discrete occupations.

By understanding site formation and occupation episodes at 23CT389, analyses of past human activity are more informed. Furthermore, insight into site formation processes can help unravel the number and nature of occupation episodes, thereby addressing questions of site use and function. Future work, such as lithic and paleobotanical analysis, can provide a more comprehensive understanding of past human behavior at 23CT389.

CHAPTER 2

BACKGROUND RESEARCH

The Ozark Plateau has a rich archaeological record spanning the Paleoindian through the Historic periods (Chapman 1975, 1980; Dempsey 2012). Dalton sites are common, and at least one locality, the Big Eddy Site, may have a pre-Clovis component (Ray et al. 2000). This section describes the 2017 excavations at 23CT389, site formation processes, the modern environment and the Quaternary geology of the region, and prior geoarchaeological and geomorphological research relevant to the Spring Valley site.

2017 Excavation History

The Odyssey excavations at 23CT389, which serve as the basis for my thesis, occurred from June 10 through July 29, 2017. Led by Jack Ray of Missouri State University, crew size varied between six to ten people. A total of 17 test units were opened south of a historic sidewalk (Figure 5). An excavation grid was established, and a local datum was placed 13 m to the west of the excavation block. All depths will be described as centimeters below local datum or cmbd.

The excavation crew used a Topcon GTS 313 Total Station for mapping purposes. First the location of the excavation block was mapped, followed by the local area including the bathhouse, the sidewalk, and local topography. During excavations, select cultural materials were mapped in situ including grinding stones, lithic tools, charcoal, and features.

Test Units (TU) 5 and 7 were taken to a depth of 330 cmbd, TU 3 to a depth of 300 cmbd, and TU 1 to a depth of 210 cmbd. The remaining test units were terminated at a depth of 150 cmbd. The northern halves of Test Units 3 and 7 were screened through ¼” mesh and all

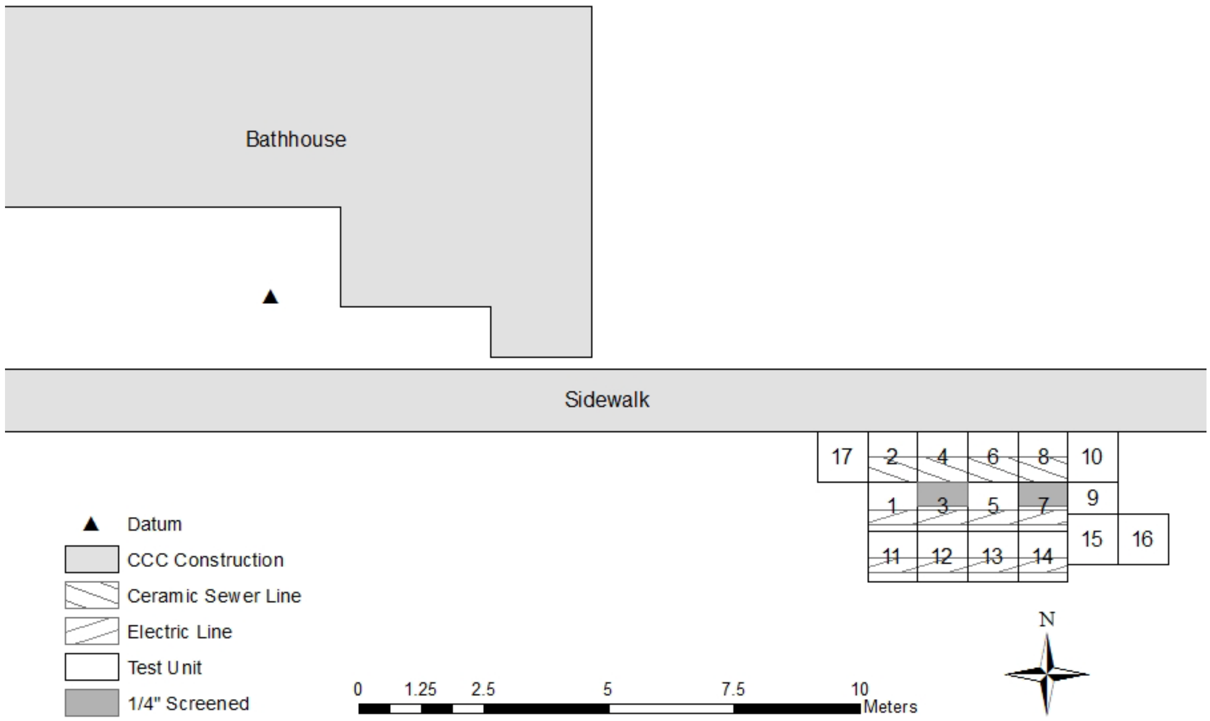

Figure 5. Map of 23CT389 showing the locations of test units, screened portions of units, utility lines, and CCC-era construction.

artifacts were recovered. Not all units were screened due to time and budget constraints, and instead were shovel skimmed. Artifacts encountered while shovel skimming were collected, but small pieces of debitage were probably missed. Two auger tests went to a depth of 80 cm below the base of excavations, or 410 cmbd. The augers did not encounter basal gravels.

During excavation, several electric lines and a ceramic sewer pipe were exposed (Figure 6). Two sets of live electric lines ran east-west through the site inside former trenches approximately 25 cm wide and up to 140 cmbd (Figure 7). Also, a ceramic sewer line was exposed along the southern margins of TUs 2, 4, 6, and 8 inside a former trench approximately 45 cm wide and 145 cmbd.

Figure 6. Photograph of electric lines and ceramic sewer line. PVC pipe was placed around electric lines to prevent accidental damage during excavation and backfilling by the Odyssey team. View to the east.

Figure 7. Exposed electric line trenches during excavation. View to the west.

Site Formation Processes

Key to interpreting the archaeological record at Spring Valley are site formation processes. According to Schiffer (1987:7), site formation processes are "factors that create the historic and archaeological records" (Schiffer 1987:7) and include both depositional environments and post-depositional disturbances. Formation processes include both anthropogenic and natural forces that affect artifacts and the spatial integrity of a site from the moment of deposition until moment of removal (i.e. excavation or erosion) (Mandel et al. 2017; Schiffer 1987).

Spring Valley experienced anthropogenic site formation prior to European contact and there was significant mixing in 1935. The CCC employees stripped the surface of the co-alluvial fan to construct a bathhouse in 1935, effectively truncating the archaeological record. Furthermore, by widening Spring Valley Branch's channel, the distal portion of the fan was removed along with part of the archaeological record. Trenches excavated to emplace the ceramic sewer line and the electric lines undoubtedly affected archaeological materials as well. In addition to these anthropogenic processes, multiple natural site formation processes, particularly pedoturbation, have likely affected the spatial integrity of the archaeological record at Spring Valley.

Archaeological sites can remain exposed on the surface for extended periods prior to burial, be buried rapidly, never be buried, or repeatedly buried and exposed. During these processes, multiple anthropogenic and natural processes impact the spatial association of cultural materials. Exposed artifacts are susceptible to movement by water, wind, gravity, animal trampling, and transport by people. Buried materials are subject to chemical weathering and translocation by physical means, such as animal burrowing or root movement. Organic artifacts can decay regardless of exposure to surface processes or burial processes.

Major processes that likely affected the integrity of Spring Valley include mass movement and pedoturbation. Mass movement (also known as graviturbation) causes materials to move downslope primarily through gravity, although water can lubricate and assist transportation. The process of mass movement can be a slow process, such as creep, solifluction, and subsidence, or may be a rapid process in the case of landslides or rockfalls (Rapp and Hill 2006).

Pedoturbation (i.e. soil mixing) includes a wide variety of forms that differentially affect the archaeological record (Mandel et al. 2017; Table 1). In the forests of the Ozark Highlands, where Spring Valley is located, bioturbation and argilliturbation are significant pedoturbation processes. Bioturbation is the mixing of soil and sediments by plants and animals and is separated into two categories: floralturbation and faunalturbation. Floralturbation processes include root growth, root decay, and tree throw. Root growth puts pressure on buried objects and can move artifacts vertically and horizontally (Mandel et al. 2017; Wood and Johnson 1978).

Root decay results in hollow cavities in soils and sediments. When these cavities collapse, they are filled with younger sediments and sometimes artifacts can fall into the voids as well resulting in downward movement of archaeological materials (Mandel et al. 2017; Goldberg and Macphail 2006).

Perhaps the most destructive floralturbation process is tree-throw. Tree-throws are the result of high winds blowing over trees (Mandel et al. 2017; Rapp and Hill 2006; Waters 1992). When a tree is knocked over, soil, rocks, and archaeological materials intertwined with the root

Table 1. Major types of soil and sediment disturbance/mixing expected at Spring Valley and associated general direction of artifact movement. Adapted from Table 1 of Mandel et al. (2017:805).

Process		**Disturbance type/mixing process**	**Direction of artifact movement**
Alluvial		Natural: displacement by stream flow	Downstream. Winnowing of fines can result in superposition of artifacts
Mass movement/graviturbation		Natural: displacement by slope processes, such as solifluction, creep and landslides	Downslope
Argilliturbation		Natural: mixing by shrink-swell processes associated with expandable clay minerals	Up and down. Smaller artifacts tend to migrate down while larger artifacts migrate up
Bioturbation	Faunalturbation	Natural: mixing by the activities of burrowing animals	Small artifacts tend to move up and large artifacts tend to move down
	Floralturbation	Natural: mixing by the activities of plants	Root growth: all directions Root decay: down Tree throw: all directions and can cause inverted stratigraphy and mixing of assemblages

mass are pulled from the substrate, leaving a shallow depression. Over time, soil and cultural materials within the root mass begin to fall back into the depression or accumulate nearby. Tree-throws can significantly rework surficial sediments in forested areas and can destroy the spatial patterning of an archaeological site (Mandel et al. 2017; Waters 1992). Furthermore, if a felled tree is burned either through natural or cultural processes, the product can closely resemble a cultural feature, possibly confusing archaeological interpretation.

Faunalturbation is caused by fossorial animals, including (but not limited to) gophers, moles, badgers, earthworms, and ants. The burrowing activity of fossorial animals can turn over or translocate large quantities of soil, sediment, and associated archaeological materials (Bocek 1986; Mandel et al. 2017; Wood and Johnson 1978). During burrow management and maintenance, fossorial animals move small artifacts upwards in profile. The fossorial animals burrow beneath larger artifacts, such as bifaces and cores, and when the hollow cavities collapse the artifacts move downwards in the profile (Bocek 1986; Mandel et al. 2017).

Argilliturbation is another common and significant site formation process. Argilliturbation involves the mixing of soil due to shrinking and swelling of expandable clay minerals. Phyllosilicates are the most common clay type and are categorized based on the layering of tetrahedral and octahedral layers (Brady and Weil 2010). When a phyllosilicate clay has a one-to-one ratio of octahedral to tetrahedral sheets, it is called a 1:1 silicate clay and these clays do not expand (Brady and Weil 2010). When clays have a ratio of two-to-one tetrahedral to octahedral sheets, it is a 2:1 clay. Of 2:1 clays, two subgroups (smectite and vermiculite) expand when moistened, whereas fine-grained micas (illite) and chlorite do not (Brady and Weil 2010).

Expandable clays shrink during dry episodes, causing the formation of large vertical cracks on the surface. Artifacts and other materials fall into these cracks when they are open. When soil moisture increases, the clays expand, closing the cracks and burying artifacts (Mandel et al. 2017; Schiffer 1987; Wood and Johnson 1978). Due to the clay-rich nature of the deposits at Spring Valley, it is possible that argilliturbation has been a significant site forming process.

Environmental Setting

A discussion of the landscape and environment of the Ozark Plateau is integral to understanding processes affecting 23CT389, and to comprehending the relationship of people to the environment and their settlement/subsistence strategies.

Modern Climate. The Ozark Plateau has a continental climate with hot, relatively wet summers and mild, dry winters. The study region is classified as a warm-summer subtype of the temperate humid climate (Trewartha and Horn 1980). Mean annual precipitation for the study area is 114 cm (Thornberry-Ehrlich 2016). The average January and July temperatures at the nearby town of Van Buren, Missouri, are 0.5 ºC and 24.8 ºC, respectively (High Plains Regional Climate Center 2018).

Hydrology. The Spring Valley site is located near the confluence of the Current River and the outflow of the Big Spring (Figure 2) in southwestern Missouri. The Current River is a seventh-order stream that ultimately drains into the Mississippi River. The headwaters for the Current River are in ONSR, and the river is fed by many tributaries and perennial springs. Seasonal precipitation and extreme weather events cause the water levels to fluctuate considerably, but up to 90% of the total flow of the river can be sourced to karstic springs in the valley. Therefore, the drainage system is considered karstic (Thornberry-Ehrlich 2016). Unique flora and fauna resources are associated with the springs, which would have made them attractive to local indigenous groups through time (Thornberry-Ehrlich 2016).

The Spring Valley site is located ca. 400 m south of Big Spring (Figure 2). Big Spring (Figure 8) is among the largest freshwater springs in North America, with an average daily discharge of 1.1 billion liters of water and peak flow of 3 billion liters per day after large influxes of precipitation (Thornberry-Ehrlich 2016). The recharge zone is up to 80 km away from Big Spring, and it takes up to 14 days for water to move from the point of recharge to the spring. Dissolved carbonates in the spring water create a vivid blue color, and fine-grained sediments are transported in the outflow channel and deposited on the floodplain.

Vegetation. Vegetation in the study area is diverse, with microenvironments influencing plant communities in various topographic settings (Huber and Rapp 1983). The primary plant community is oak-hickory forest interspersed with prairies, cedar glades, and oak savanna,

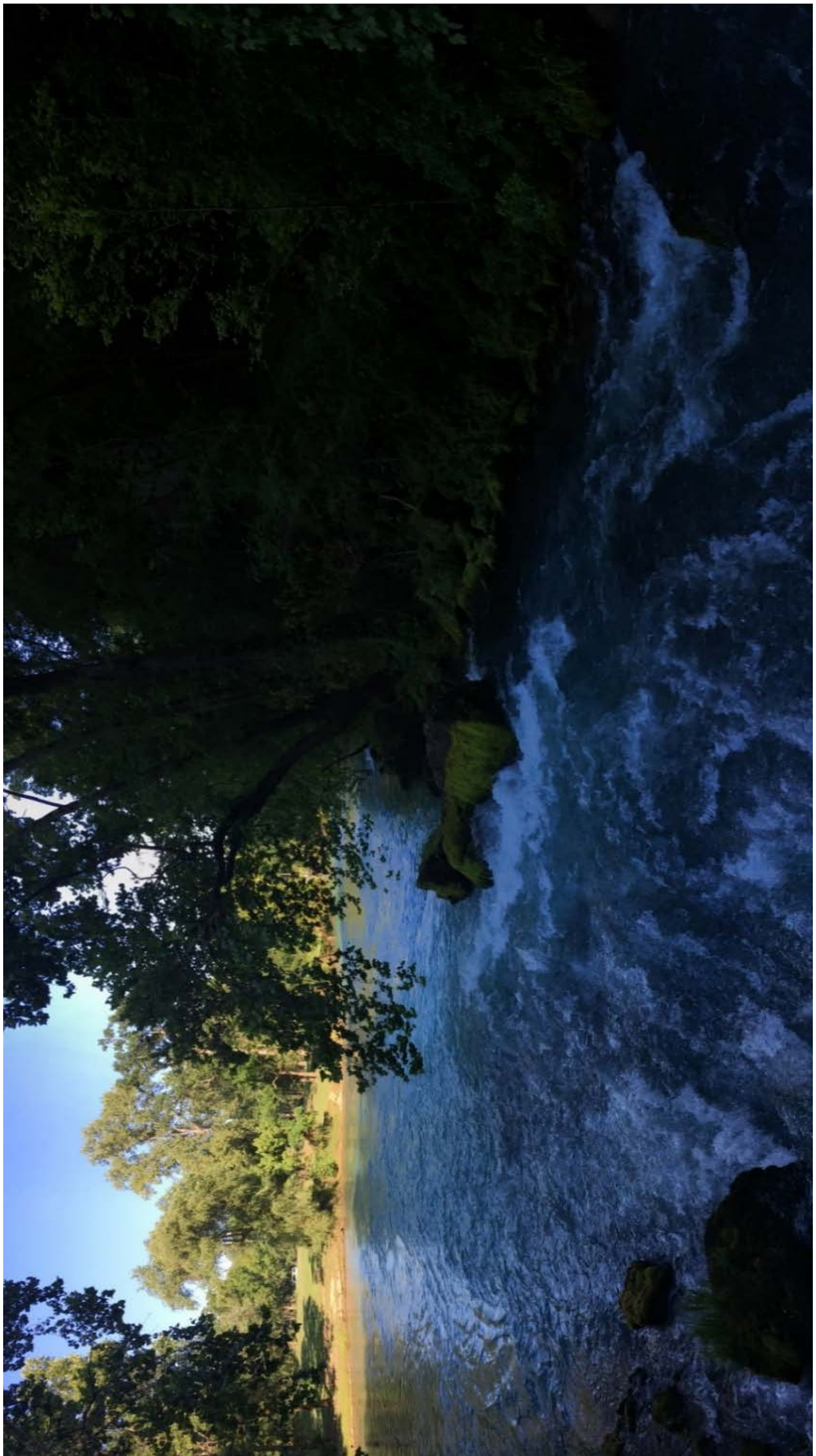

Figure 8. Photograph of Big Spring in ONSR. View is to the south.

although pine forest is also present in the uplands (Dempsey 2012). Historic logging (ca. A.D. 1880-1920) has had a dramatic impact on the region's ecology and geomorphology (Dempsey 2012; Saucier 1987).

Geomorphic setting. The Spring Valley site is associated with the remnant of a co-alluvial fan near the mouth of Spring Valley Branch, an intermittent, third-order tributary that empties into Big Spring's outflow channel. Co-alluvium represents sedimentary deposits that exist on the spectrum between alluvium and colluvium, and has properties of both (Creemens and Lothrop 2001; Creemens et al. 2003). Where colluvium grades into alluvium along footslopes and toeslopes, co-alluvial fans form. Within co-alluvial zones, where the role of water shifts between lubrication and incipient sorting, colluvium interfingers with alluvium (Creemens and Lothrop 2001; Creemens et al. 2003).

Soils. Soil formation in the study area occurs in bedrock, alluvium, and colluvium. Residual soils form on stable upland surfaces and typically are thin and cherty (Sauer 1968). Soil temperature is generally mesic, and moisture varies between udic, aquic, ustic, or xeric conditions. Ultisols are prevalent in forested areas and are the most common soil order in the Current River valley. Alfisols, Entisols, and Inceptisols occur in stream valleys and on hillslopes. Mollisols are rare and mostly occur on floodplains and stream terraces (Dempsey 2012).

Bedrock Geology. The Ozark Plateau is an elongated northeast-southwest striking dome formed by uplifted igneous rocks dipping away towards the edges of the formation (Sauer 1968). The Plateau is located in parts of Illinois, Missouri, Arkansas, Oklahoma, and Kansas (Figure 1), and together with the Ouachita Mountains to the southwest comprises the Interior Highlands.

The Current River valley is located on the Salem Plateau, a subprovince of the Ozarks. The Salem Plateau has been heavily dissected due to the steep slope at the southern edge of the

Ozark dome, forming multiple deep, bedrock-lined valleys throughout the region (Dempsey 2012; Klinger and Kandare 1987).

Bedrock in the study area is predominately Ordovician and older dolomites and limestones (Thornbury 1965). Many of these units contain quartz and chert that have provided a source of lithic material for tool production. In addition to the sedimentary units, Precambrian rhyolite outcrops in the Current River Valley (Klinger and Kandare 1987). Bedrock at or near the surface strongly influences soil formation and local plant communities (Klinger and Kandare 1987).

Big Spring emerges from the Gasconade Dolomite. This Ordovician bedrock is 485-470 million years old and consists of thick carbonate layers that are susceptible to dissolution, allowing for the formation of caves and springs. The Gasconade Dolomite is the major cave-forming unit within the Current River Valley. Chert is common within the bedrock and often erodes into the Current River (Ray 2007). The river subsequently deposits the chert on gravel bars, providing easy access for prehistoric flintknappers (National Park Service 2014; Ray 2007; Thornberry-Ehrlich 2016).

Previous Geoarchaeological Research

While there is a large body of work on the environment of the ONSR, only two researchers have conducted extensive geoarchaeological and geomorphological study of the Current River Valley: Dr. Roger Saucier (n.d. 1983, 1987, 1996) and Dr. Erin Dempsey (2012). Their work comprises the body of large-scale geoarchaeological investigation in the region and establishes an understanding of the relationship between archaeological resources and landforms. Saucier examined many areas throughout the Current River basin, whereas Dempsey focused on seven localities. Combined, their research represents two significant works for understanding the alluvial geomorphology of the Current River valley, and Dempsey assessed the potential for buried cultural deposits.

Saucier's investigations represent the first intensive effort to understand the geomorphology of the Current River valley. He advocated that the Current River valley's physical and cultural histories were intricately intertwined and must be understood together due to the close relationship between natural resources and their exploitation by pre-European contact peoples.

Saucier first identified alluvial landforms in the Current River valley through close examination of 1:24,000 USGS topographic maps, aerial and historic photographs, sub-surface data from water-well boring logs, and transit surveys (Saucier 1987). His work was extensive; he established a stratigraphic sequence and alluvial chronology, examined relationships between archaeological sites and landforms in the context of large-scale river migration and sediment transport, modeled stream channel movement and the effects of springs and intermittent streams on the river, and investigated the effects of logging on the system (Saucier 1983, 1987, 1996). Saucier established an alluvial chronology using temporally-diagnostic artifacts, as radiocarbon and thermoluminescence ages often were much younger than the associated archaeology (Saucier 1987). Years later, Dempsey (2012) closely examined Saucier's terrace sequence and alluvial chronology.

Drawing from Saucier's work, Dempsey (2012) assessed the geomorphology and alluvial chronology of the Current River valley and evaluated the potential for buried cultural deposits in the ONSR. Her methods included reconnaissance of the valley, coring, stable carbon isotope analysis, particle-size analysis, horizon development indices, and optically simulated luminescence (OSL) dating. She collected eight cores from seven localities.

Dempsey's work represented a significant contribution to the collective knowledge of the Current River. She refined Saucier's chronology and established a numeric one for alluvial landforms in the region (Table 2). She also refined the terrace sequence for the area, which enabled archaeologists to predict site locations and to approximate the age of cultural deposits in alluvial landforms. Her research revealed that archaeological deposits dating to different cultural periods may occur in multiple geologic contexts, and emphasized that this important finding must be considered when establishing criteria for surveys or testing (Table 3). Dempsey's work demonstrated that archaeological deposits can be buried as much as five meters below surface in some contexts, refuting the notion that archaeological materials were constrained to the upper 0.5 m of alluvial deposits. Finally, her work represents the first use of stable carbon isotope analysis of soil organic matter in the Current River valley, showing predominately C_3 vegetation since the late Pleistocene.

Summary

This chapter has provided the context for understanding human-landscape interaction of pre-European contact peoples. In the Ozarks, ancient peoples would have had access to excellent resources for tool-making materials and many different food and aquatic resources.

Both the physical history of the Current River Valley and prior geoarchaeological/geomorphological research should be considered when examining archaeological sites in the Ozarks. Any investigation must also regard the relationships between

Table 2. Ages of different landforms in the Current River Valley showing differences between Saucier's and Dempsey's chronologies.

Landform	Saucier's Chronology	Dempsey's Chronology
T-1	Proto/Historic Period	3,000 BP-present
T-2	15,000-7,000 BP	Locality Dependent
T-3	35,000-23,000 BP	45,000-9,300 BP
T-4	ca. 75,000 BP	-
Alluvial Fan	-	sometime before 11,900 - ca. 3,000 BP

Note: - indicates a landform that was either not examined or no chronology was developed for these landforms.

Table 3. Geologic potential for preservation of buried cultural deposits in the Current River valley (Dempsey 2012:161).

Cultural	Current River valley			
Periods	T-1	T-2	T-3	Alluvial Fan
Pre-Clovis	--	+	+++	+++
Paleoindian	--	+++	+++	+++
Early Archaic	?	+++	+++	+++
Middle Archaic	?	+++	?	+++
Late Archaic	+++	+++	?	+++
Woodland	+++	+++	?	?
Mississippian	--	?	?	?

Note: --=impossible; ? = unknown; + = low potential; ++ = moderate potential; +++ = high potential

people and the landscapes they inhabit to draw significant conclusions about past lifeways. Guided by Saucier's and Dempsey's geoarchaeological framework, such investigations will enable us to understand the landforms in which sites sit and their relationship to other areas.

CHAPTER 3

CULTURAL HISTORY OF THE OZARK PLATEAU

Archaeological research on the Ozark Plateau has uncovered a long record of human occupation, spanning the Paleoindian through historic periods with some suggestion of a pre-Clovis presence (Chapman 1975; Chapman 1980; Hajic et al. 2007; Lopinot et al. 1998, 2000; Ray et al. 2000). While there is much more history in the Ozarks than discussed here, the summary below highlights the periods during which the Spring Valley site was likely occupied: the Middle Paleoindian through the part of the Middle Archaic periods (ca. 10,800-5,500 ^{14}C yr B.P.).

The temporal range must be defined for each stage or period in any discussion of a region's cultural history. Here, I use Ray's (2016) cultural chronology for Missouri (Table 4). It is important to note that this is a technological chronology based on hafted bifaces. The various temporal designations implicate certain behavioral and technological characteristics that are not always applicable to a given archaeological tradition. For instance, Dalton has been classified as both Late Paleoindian and Early Archaic. Strong cases can be made for both designations, but I do not consider either as a useful designation (see Dalton section for more information). This chronology is useful, however, to broadly characterize the cultural history of the region.

Multiple diagnostic hafted bifaces were recovered during the 2017 excavations at Spring Valley, suggesting ephemeral Middle Paleoindian and Middle Archaic components, a significant Dalton occupation(s), and multiple Early Archaic components (Table 5).

In this section, a culture-historical framework is used to broadly characterize the human occupations of the region. It is important to note that there is a difference between technology and culture. Technologies are the material aspects a culture, but they do not represent the entirety

Table 4. Archaeological time periods for Missouri. Smaller text denotes stages of broader temporal periods. Modified from Table 1 in Ray (2016:2).

Stage/Period	^{14}C yr B.P.	Calibrated Years B.P.
Pre-Paleoindian	? -11,500	24,320-13,275
Paleoindian*	11,500-9800	13,430-11,185
Early Paleoindian	11,500-10,900	13,430-12,715
Middle Paleoindian*	10,900-10,500	12,805-12,390
Late Paleoindian*	10,500-9800	12,565-11,185
Archaic*	9,800-2,800	11,250-2845
Early Archaic*	9,800-7,000	11,250-7,760
Middle Archaic*	7,000-4500	7,930-5,040
Late Archaic	4,500-2,800	5,300-2,485
Woodland	2,800-1,000	2,965-805
Early Woodland	2,800-2,200	2,965-2,130
Middle Woodland	2,200-1,500	2,320-1,330
Late Woodland	1,500-1,000	1475-805
Mississippian	1,000-410	960-330
Early Mississippian	1,000-800	960-675
Middle Mississippian	800-600	760-540
Late Mississippian	600-410	655-330
Protohistoric	410-250	410-250
Historic*	250-present	250-present

*: indicates documented presence at Spring Valley.

Note: Dalton has been described both as Late Paleoindian and Early Archaic. See Dalton section for discussion.

Table 5. Hafted bifaces types recovered from 23CT389 and their associated archaeological periods.

Biface Type	**Period**	**^{14}C yr B.P.**	**Count**
Gainey	Middle Paleoindian	10,800-10,500	1
Dalton	Transitional	10,500-9,800	15
San Patrice (Hope Variety)	Transitional	10,500-9,800	1
Breckenridge	Early Archaic	9,800-9,500	2
Graham Cave	Early Archaic	8,700-8,100	1
Hardin	Early Archaic	8,700-8,300	1
Searcy	Early Archaic	7,900-7,100	5
Taney	Early Archaic	7,800-6,900	1
Jakie	Early Archaic	7,100-6,200	1
White River	Middle Archaic	6,300-5,500	1

of a cultural system. Nevertheless, technologies and their expressions are useful to describe an archaeological tradition and to broadly examine past human behavior (Ahler et al. 2010). Here, I only discuss cultural periods for which artifacts were recovered at Spring Valley. I focus on the Dalton tradition and the Early Archaic because most of the materials recovered at 23CT389 were associated with those cultural periods.

Middle Paleoindian (10,900-10,500 ^{14}C yr B.P.)

Middle Paleoindian lithic assemblages demonstrate elaboration on earlier fluting techniques and development of new regional forms of hafted bifaces such as Gainey, Cumberland, Sedgwick, Quad, and Plainview/Goshen (Ahler et al. 2010). The Middle Paleoindian component at 23CT389 consists of a Gainey hafted biface fragment (Figure 9).

First reported at the Gainey site in Michigan (Simmons et al. 1984), Gainey technology is similar to earlier Clovis materials, but is thought to represent a distinct type (Morrow 1995;

Figure 9. Gainey hafted biface recovered from 23CT389.

Morrow 1996a; Ray 2016; Sandstrom and Ray 2004). Both technologies share concave bases, fluting, and lanceolate forms. Several authors have claimed that Gainey bifaces have guide flutes, but there are many examples of guide flutes in Clovis bifaces as well (Eren et al. 2011; Ray 2016; Sandstrom and Ray 2004; Williams 2016). Morrow (1996) has argued that interflute thickness represents a significant difference between Gainey and Clovis. Other researchers have contended that interflute thickness and/or base depth represent the significant differences between the two technologies (Morrow 1996; Williams and Niquette 2018).

Typological and temporal correlation of many Middle Paleoindian hafted biface types remains unclear. Sites with stratified Gainey deposits are rare, and most Gainey components are limited to surface or mixed deposits. For instance, at the Big Eddy site in the western Ozarks, the rapid accumulation of sediments made it difficult to differentiate between Middle and Late Paleoindian components (Ahler et al. 2010). Morrow (2015) suggests that Gainey-type hafted bifaces are coeval with Folsom bifaces found in the Great Plains. Ray (2016) proposes a chronology of 10,800-10,500 ^{14}C yr. B.P. for Gainey based on radiocarbon ages associated with Gainey-type hafted bifaces in the Ozarks.

While little is known about Gainey settlement and subsistence in the Ozarks, Gainey sites from elsewhere in North America provide analogues for Gainey lifeways in Missouri. At the Withington site in Wisconsin, Gainey cultural materials were made of Hixton Silicified Sandstone, a material type that is found over 170 km to the north, indicating long distance transport and movement (Loebel 2014). It has also been suggested that Gainey peoples exploited a mix of small and mid-sized game, from hares to caribou, based on faunal remains recovered from the Udora Site in Ontario, Canada (Storck and Spiess 1994). Gainey peoples were highly mobile hunter-gatherers.

The Dalton Tradition (10,500-9,800 ^{14}C yr B.P.)

The Dalton tradition occurs in the archaeological record in the Eastern Woodlands, the Midwest, and to some extent, the Great Plains (Anderson and Sassaman 1996; Ballenger 2001; Ray 2016). I employ Goodyear’s (1982) traditional chronology as modified slightly by Ray (2016) of 10,500-9,800 ^{14}C yr B.P. for Dalton. This chronology is based on radiocarbon ages from cave deposits and stratified open-air sites in the region, including a suite of radiocarbon ages from a discrete, deeply buried Dalton component at the Big Eddy site in western Missouri (Lopinot and Ray 2010; Ray 1998).

Originally designated as Late Paleoindian, the temporal designation of the Dalton archaeological tradition has been the source of much debate (e.g., Goodyear 1982; O'Brien and Wood 1998:75-96; Ray and Lopinot 2005; Sherwood et al. 2004). Technologically, Dalton hafted bifaces resemble earlier Paleoindian biface types such as Clovis, but other aspects of the tool kit, such as the Dalton adze are more like later Early Archaic traditions (Ballenger 2001; Yerkes and Koldehoff 2018). Furthermore, even though some aspects of Dalton technology have been classified as Paleoindian, Dalton subsistence practices, settlement organization, and some technologies represent the start of many traditions that were hallmarks of the Archaic period (Koldehoff and Walthall 2009). For the purposes of my thesis, I consider Dalton technology as an intermediate phase between the earlier fluted-biface complexes and later side-notched hafted bifaces that is not typical of either the Late Paleoindian or Early Archaic designations. Instead, Dalton should be understood within the context of changing environmental conditions and shifting economic strategies during the early Holocene. It is therefore useful to view Dalton as a transitional complex.

Any discussion of Dalton groups must consider the diversity of landscapes and ecoregions these people occupied throughout the Midwest and Southeastern United States. These groups of people were discrete cultural entities that shared similar technologies, but not necessarily other aspects of culture such as ritual, settlement, or subsistence practices.

Dalton Lithic Technology. While there are variations in Dalton hafted bifaces and technologies throughout the Southeast, there are similarities among these assemblages. Two common and significant diagnostic tools include Dalton hafted bifaces and Dalton adzes (see Figure 10.A-C and Figure 10.E-G). Dalton hafted bifaces have thinned bases and sometimes

Figure 10. Early Holocene diagnostics recovered from 23CT389. A-C: Dalton hafted bifaces. D: San Patrice, Hope variety hafted biface. E-G: Dalton adzes.

multiple, short flutes on one or both faces. Hence, Chapman (1975:245) describes the Dalton bifaces as being highly distinctive. These tools likely had extensive use lives. Many appear to have begun as both projectile points and as serrated knives. Beveling on many recovered specimens indicate intensive retooling for cutting and other activities (Ahler 1971; Ballenger 2001; Goodyear 1974).

Dalton hafted bifaces were used not only as projectile points, but as knives and often were reworked into a variety of tools, such as awls or drills (Figure 10.A-C). Dalton hafted bifaces were intended to be used regularly and were multifunctional to meet daily demands (Kay 2012). Furthermore, preliminary research suggests Dalton practiced vastly different resharpening techniques when compared to earlier technologies such as Clovis and Gainey (Williams and Niquette 2018).

The Dalton adze (Figure 10.E-G) is another significant diagnostic Dalton tool form. Dalton adzes were among the first of their kind, and adzes continued to be used into later cultural periods. The Dalton adze is a large, portable biface and is significantly heavier than Dalton hafted bifaces (Ballenger 2001). Grinding and smoothing of lateral edges near the pole demonstrate prehafting modifications (Walthall and Holley 1997). Use-wear studies have demonstrated that the Dalton adze was used for woodworking (Ballenger 2001; Gaertner 1994; Morse 1997; Morse and Goodyear 1973; Yerkes and Gaertner 1997). It has been suggested that adzes were used for making dugout canoes (Koldehoff and Walthall 2009; Gaertner 1994; Morse and Morse 1983; Yerkes and Koldehoff 2018), although they also probably were employed to fell trees for fuel, shelter construction, and to manufacture containers for food and water. The mass of adzes provides more potential energy for woodworking, and their percussive use caused these tools to break frequently. After breaking, these tools were either repaired or repurposed as a bifacial core for expedient tool use (Walthall and Holley 1997). While elements of the adze could be repurposed, this often did not occur until the adze was near the end of its use-life (Walthall and Holley 1997).

Dalton Settlement and Subsistence. There has been considerable debate over Dalton settlement patterns in the Ozarks. The study of Dalton sites in that region has led to the generation of three primary settlement models. Morse (1971) proposed a settlement model based on research in northeastern Arkansas. He held that there were a few large base settlement sites that encompassed the full range of Dalton tools and cultural materials and many smaller, satellite camps used for specific functions, including butchering, food collection and processing, and interment of the dead. Satellite camps were differentiated from base camps based on numbers and types of artifacts (Morse and Morse 1983). Morse's model held that drainage basins strongly dictated the movement and settlement patterns of Dalton groups, as the drainage basins were considered natural cultural boundaries in which distinct Dalton bands lived year-round (Morse 1971, 1983, 1997).

Schiffer (1975) also studied Dalton sites in Arkansas, but he advanced a different model compared to Morse. Based on his work in the L'Anguille drainage in northeastern Arkansas, Schiffer envisioned greater mobility of Dalton populations. Territories were hexagonal in shape and incorporated a multitude of environmental and physiographic zones that allowed for the exploitation of various resources at different times of the year. In Schiffer's model, most Dalton sites were seasonal base camps and short-term exploitative camps that left an ephemeral archaeological signature (Schiffer 1975). Generalized habitation sites would have encompassed a broad array of Dalton material culture (Schiffer 1975).

Price and Krakker (1975) proposed a model based upon the Lepold site on the Little Black River in Arkansas. Unique recovered materials included burned clay with fabric impressions and mason wasps' nests. The latter suggested the presence of substantial structures that endured for extended periods. Price and Krakker (1975) contended that the Lepold site represented a semi-permanent winter/spring base camp. Spring/summer camps were more ephemeral than base camps, and were located in a wider variety of locations than the base camps. Territories did not have regular shapes, but instead included a variety of environmental zones (Price and Krakker 1975).

Support for one Ozark settlement model over the others is lacking (Kay 2012; Lynott et al. 2006). It may, moreover, be imprudent to presume that all Dalton groups practiced the same settlement patterning and organization. As each model was based in a different study area, it is entirely possible that the models reflect adaptations to their specific localities. It is likely that settlement patterning is related to the distribution of resources in the Ozarks, and that Dalton groups organized their lifestyles around this distribution. Hence, it is important to understand Dalton subsistence practices, as these are often related to settlement strategies (Ahler et al. 2010).

Climate changes that affected the reorganization of plant and animal communities occurred over the course of centuries at the end of the Pleistocene and into the Holocene (Delcourt and Delcourt 1984; Delcourt et al. 1997, 1999; Jones 2010; Jones et al. 2017; Martin and Martin 1987). Whereas earlier Paleoindian groups exploited Pleistocene megafauna, caribou, and boreal forests, Dalton groups were compelled to utilize Holocene resources. Large megafauna died off and new seasonally abundant resources became established, including deer, wild turkey, fish, waterfowl, and nuts (Koldehoff and Walthall 2009). Dalton groups were among the first human populations to systematically exploit these new resources, thereby setting the stage for the core hunting and gathering subsistence practices used by later Archaic groups for several millennia.

Recorded Dalton assemblages containing well-preserved animal and plant remains are limited on the Ozark Plateau. Most excavated Dalton-age sites have revealed only lithics, with little to no evidence of subsistence practices. When faunal and floral remains have been recovered, they have consisted of fully Holocene biota such as deer (McMillan 1976a, 1976b; McMillan and Klippel 1981; Parmalee et al. 1976).

One of the most remarkable Dalton sites with significant evidence of subsistence practices is Rodgers Shelter in the western Ozarks. Rodgers Shelter represents a probable spring/fall hunting camp. Sealed deposits in the shelter indicate clear reliance on forest-dwelling and forest-edge resources, especially deer (Sabo et al. 1990), although many other species are present. For example, Parmalee et al. (1976) recorded cottontails, raccoons, squirrels, gophers, beavers, turkeys, wood rats, elk, muskrat, coyote, swans, crow, turtles, snakes, and fish. Hickory nuts and walnut shells are also present (Sabo et al. 1990). McMillan (1976) noted that the Rodgers Shelter Dalton deposit reflected short-term encampment, and that hunting appears to be an important subsistence practice for the occupants.

Despite the dearth of well-preserved floral and faunal assemblages on the Ozark Plateau, inferences about Dalton subsistence can be drawn from other areas of the Eastern Woodlands, including Dust Cave, Alabama. Excavations there revealed remarkable stratigraphic integrity and preservation of organic materials (Sherwood et al. 2004). Botanical remains were dominated by nutshell, particularly hickory. Walnut, chenopod, star grass, and hackberries also were recovered (Walker et al. 2001). Faunal remains included waterfowl, muskrat, swamp rabbit, pond turtles, turkey, squirrels, white-tailed deer, and box turtle (Walker et al. 2001). The floral and faunal assemblage from Dust Cave is indicative of a trend towards generalized foraging practices, which is consistent with the record from Rodgers Shelter.

San Patrice (10,500-9800 ^{14}C yr B.P.)

San Patrice was first described based on artifacts recovered from San Patrice Creek in De Soto Parish, Louisiana by Webb (1946). Duffield (1963) expanded the definition of this hafted biface type to include three sub-varieties: Hope, St. Johns, and Goodwin (although Goodwin has fallen into disuse). Ray (2016) proposed three subtypes in Missouri: Hope, Sac, and St. Johns. At Spring Valley, a single Hope variety hafted biface was recovered (Figure 10.D).

San Patrice hafted bifaces occur primarily in the Gulf Coastal region, but have also been recorded in western Mississippi, central and eastern Oklahoma, southeastern Kansas, northern Arkansas, and southern Missouri (Ray 2016). The first reliable radiocarbon ages for Hope variety San Patrice comes from the stratified deposits of the Big Eddy site, where a discrete cultural horizon consisting of San Patrice materials yielded radiocarbon ages suggesting a temporal span of 10,500-9,800 ^{14}C yr B.P. (Lopinot and Ray 2010:121; Ray 2016:108).

Hope variety San Patrice bifaces have a short stem with shallow side notches. The sides of the stem often are incurvate and the base is generally deeply concave. Blades are slightly excurvate to straight, and resharpened specimens typically are resharpened bifacially (Ray 2016:207). Hope variety bifaces can easily be mistaken for extensively re-sharpened Dalton bifaces. Exhausted Daltons, however, often result in a drill-like form (Ballenger 2001; Goodyear 1974), not the “short stubby shape of Hope” (Ray 2016:108).

San Patrice sites have been recorded in a wide variety of environments, but generally subsistence and settlement patterns are similar to that of Dalton. Holocene biota characterizes San Patrice subsistence bases. Furthermore, San Patrice demonstrates decreased residential mobility when compared to earlier Paleoindian groups (Rees 2010).

The Early Archaic (9,800-7,000 ^{14}C yr B.P.)

On the Ozark Plateau, the Archaic period lasted from ca. 9,800 through 2,800 ^{14}C yr B.P. (Ray 2016). During the Archaic, new technologies and forms of exploitation appear in the archaeological record, and new cultural manifestations were established (Ahler et al. 2010). At 23CT389, multiple Early Archaic (9,800 – 7,000 ^{14}C yr B.P.) diagnostics were recovered

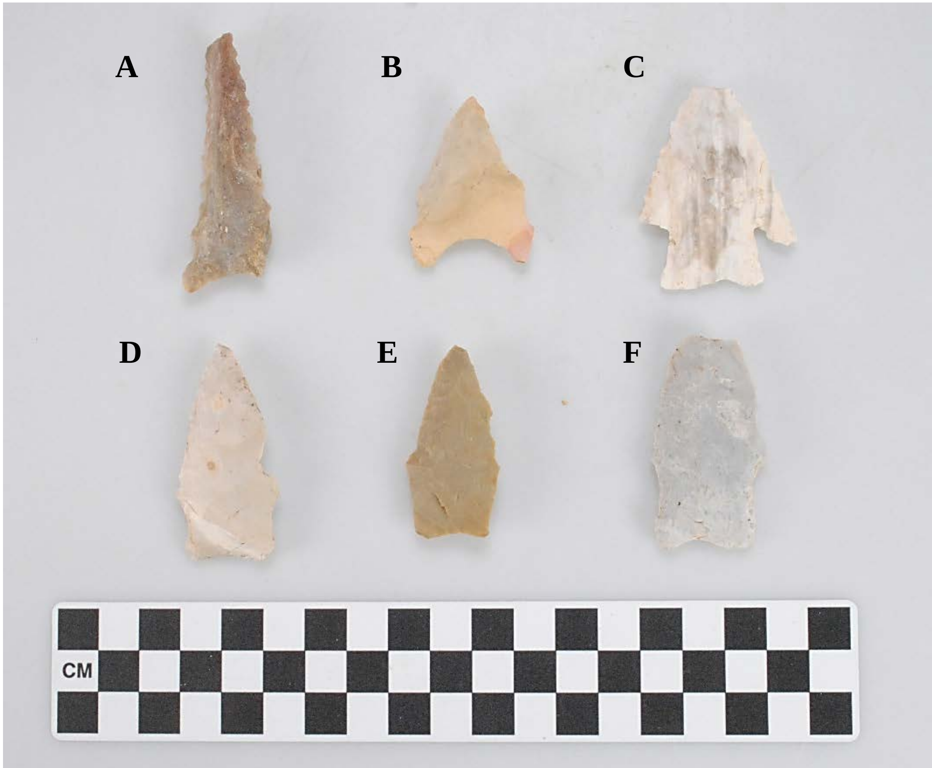

Figure 11. Early Archaic hafted bifaces recovered at 23CT389. A: Breckenridge; B: Graham Cave; C: Hardin; D: Jakie; E: Searcy; and F: Taney.

including Breckenridge, Graham Cave, Hardin, Jakie, Searcy, and Taney hafted bifaces (Figure 11). These hafted bifaces bear little resemblance to earlier lanceolate, fluted Paleoindian forms. The following section describes the Early Archaic and its significance in the history of the region.

Early Archaic Lithic Technology. Chipped stone dominates early Archaic material culture, although groundstone tools began to appear in the later part of this period (Ray et al. 2009). In general, Early Archaic bifacial tools are larger than those of the Late Paleoindian with the exception of chipped-stone adzes that are smaller than those of the preceding Dalton toolkits. Hafted bifaces demonstrate the removal of broad, thin flakes during reduction. Late-stage reduction may have involved the removal of parallel flakes from the edges, establishing a distinctive flaking pattern shared among several Early Archaic hafted bifaces. Most bifacial tools were made from large flake blanks (Ahler et al. 2010).

Similar to Dalton, hafted bifaces from the Early Archaic are often alternately beveled (Ray et al. 2009), resulting in a parallelogram shaped cross-section. This beveling is likely caused by the resharpening of blade edges from only one face to conserve material and extend the use-life of the tools (Ray et al. 2009; Solberger 1971). Most Early Archaic bifaces were multifunctional tools, used as both projectile points and as cutting implements (Ahler 1971; Ahler et al. 2010), which reflects continuity with earlier Dalton technologies. Unifacial tools are also present in Early Archaic contexts and include tools such as subtriangular end scrapers, spurred end scrapers, side scrapers, and back knives. The prominence of unifacial tools, however, decreases throughout the Early Archaic period (Ahler et al. 2010).

Hafting elements of hafted bifaces in the Early Archaic record reflect considerable variability when compared to those in the Paleoindian record. These elements are the products of engineering experimentation to create tools that would be less likely than earlier bifaces to break upon impact, or to improve use of hafted bifaces as knives for cutting (O'Brien and Wood 1998:113-115). By the end of the Early Archaic, most major hafting modes (e.g., lanceolate, contracting stem, expanding-stem, corner-notched, and side-notched) are represented in archaeological contexts and are present as both large and small hafted bifaces (Ahler et al 2010; O'Brien and Wood 1998).

Early Archaic Settlement and Subsistence. Proximity to critical resources that are predictable and reliable has long been considered a determinant for archaeological site location. Changes in site location throughout time can reflect changes in resource distributions, density, or preference. During the Early Archaic, groups are assumed to have migrated seasonally, moving between base and resource camps depending on resource availability. Subsistence was diverse and incorporated a variety of animal and plant resources (Ahler et al. 2010; O'Brien and Wood 1998).

Ahler et al. (2010) produced a seminal work examining continuity of subsistence patterns during the Archaic in the Ozark Highlands. They studied archaeobotanical and faunal remains at a multitude of sites in the Gasconade River drainage. The results of their study warrant further discussion, as it represents one of the few comprehensive archaeological investigations conducted in the Missouri Ozarks.

According to Ahler et al. (2010), in the Early Archaic record, the diversity of woody vegetation was limited, with Oak species as the dominant material. Nutshell was abundant, particularly hickory and *Juglandaceae,* but hazelnut shell was completely absent in the assemblages that were studied (Ahler et al. 2010).

Early Archaic faunal assemblages have been well recorded in the Ozarks, and primarily consist of mammal remains, although low numbers of fish, amphibian, bird, and reptiles were present (Ahler et al. 2010). Of interest was the wide variety of small-bodied species as opposed to larger game. Deer were common and likely contributed a large proportion of the total meat yield (Ahler et al. 2010). This generalized assemblage indicates exploitation from a wide variety of environmental zones in the Ozarks, implying continuity with Dalton economies.

The Middle Archaic (7,000-4,500 ^{14}C yr B.P.)

A single White River hafted biface was recovered during excavations at 23CT389, indicating an ephemeral Middle Archaic component (Figure 12). On the Ozark Plateau, the

Figure 12. Middle Archaic White River hafted biface recovered from 23CT389.

Middle Archaic spanned 7,000-4,500 ^{14}C yr B.P. This period corresponds to the Altithermal, a climatic event characterized by warm, dry conditions throughout much of North America (Dean et al. 1996; Delcourt and Delcourt 1984). While the Altithermal greatly affected the Great Plains region, Dempsey (2012) demonstrated that within ONSR, vegetation communities changed only slightly in some areas, such as at Chubb Hollow, but there is little evidence for change elsewhere. Overall, the Middle Archaic represents a period of cultural continuity with the preceding Early Archaic in the Ozarks (Ahler et al. 2010).

Middle Archaic Lithic Technology. In general, lithic bifacial tools of the Middle Archaic are smaller than those of the Early Archaic. Middle Archaic hafted bifaces lack the distinctive broad and shallow flaking removals characteristic of Early Archaic bifaces. The flaking pattern of Middle Archaic bifaces is often more random and less well-executed than flaking patterns of

Early Archaic bifaces (Ahler et al. 2010; O'Brien and Wood 1998). Core reduction was the primary strategy to make bifacial tools as opposed to the use of large flake blanks. Middle Archaic hafted bifaces have biconvex or hexagonal cross sections resulting from bifacial resharpening. Ahler et al. (2010) suggested that this change in resharpening techniques was in response to changes in mobility that resulted from extended occupations in limited areas. Such resharpening increased the use of locally available materials and reflects changing tool curation strategies (Ahler et al. 2010). Groundstone technology proliferated during the Middle Archaic (Ahler et al. 2010; Ray et al. 2009). Significant Middle Archaic groundstone technologies included fully grooved and ungrooved celts, pitted cobbles, metates, manos, and atlatl weights (Ray et al. 2009; Chapman 1975).

There is an emphasis during the Middle Archaic on the exploitation of locally available lithic resources, perhaps resulting from increasing population densities that in turn constrained individual group ranges (Ahler et al. 2010). In the late Early Archaic, heat treating was sporadically used, but during the Middle Archaic this technology became widespread to increase the knapability of local materials (Ray et al 2009). Heat treating allows for some poor-quality cherts to be transformed into higher quality material, thereby allowing individual knappers to have access to better material, as opposed to relying on high quality, exotic cherts.

Another significant aspect of Middle Archaic lithic assemblages is the paucity of unifacial tools. Tools that were primarily unifacial during the Early Archaic reemerged as bifacial technologies during this period. They were either made directly as bifacial correlates or made from recycled projectile points (Ahler et al 2010).

Variation in hafting elements decreases during the Middle Archaic, probably as a result of continued experimentation with hafting modes and an emphasis of Middle Archaic groups on local resources. Ahler et al. (2010:85) note:

> There is little evidence in the first half of the Middle Archaic period for panregional exchange networks or other means of disseminating information about technological findings and standards over long distances. With a shift in emphasis towards local resources and local interactions, there may have been little perceived need for exchange of information or materials over long distances.

The relative lack of diagnostic Middle Archaic projectile points is likely the result of the lack of a rigorous exchange network. The emphasis on local exploitation limited interaction between groups of people; hence, there was no mechanism in place to exchange technological findings.

Middle Archaic Settlement and Subsistence. Middle Archaic botanical assemblages in the Ozarks are more diverse than during the Early Archaic (Ahler et al. 2010). Floodplain species such as maple, Kentucky coffee tree, basswood, and sycamore were used as fuel wood, with cedar and pine constituting approximately 10 percent of the total fuel and oak 50 percent. Hickory shell dominates the mast remains. A range of seeds, including goosefoot, maygrass, knotweed, amaranth, grape, and American lotus, have been recovered in Middle Archaic deposits. Small pieces of cucurbit were found in some areas, although these may be contaminants from overlying Woodland deposits (Ahler et al. 2010).

Overall, the Middle Archaic shows more botanical diversity than the preceding Early Archaic, although continuity is evinced from the emphasis on hickory processing and the use of oak as fuel wood. Exploitation of both upland and floodplain taxa indicate a broader subsistence base related to botanical sources. While this cultural period represents the height of the Altithermal, the presence of upland and lowland taxa in botanical assemblages suggests Middle Archaic groups in the Ozark Highlands were largely unaffected by this warming and drying period. Groups still practiced generalized foraging, and many resources were similar to the preceding Early Archaic, although with more diversity.

Faunal assemblages from the Middle Archaic are still dominated by mammals, although bird remains slightly increase. Otherwise, the general faunal exploitation strategy is similar to that of the Early Archaic, where people exploited multiple environmental zones and situated sites so as to allow for diffuse exploitation strategies. (Ahler et al. 2010).

There appears to be continuity with the Early Archaic in Middle Archaic settlement patterns and organization, although there is some evidence of more specialized site types and functions (Ahler et al. 2010; O'Brien and Wood 1998). Ahler and his colleagues identified three Middle Archaic settlement site types: episodic short-term use, episodic generalized use, and repeated generalized use. The three site types are consistent with small group sizes and localized mobility, indicating that Middle Archaic groups depended more on foraging than collecting (Ahler et al. 2010). In addition to these three primary site types, a single site was found to have more specialized use in the Gasconade River Drainage. Aside from that notable exception, Middle Archaic sites appear to demonstrate generalized use and repeated occupations, similar to the Early Archaic. These trends towards larger sites and more intensive or frequent use of sites persist during the Late Archaic.

Summary

Decades of research in ONSR and elsewhere in the Ozarks have created a foundation for the present investigation at 23CT389. Much is known about the technology, subsistence, and settlement strategies people employed in the region. Nevertheless, significant questions remain, particularly in regard to the early archaeological record and the Dalton groups who inhabited this region.

Spring Valley consists of multiple occupations, spanning at least the Middle Paleoindian through the Middle Archaic periods. As the site formation processes and their impact on the cultural record at Spring Valley are described in subsequent chapters, it is important to understand the cultural context in which the archaeological materials were deposited.

CHAPTER 4

METHODS

My study examines the stratigraphic integrity of 23CT389 by addressing three research questions. Many methodologies employed in this study provide insight into more than one question. The first question focused on the formation of and post-depositional processes at the Spring Valley site:

1. How did the site form and what post-depositional processes have occurred?

Soil stratigraphy, particle-size distribution, coefficient of linear extensibility (COLE), debitage analysis, and spatial analysis of piece-plotted artifacts all provide insight into site formation processes at Spring Valley. Each of these procedures is described in more detail below.

The second question concerns the impact of the post-depositional processes upon the archaeological record at the Spring Valley site:

2. How did post-depositional processes affect the archaeological record?

Multiple approaches were used to determine the effects of post-depositional processes. COLE was used to determine if argilliturbation was a potential source of post-depositional movement. Refitting, debitage analysis, and spatial analysis allowed for an examination of the horizontal and vertical movement of artifacts due to pedoturbation. These methodological procedures are detailed below.

The final question regards the number of occupations at 23CT389:

3. Is it possible to identify discrete occupations at Spring Valley?

This question required an examination of the spatial relationships between piece-plotted artifacts, debitage analysis, and a detailed understanding of site formation processes derived from the other methodologies.

Field Methods

Five profiles were described using standard procedures and terminology outlined by Birkeland (1999) and Schoeneberger et al. (2012). Bulk soil samples were taken from each soil horizon. Soil horizons over 40 cm thick were subdivided into equal parts, varying in thickness from 20 to 30 cm.

Laboratory Methods

Particle-Size Distribution Analysis. Analysis of particle-size distribution (PSD) is a tool that determines the relative proportions of the sand, silt, and clay in a sample. This is a routine procedure in geoarchaeological studies that helps determine the magnitude of diagenetic or pedogenetic alterations throughout a soil (Gladfelter 1985; Goldberg and Macphail 2006). Also, PSD can be used to determine the source of parent material, and to infer the mode of deposition of sediments (Goldberg and Macphail 2006). Since pedogenesis requires landscape stability, this procedure has potential to address questions about the duration of stability at the Spring Valley site, which in turn allows an understanding of how long the archaeological assemblage was affected by soil-forming processes.

Analysis of PSD was conducted at the Kansas Geological Survey's Paleoenvironmental Laboratory. A representative profile (Profile 4) was selected for PSD, and the particle-size distribution was determined using a slightly modified version of the pipette method (Gee and Brauder 1986). Samples were air dried at 20 °C and homogenized using mortar and pestle, and then passed through a 2 mm sieve. Ten grams of sample were dispersed with a sodium hexametaphosphate solution and mechanically shaken. Wet sieving removes the sand fraction from suspension, which is then fractionionated through dry sieving. Twenty-five milliliter silt and clay aliquots were removed from the remaining suspension with a pipette, oven dried, and weighed. The results were presented as weight percentages, totaling 100 percent of the less than 2mm fraction.

Coefficient of Linear Extensibility (rod method)

The coefficient of linear extensibility (COLE) is often used to determine the shrink-swell capacity of a soil (Grossman et al. 1968; Schafer and Singer 1976). COLE is a derived value denoting the fractional change in clod dimension from a moist to dry state (Grossman et al. 1968; Soil Survey Staff 2016). Shrink-swell behavior in soils is governed by the dominant clay mineralogy. As water moves into and out of the interlayer space of 2:1 phyllosilicate clays, it causes the mineral to expand and contract on a molecular level (Brady and Weil 2010; Vaught et al. 2006).

The standard method to derive the COLE value uses natural soil clods ranging from 50 to 200 cm^3 in volume and requires a laboratory. Schafer and Singer (1976) proposed a method ($COLE_{rod}$) that does not require laboratory measurements to find the COLE value. The change in the length of rods formed from soil paste can be measured between selected moisture contents (Schafer and Singer 1976). This method does not require natural soil clods, so bulk soil samples can be used. In addition, the $COLE_{rod}$ method is highly correlated to the standard COLE procedure (Schafer and Singer 1976; Simon et al. 1987; Vaught et al. 2006).

$COLE_{rod}$ has potential to inform on the effects of argilliturbation on archaeological sites. For this study, approximately 100 g of the less than 2 mm in diameter sieved soil were placed into a paper cup. Water was added and mixed with the dried soil until a paste slightly drier than saturated was obtained. This paste was equilibrated for 24 hours. A 24-cm^3 syringe with a 1-cm hole at the tip was then filled with the paste and extruded onto the smooth surface of a baking sheet or plastic tray, resulting in three rods ranging between 6 to 10 cm in length. The ends of the rods were trimmed with a moist spatula and then the length was recorded. After the rods air-dried over 48 hours, they were re-measured (cf. Schafer and Singer 1976).

Since COLE is a measure of linear extensibility between two moisture contents, $COLE_{rod}$ was calculated using the following formula:

$$COLE_{rod} = (l_m - l_d)/l_d$$

where l_m is moist rod length and l_d is dry length. The resulting value then was used to evaluate shrink-swell behavior.

$COLE_{rod}$ has been used to develop classes of shrink-swell potential, and often is associated with hazard potential for structural damage (Table 6). Simon et al. (1987) compared $COLE_{rod}$ values for Alfisols and Ultisols in their study, so those values were used to compare shrink-swell class of soil at Spring Valley. $COLE_{rod}$ classes presented by Schafer and Singer (1976) are included in Table 6 for comparative purposes.

Radiocarbon Chronology

Radiocarbon ages provide a numerical chronology for archaeological sites. To establish a site chronology, 35 charcoal samples in the form of carbonized plant remains (nutshell, wood, etc.) were collected from the site. Four of these samples were submitted to Direct AMS, Inc. for

Table 6. Hazard classes for COLE and $COLE_{rod}$ (Vaught et al. 2006). $COLE_{rod}$ classes are previously reported by Simon et al. (1987) and Schafer and Singer (1976).

		$COLE_{rod}$	
Hazard class	COLE	Simon et al. (1987)	Schafer and Singer (1976)
Slight	<0.03	<0.07	<0.03
Moderate	0.03-0.06	0.07-0.14	0.03-0.08
High	0.06-0.09	0.14-0.20	0.08-0.14
Very High	>0.09	>0.20	>0.14

AMS ^{14}C dating. Two of the samples were from intact archaeological features, and the remaining two samples were from the soil matrix at depths of 99 and 236 centimeters below datum (cmbd).

Refit Analysis

Refit analysis was used to assess the extent to which post-depositional processes have transformed the archaeological record. Refitting of cultural materials is a technique during which individual artifacts are pieced together to determine how they were once attached prior to reduction (Hofman 1992a).

A relatively simple procedure, although time-consuming, refit analysis can be applied to a variety of materials, such as lithics and ceramics. It is also useful in addressing questions of technology, spatial organization, and site formation processes (Bruner 2003, Hofman 1986, 1992a, 1992b). As emphasized by Bruner (2003), refitting is a particularly useful method to evaluate the contextual integrity of archaeological materials. Her thesis demonstrated that there had been significant vertical mixing within the Vindija Cave, implying that prior interpretations of the site had been based on false assumptions, and new ones were needed to accurately portray the occupations of the site (Bruner 2003). Hofman (1992b) employed refitting at a site associated with an alluvial terrace. Refitting indicated the presence of a single dispersed buried occupation surface with materials dispersed across stratigraphic boundaries. Artifacts commonly were translocated as much 30 cm over 7,000 years (Hofman 1992b).

Limited refitting was conducted using materials from Test Units 3 and 7 and piece plotted artifacts recovered from the site. All artifacts were catalogued according to provenience. Additional data such as size, cortex, and presence or absence of a platform were collected (Table 7). Artifact size was determined by sieving materials through a series of screens. Artifacts smaller than 0.5 inches were counted but not catalogued due to difficulty in determining multiple attributes.

Refit efforts were focused on Test Units 3 and 7 because half of these units were screened through ¼” mesh, providing a strong, representative sample of materials from test excavations. In the other test units, debitage was recovered opportunistically while excavating, and therefore was a more limited, potentially biased sample.

Once the process of cataloguing artifacts was complete, artifacts were laid out on tables by unit, and level. Lithic material primarily consisted of Roubidoux and Gasconade cherts. These two material types are very similar. Typically during refitting, artifacts are grouped by raw material type, but due to difficulty in distinguishing between the two, this was not done during this study. All artifacts, regardless of material type, were compared to identify potential refits.

Refitting followed methods similar to other studies (e.g., Bradbury 2010; Cahen et al. 1979; Hofman and Enloe 1992; Morrow 1996b). To address questions of vertical and horizontal movement, artifacts such as preforms, cores, and scrapers from proveniences throughout the site were systematically compared to debitage. First, an artifact was chosen and systematically compared to all flakes of a given level in a test unit, then compared to the next level and so forth until all the debitage was compared to the artifact. The process was repeated with all levels in the

Table 7. Catalogue for debitage and cores. Entries in the columns indicate the set of data entered for each artifact.

PROVENIENCE				ARTIFACT INFORMATION				REFITTING	
CAT#[a]	**BAG#**	**TU[b]**	**LVL[c]**	**ART_ TYPE[d]**	**SIZE**	**PLAT?[e]**	**CRTX[f]**	**REFIT[g]**	**SET**
				CORE	<1/4”	PRESENT	0	Y	N/A
				DEB	1/4-1/2”	ABSENT	1 to 50	N	SET #
					1/2-1”		51 to 99		
					1”+		100		

[a]: Catalogue number
[b]: Test Unit
[c]: Excavation level
[d]: Artifact type can be either core (CORE) or debitage (DEB).
[e]: Presence or absence of a platform
[f]: Cortex on the dorsal face of a piece of debitage
[g]: identifies if a refit is present or absent; Y = yes; N = no

next unit. Each time an artifact was found to refit with another, it was termed a “case.” Each case was then compared to every other artifact.

To create a standardized terminology for refitting studies, Cziesla (1990:3) established three types of refit cases:

1. Artifacts separated as the result of reduction
2. Artifacts separated as the result of resharpening of an objective piece
3. Artifacts broken either by cultural or natural processes

These grouping schemes are informative for contextual analysis due to the spatial and vertical relationships of refitted artifacts. This procedure can help determine how artifacts deposited contemporaneously could become separated due to post-depositional and site formational processes.

Debitage Analysis

Using the catalogue generated by the refit analysis, the artifacts for each size class and level were entered into a pivot table. Next, tables and figures were generated to account for size-sorting of debitage.

Spatial Analysis

Interpretation of past human behavior at a given site relies on understanding how artifacts are spatially located and associated with each other (e.g., Binford 1962, 1964; Hodder 1977; Schiffer 1972). During the 2017 excavations, technical problems with the Topcon GTS 313 total station resulted in misalignment of many piece-plotted artifacts. To examine spatial relationships between artifacts, the data had to be processed. Elevations recorded by the Topcon GTS 313 were correct, but northings and eastings of many individual shots appeared to be incorrect.

The mapping problem was traced to the machine "resetting" its azimuth when taking a shot. The back sight was set to the east as opposed to the north and when the machine shut down, it would reset this azimuth but maintained its elevation and distance information. As a first step, using a combination of AutoCAD and ESRI's ArcMap, the angle for each piece plotted item was compared to known locations within the excavation block. This point could then be rotated based on this new azimuth. While there is error, in most cases the error is less than one cm. In some instances (see Appendix IV for field recorded data and processed data), error is greater. Nonetheless, this reconstruction provides better accuracy than only knowing the quadrant of a Test Unit that yielded an artifact.

Archaeologist Jack Ray of Missouri State University identified diagnostic materials. To classify the data for plotting, I assigned a new data field to the piece plots. Diagnostic materials were grouped by age or cultural designation (i.e., Early Archaic, Dalton, etc.), radiocarbon ages, preform stage, and indeterminate age materials. Once this task was accomplished, the spatial analysis of piece plotted artifacts was conducted using ESRI's ArcScene suite.

ArcScene allows for plotting X, Y, and Z data in three-dimensions. Using ArcScene to map artifacts allows for a better understanding of the spatial relationship between materials recovered at 23CT389. Total station data were entered into the program by treating easting as the X-axis, northing as the Y-axis, and elevation as the Z-axis. In this way, I could filter the data to understand the relationship between artifacts. Materials recovered from historic fills and utility line trenches (i.e., the electric lines and ceramic sewer pipe trenches) were not plotted or analyzed. In addition, the bottom of each excavation unit was plotted.

CHAPTER 5

RESULTS AND DISCUSSION

This chapter presents the results of analyses of soil stratigraphy, particle-size analysis, $COLE_{rod}$, lithic analysis, spatial analysis, and refit analysis. All soil and sediment descriptions are presented in Appendix I, summaries of debitage are in Appendix II, and $COLE_{rod}$ measurements are in Appendix III. Combined use of geoarchaeological and archaeological methodologies were key to understanding the Spring Valley site.

Soil Stratigraphy and Lithology

Five soil profiles were described at 23CT389 (Appendix A). Profiles 1 through 4 were in the four cardinal directions surrounding the main block, and Profile 5 was in the eastern wall of Test Unit 16. Profiles 3 and 5 were continuous profiles from the surface to base of excavations. Profiles 1, 2, and 4 were composite profiles including the walls of multiple test units (Figure 13).

All the soil profiles were represented by fills overlying Bt horizons with the notable exception of an AB horizon that was traced along the southern wall of the main excavation block and into TU 15 and TU 16. Anthropogenic fills were designated A through E in the order of their discovery. In 1935, the co-alluvial fan was leveled by heavy equipment in order to construct the bathhouse, truncating the existing surface soil. While an indeterminate amount of soil was removed during CCC construction, the soil recorded during the 2017 excavations resembles the Alred-Reuter Complex (Soil Survey Staff 2018). The Alred-Reuter complex is a loamy-skeletal over clayey, siliceous, semiactive mesic Typic Paleudalf. This Alfisol has Ap-E-Bt1b-Bt2b horizonation.

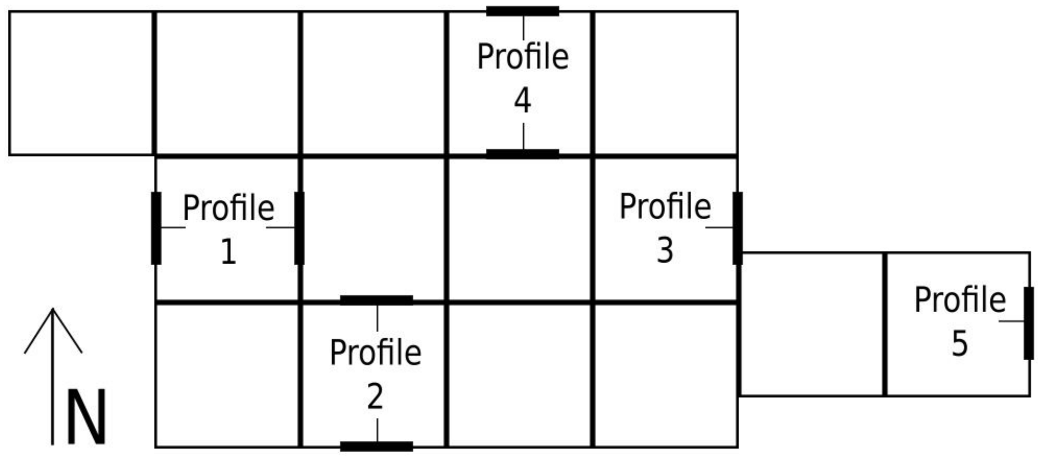

Figure 13. Location of profiles in the excavation block at Spring Valley. Single dashes indicate continuous profiles. Profiles with multiple dashes indicate a composite profile.

Profile 1. Profile 1 was a composite profile in the western wall of the main excavation block (Figure 14). Near the end of excavations, TU 1 was terminated at a depth of 210 cmbd in favor of excavating TUs 3, 5, and 7, so Profile 1 was continued along the west wall of TU 3 from 210 to 300 cmbd.

Three modern fills, designated as A, B, and C from top to bottom, comprise the upper 71 cm of Profile 1. The fills overlie Soil 1. Soil 1 is represented by a strongly expressed Bt horizon that is 215 cm thick. Clay films in the Bt horizon become more strongly developed with depth. Pressure faces occur on ped surfaces starting at 144 cmbd. Roots are present throughout the profile, ranging in size from coarse to very fine in fills, and medium to very fine in Soil 1. Krotovina 1-4 cm in diameter are common throughout Soil 1.

Profile 2. Profile 2 was a composite profile in the southern portion of the excavation block. The profile is in the southern wall of TU 12 from the surface to 150 cmbd, and in the southern wall of TU 3 from 150 to 334 cmbd (Figure 15).

The top 50 cm of Profile 2 is composed of Fills A, B, and C. The modern fills mantle Soil 1. Soil 1 is characterized by an AB-Bt profile. The AB horizon is 24 cm thick and the Bt horizon is 226 cm thick. Clay films in the Bt horizon become more strongly developed with depth. Many roots are present in Profile 2. Root size is coarse to fine in the fills, and medium to very fine in Soil 1. Krotovina 1-4 cm in diameter are common throughout Soil 1.

Profile 3. Profile 3 was a continuous profile in the eastern wall of the main excavation block, along the wall of TU 7 (Figure 16). Fill C is 20 cm thick and overlies Soil 1. Soil 1 is represented by a strongly expressed Bt horizon that is 214 cm thick. Clay films become more strongly developed with depth. Pressure faces occur starting at 244 cmbd. Many coarse to fine roots are present in both Fill C and Soil 1. Krotovina 1-4 cm in diameter are common throughout Soil 1.

Profile 4. Profile 4 was designated as a representative profile for the site, as it was the thickest profile recorded at the Spring Valley site (Figure 17). Profile 4 is a composite profile in TUs 6 and 5. The upper 116 cm of the profile is in the northern wall of TU 6 to a depth of 150 cmbd, and the remaining 184 cm of the profile is in the northern wall of TU 5.

The sidewalk and Fills D, E, B, and C comprise the upper 53 cm of the profile. Soil 1 is represented by a strongly expressed Bt horizon that is 262 cm thick. Clay films become continuous and well-developed at a depth of 174 cmbd. Pressure faces appear on ped surfaces at 225 cmbd. Many coarse to very fine roots are present throughout the profile. Krotovina 1-4 cm in diameter are common throughout Soil 1. Particle-size analysis was conducted on 11 soil samples from Profile 4 (Table 8). Bt1b and Bt2b consist of silt loam, whereas the rest of the profile is silty clay loam.

Table 8. Particle-size distribution results from Profile 4 at 23CT38.

Horizon	**Depth (cmbd)**	**TS [a]**	**CSi [a]**	**MSi [a]**	**FSi [a]**	**TSi [a]**	**CC [a]**	**FC [a]**	**TC [a]**	**USDA Texture [b]**
Bt1b	64-81	8.49	14.76	42.53	7.48	64.77	11.83	14.90	26.74	SiL
Bt2b	81-109	11.44	12.96	41.25	7.80	62.02	11.19	15.35	26.54	SiL
Bt3b	109-135	13.14	10.75	39.59	8.44	58.79	12.47	15.61	28.08	SCL
Bt3b	135-161	17.58	11.11	35.24	7.36	53.71	12.54	16.18	28.72	SCL
Bt3b	161-174	12.32	10.87	40.23	8.89	59.99	12.41	15.29	27.69	SCL
Bt4b	174-201	15.98	11.69	34.73	8.19	54.60	12.92	16.50	29.42	SCL
Bt4b	201-225	13.64	13.39	32.62	8.06	54.06	13.30	19.00	32.30	SCL
Bt5b	225-257	13.71	15.80	27.44	6.33	49.57	15.29	21.43	36.71	SCL
Bt6b	257-281	15.43	9.42	32.04	7.68	49.14	13.75	21.68	35.43	SCL
Bt6b	281-303	17.21	15.50	25.20	6.97	47.68	12.66	22.45	35.11	SCL
Bt7b	303-326	16.29	19.23	20.79	7.36	44.37	11.26	28.08	39.34	SCL

[a]: TS = Total Sand; CSi = Coarse Silt; MSi = Medium Silt; FSi = Fine Silt; TSi = Total Silt; CC = Coarse Clay; FC = Fine Clay; TC = Total Clay
[b]: SiL = Silt Loam; SCL = Silty Clay Loam

Profile 5. Profile 5 was in the eastern wall of TU 17 (Figure 18). Fills B and C compose the upper 59 cm of the profile. An AB horizon underlies the modern fills and is 15 cm thick. Below the AB horizon is a 26 cm thick Bt horizon with discontinuous clay films. Many, medium to fine roots are present throughout the profile. Krotovina 1-4 cm in diameter are common throughout Soil 1.

Summary. Profiles at 23CT389 consist primarily of well-developed Bt horizons underlying modern fills. The degree of soil development indicates a prolonged period of landscape stability, probably exceeding 5,500 years based on the archaeological record of the site. This long-lasting stability suggests that pedoturbation has been an ongoing process, affecting the archaeological record at 23CT389. The presence of many roots and common krotovina throughout the profiles and elsewhere in the site indicates bioturbation as a site forming process (Figure 19). Also, common pressure faces on ped surfaces suggest that argilliturbation has been a significant process at Spring Valley.

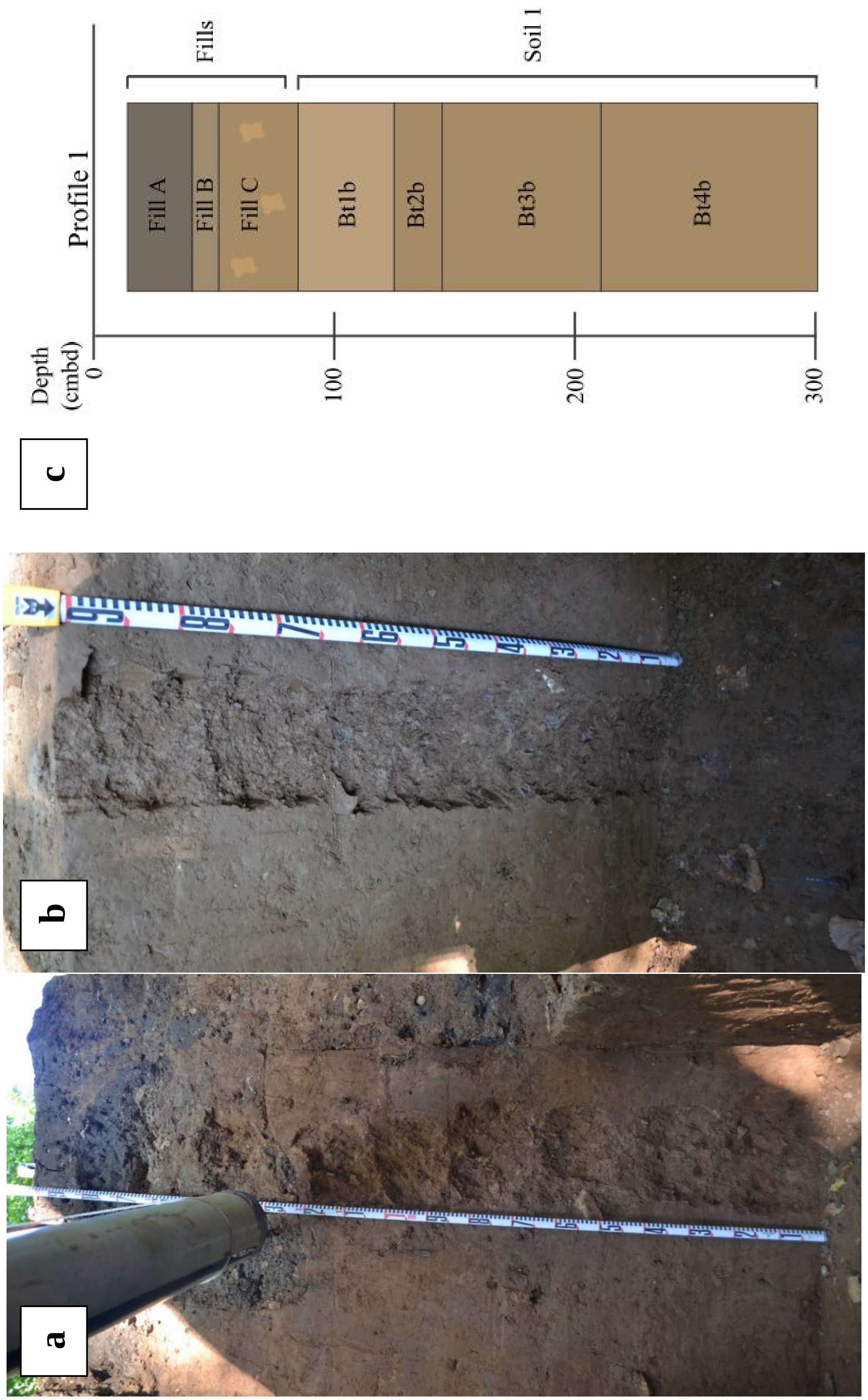

Figure 14. Profile 1 at 23CT389, view to the east. (a) Profile 1 from surface to 210 cmbd; (b) graphic representation of Profile 1.

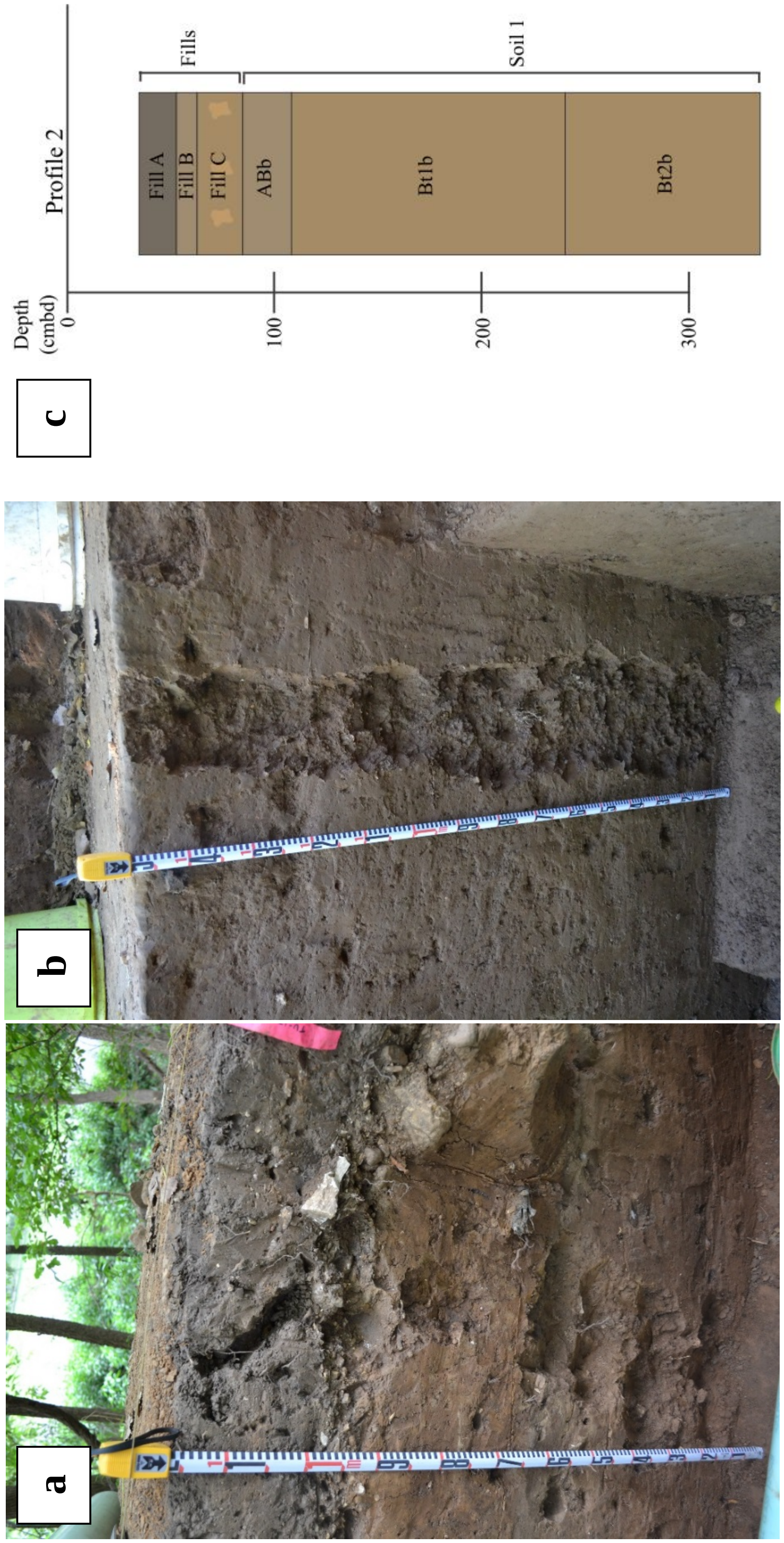

Figure 15. Profile 2 at 23CT389, view is to the south. (a) surface to 150 cmbd in TU 12; (b) 150 to 300 cmbd in TU 3; (c) graphic representation of Profile 2.

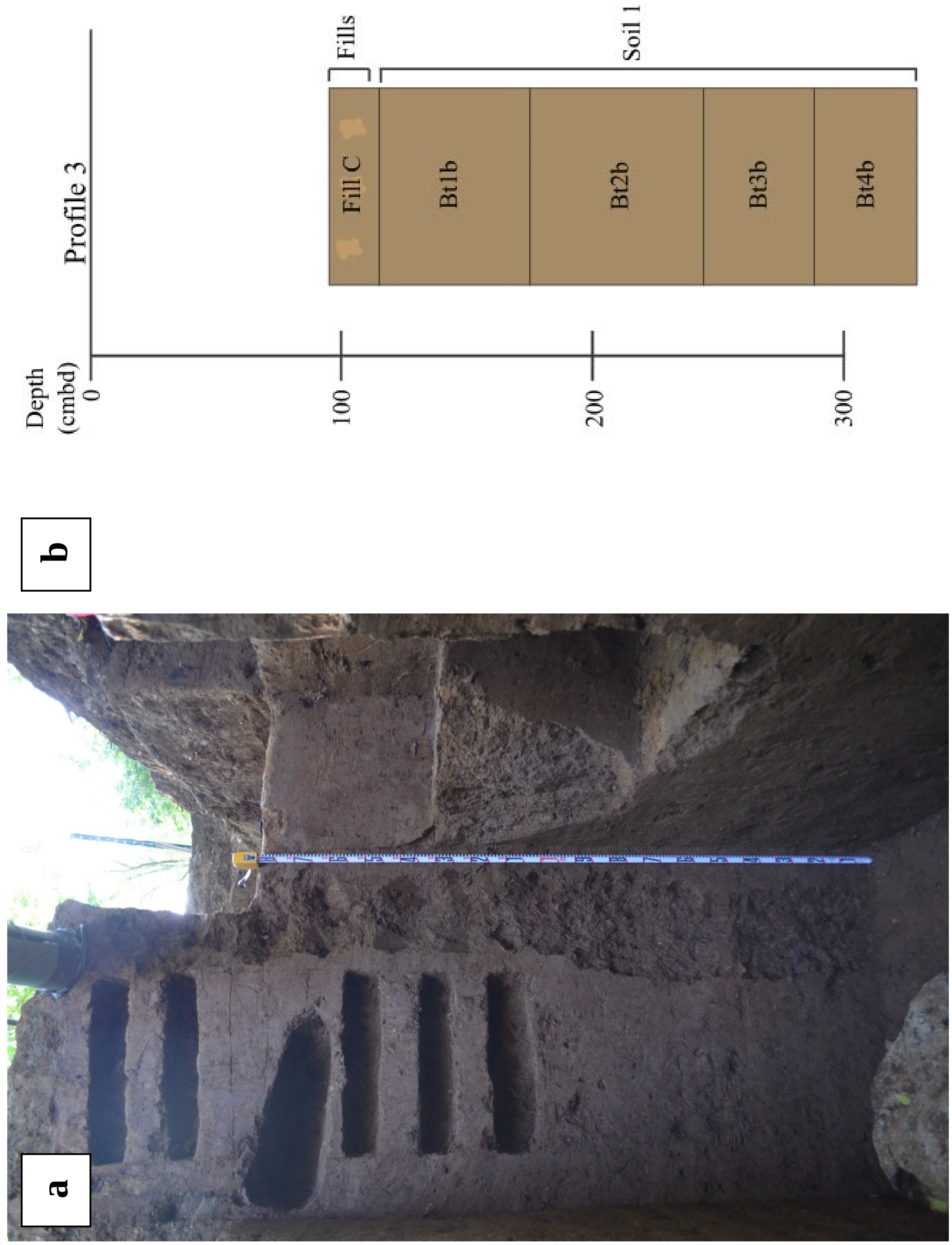

Figure 16. Profile 3 at 23CT389, view is to the east. (a) Profile 3 from Fill 3 to 330 cmbd; (b) graphic representation of Profile 3.

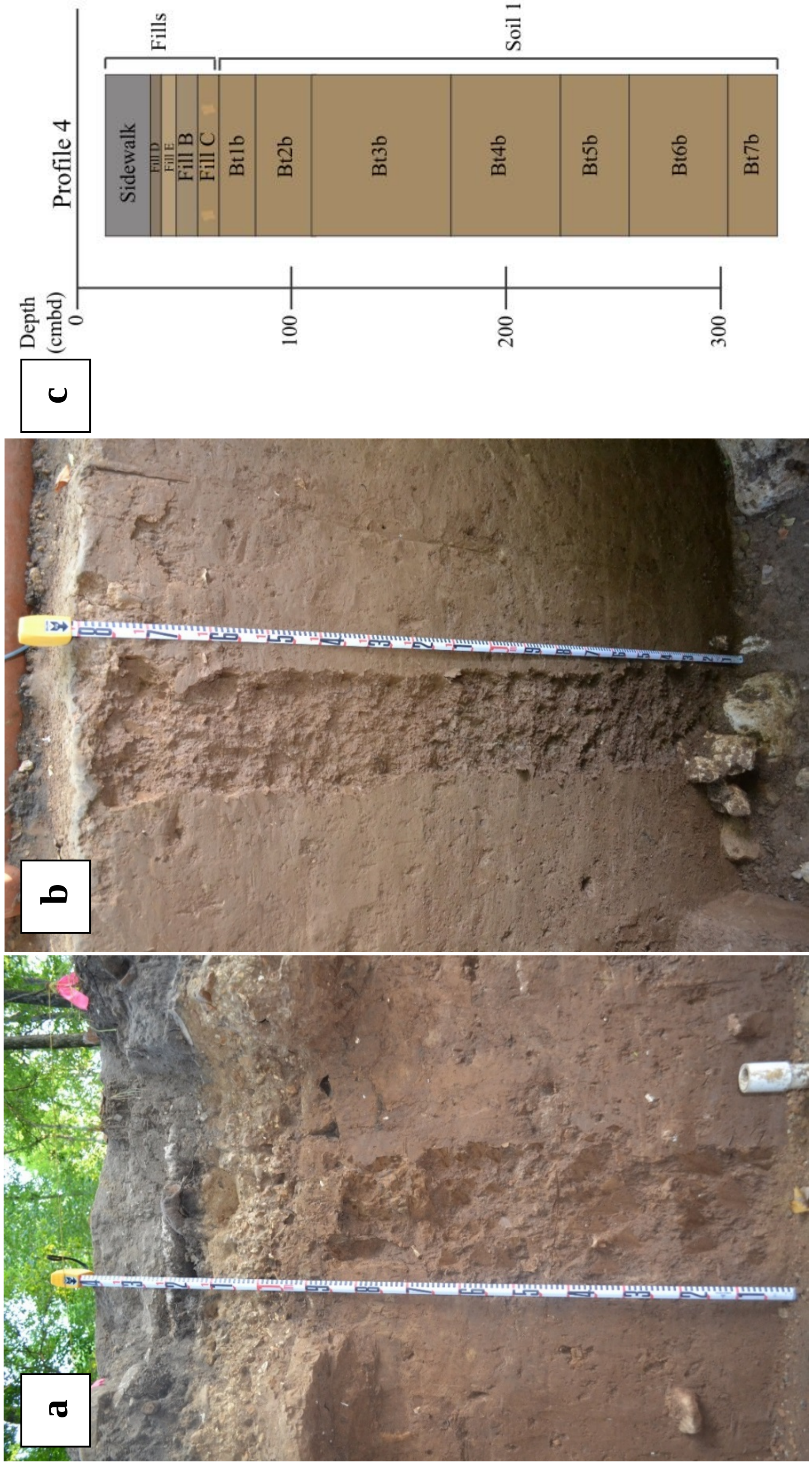

Figure 17. Profile 4 at 23CT389, view is to the north. (a) Surface to 150 cmbd; (b) 150 to 330 cmbd; (c) graphic representation of Profile 4.

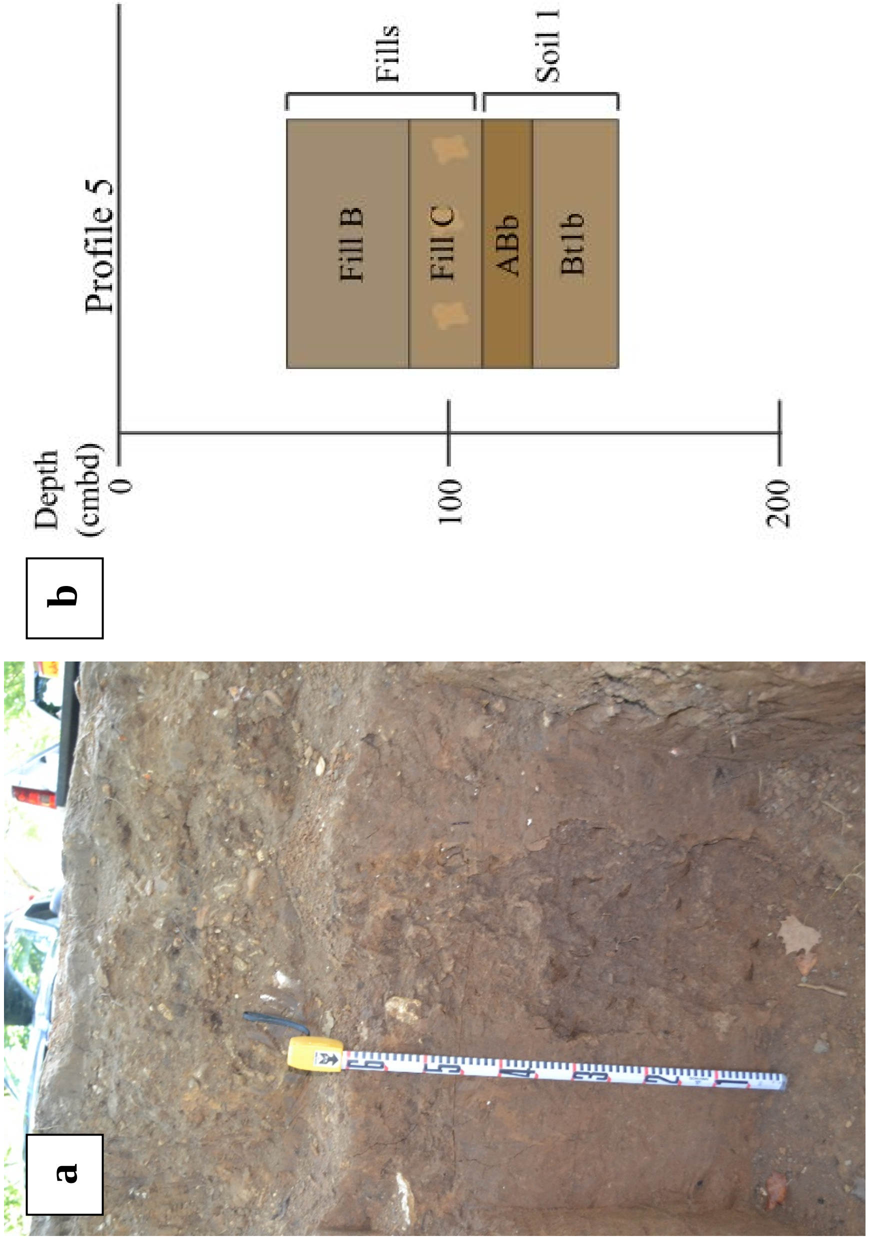

Figure 18. Profile 5 at 23CT389, view to the east. (a) Profile 5 from surface to 150 cmbd; (b) graphic representation of Profile 5.

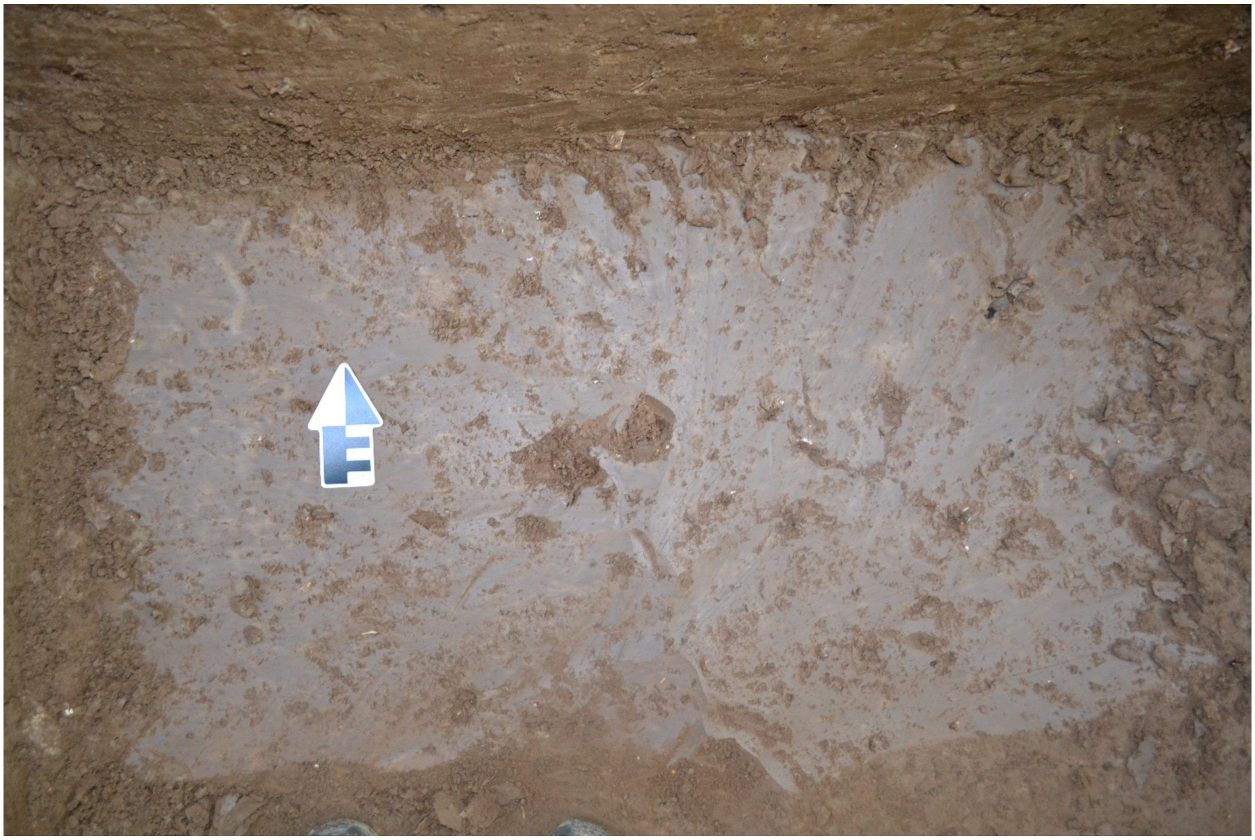
Figure 19. Part of the floor of level 25 in TU 5 showing numerous krotovina encountered.

Coefficient of Linear Extensibility

$COLE_{rod}$ was conducted on bulk soil samples from Profile 4. Three rods were measured for each horizon for a total of 33 samples (Appendix B). The $COLE_{rod}$ measurements for each horizon were averaged and classified according to Simon et al.'s (1987) classification scheme (Table 9; Figure 20).

$COLE_{rod}$ varies from a minimum of 0.036 to a maximum of 0.16. A linear least square regression demonstrates a positive trend towards increasing $COLE_{rod}$ with depth, where depth is represented by the midpoint of the sample (y=1740x, R^2=0.5755). These values indicate an increasing shrink-swell capacity of the soil with depth. A Pearson correlation demonstrates a significant relationship between $COLE_{rod}$ values and clay content with depth (correlated at 0.785, p=0.004), explaining the increasing shrink-swell capacity at Spring Valley.

A Gainey hafted biface fragment was recovered at a tilted position at a depth of 233.5 (Figure 21). When an artifact is discarded onto a surface and buried, the position of the artifact is typically horizontal. Shrink-swell action can move an artifact to a diagonal or vertical position. The $COLE_{rod}$ value for the depth of the Gainey biface is 0.11, indicating moderate shrink-swell potential based on Simon et al.'s (1987) classification scheme. The tilted position and corresponding $COLE_{rod}$ value suggest argilliturbation has probably affected the original position of the Gainey biface fragment.

In addition to the trend of a general increase with depth, $COLE_{rod}$ results suggest that argilliturbation has been a major site-forming process. Most of the chipped stone assemblage occurs between levels 8 and 18, corresponding to depths between 70 and 180 cmbd. While the upper portion (ca. 10-15 cm) of this may not be greatly affected by argilliturbation, the 1

Table 9. Average $COLE_{rod}$ per horizon and associated shrink-swell classes

Horizon	Depth (cmbd)	Averaged $COLE_{rod}$	Shrink-swell Classes: Simon et al. (1987)	Shrink-swell Classes: Schafer and Singer (1976)
Bt1b	61-81	0.03599	Slight	Moderate
Bt2b	81-109	0.07759	Moderate	Moderate
Bt3b	109-174	0.086381	Moderate	High
Bt4b	174-225	0.118058	Moderate	High
Bt5b	225-257	0.11006	Moderate	High
Bt6b	257-303	0.153852	High	Very High
Bt7b	303-326	0.16038	High	Very High

remainder is well within the moderate shrink-swell class defined by Simon et al. (1987). Hence, it is likely that argilliturbation affected the archaeological record at 23CT389.

It is important to note that COLE only informs on the theoretical shrink-swell capacity of a soil, not the actual shrink-swell behavior occurring at a locality. Shrink-swell behavior is influenced by many factors, but two significant variables affecting Spring Valley are moisture content and overburden pressure.

Soil moisture varies with depth. The water content of the upper portion of a soil is more variable than the water content lower in profile. Soil near the surface is therefore more susceptible to wetting-drying cycles and associated shrink-swell behavior, causing argilliturbation to primarily affect near-surface cultural materials. Soil lower in a profile maintains a consistent amount of moisture, thereby limiting the shrink-swell behavior of clays. Hence, cultural materials in the lower portion of the soil tend to be less affected by argilliturbation than other forms of pedoturbation.

Overburden pressure is related to the distribution of weight in a column of soil. The lower portion of a soil profile is subjected to greater weight and therefore more pressure from the overlying materials compared to the upper portion of a soil profile. The greater overburden pressure in the lower portion of a soil profile reduces volume changes caused by expandable clays. Therefore, archaeological materials that are deeply buried tend to be less affected by argilliturbation than artifacts near the surface.

As the landform at Spring Valley aggraded, fluctuations in moisture near the surface and the low near-surface overburden pressure favored argilliturbation and associated displacement of cultural deposits. However, when the archaeological materials became deeply buried, the combined effects of consistent moisture content and greater overburden pressure limited the ability of clays to shrink and swell and, therefore, reduced the effects of argilliturbation on the buried cultural deposits.

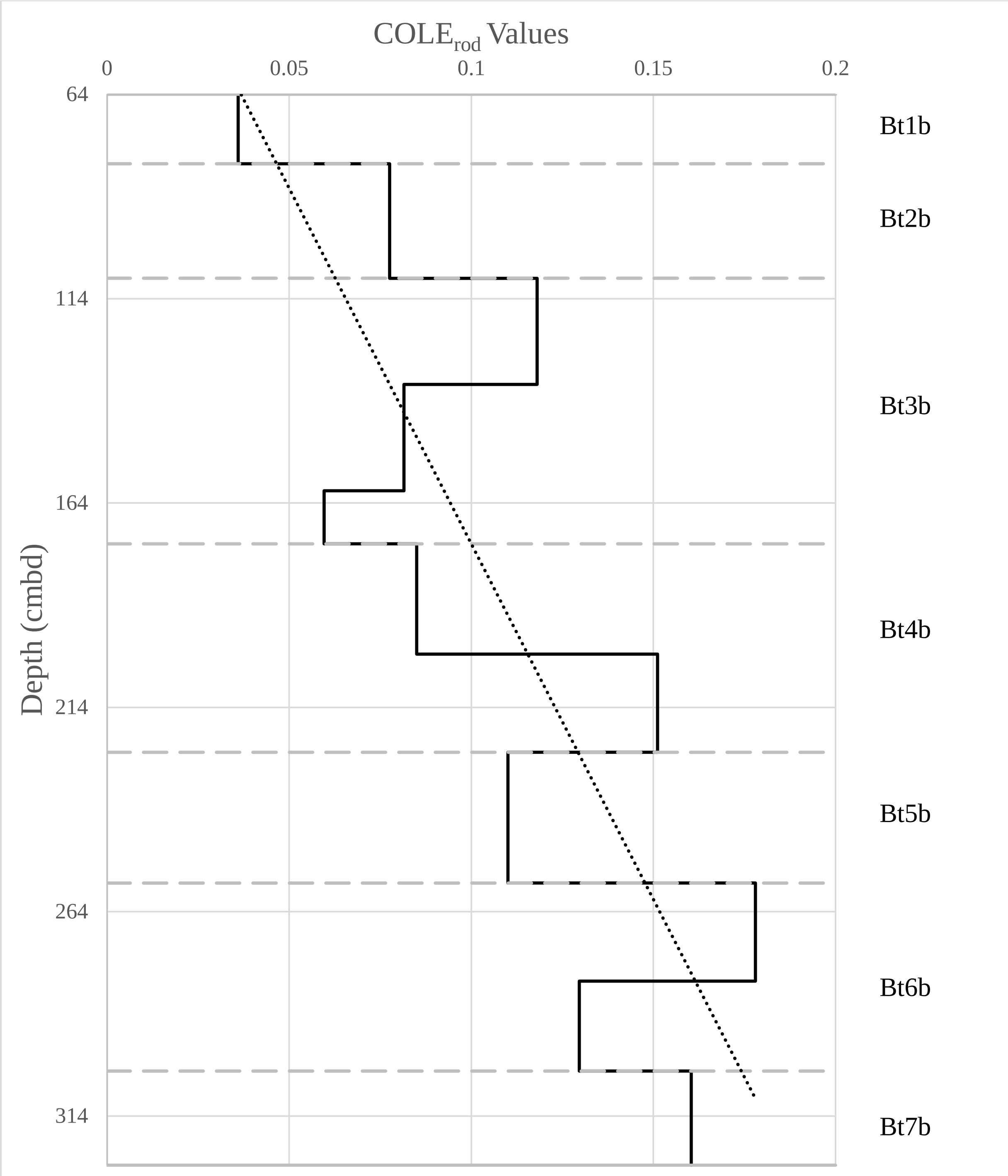

Figure 20. COLE$_{rod}$ by depth in Profile 4. Trendline shows general increase of values with depth.

Figure 21. A Gainey hafted biface fragment recovered at a depth of 236 cmbd the southwest quadrant of TU 5. Notice the tilted position of the artifact, often indicative of argilliturbation at archaeological sites.

Radiocarbon Chronology

Four charcoal samples were submitted for AMS radiocarbon dating (Table 10). An age of 9214±43 ^{14}C yr B.P. was determined on a piece of charred nutshell from TU 2 at a depth of 99 cmbd. This sample yielded the oldest of the four radiocarbon ages.

A charred nutshell from Feature 1 in TU 5 yielded an age of 8992±44 ^{14}C yr B.P. Feature 1 was at a depth of 143 to 159 cmbd and consisted of a slight concentration of charcoal, burned sediment, flakes, and a large unmodified quartzite cobble. A Dalton adze (PP-67) and an end scraper (PP-69) are associated with Feature 1, indicating a Dalton affiliation.

Charred nutshell from Feature 2 in TU 7 yielded an age of 8916±41 ^{14}C yr B.P. Feature 2 at a depth of 162 to 170 cmbd and was a light concentration of charcoal and burned sediment surrounding a pitted stone and an unmodified stone.

A charred nutshell recovered close to a Gainey biface fragment yielded an age of 8283±38 ^{14}C yr B.P. The sample was recovered in TU 5 at a depth of 236 cmbd, and was the deepest sample submitted for radiocarbon dating.

The ages of the four radiocarbon samples are in inverted stratigraphic order, suggesting that some of the sampled charcoal migrated from younger sediments downwards. The oldest radiocarbon sample (9214±43 ^{14}C yr B.P.) is slightly above what appears to be a Dalton occupation surface based on a spatial analysis of lithic artifacts. This radiocarbon age post-dates the typical date range of Dalton in the Ozarks (10,500-9,800 ^{14}C yr B.P.) and may reflect the age of the sediments overlying Dalton materials.

The two radiocarbon ages determined on charcoal from Features 1 and 2 are atypical for Dalton. The presence of an adze in Feature 1 suggests a Dalton affiliation, which is typically ascribed a time span of 10,500-9800 ^{14}C yr B.P. in the Ozarks (Ray 2016). The radiocarbon age of 8916±41 ^{14}C yr B.P. determined on nutshell from Feature 2 is statistically the same as the age of 8992±44 ^{14}C yr B.P. determined on nutshell from Feature 1, suggesting the features were used at or near the same time, but about 1,000 years later than previously recorded Dalton sites in the Ozarks. However, at the Claussen site in northeastern Kansas, a Dalton component yielded radiocarbon ages clustering at ca. 9200 ^{14}C yr B.P. (Cordova et al. 2011). There are three possible explanations for the radiocarbon ages determined on charcoal from Features 1 and 2 at Spring Valley. The first hypothesis is that younger charcoal migrated vertically through the soil and became incorporated into the matrix of the features. The second hypothesis is that

Table 10. AMS Radiocarbon ages from samples from 23CT389.

Provenience	Depth (cmbd)	Material Dated	^{14}C age	Cal yr B.P. (2-sigma) *	Laboratory No.
TU 2	99	Charred nutshell	9214±43	10,500-10,255	D-AMS 024890
Feature 1	143-159	Charred nutshell	8992±44	10,240-9930	D-AMS 024886
Feature 2	162-170	Charred nutshell	8916±41	10,190-9910	D-AMS 024887
TU 5	236	Charred nutshell	8283±38	9,420-9,140	D-AMS 024888

* calibrated with OxCal v4.3.2 Bronk Ramsey (2017); r:5 IntCal13 atmospheric curve (Reimer et al 2013).

Dalton existed in the Ozarks for longer than previously thought. The third hypothesis is that the radiocarbon ages are correct for the features, but the Dalton adze was translocated from elsewhere. No krotovina large enough to account for the displacement of an artifact the size of an adze were documented in Feature 1, suggesting that the third hypothesis is unlikely.

Finally, the youngest radiocarbon age of 8283±38 ^{14}C yr B.P. was recovered near a Gainey hafted biface at a depth of 236 cmbd. Based on the spatial analysis of lithic artifacts at the site, it is likely that pedoturbation heavily disturbed this portion of the site, as will be discussed below, mixing Early Archaic, Dalton, and Middle Paleoindian artifacts. The pedoturbation in this portion of the site likely resulted in the downward movement of charcoal and the Gainey biface, suggesting that both materials have been displaced from their original contexts.

Refit Analysis

Ray and Mandel (2017) identified three refit cases, but no additional cases were discovered during my analysis. Refit items consisted of two projectile point fragments, and four preform fragments, representing slightly over 7% of the piece plotted artifacts.

Refit Case 1 consists of the distal and proximal portions (PP30 and PP54) of a Dalton projectile point made of Roubidoux chert (Figure 22a). The proximal portion (PP54) was recovered in TU3 at a depth of 113 cmbd, and the distal fragment (PP30) was recovered from TU 6 at a depth of 131 cmbd. PP54 and PP30 were separated by 2.3 m horizontally and 18 cm vertically.

Refit Case 2 consists of the distal and proximal portions of a middle-stage preform made of Roubidoux Quartzite (Figure 22b). The proximal portion (PP8) was recovered in TU 1 at a depth of 85 cmbd, and the distal fragment (PP56) was recovered from TU 13 at a depth of 128 cmbd. PP8 and PP56 were separated by 2.3 m horizontally and 43 cm vertically.

Refit Case 3 consists of the proximal and midsection portions of a late-stage preform made of Roubidoux chert (Figure 22c). The proximal portion (PP93) was recovered from TU 7 at a depth of 200 cmbd, and the midsection (PP91) was recovered from the same unit at a depth of 99 cmbd). PP93 and PP91 were separated 40 cm horizontal separation but only 1 cm vertically.

The three refit cases are relevant to understanding site formation processes at 23CT389. Refit Case 1 supports the presence of a possible Dalton occupation surface, as discussed below. Refit Case 2 supports the presence of a potential Early Archaic occupation surface. Refit Case 3 seems to support translocation of cultural materials as a result of pedoturbation. All of these are discussed in the spatial analysis section below in more detail.

Figure 22. Three refit cases at 23CT389.

Debitage Analysis

The 1,115 pieces of debitage recovered from the screened portions of TU3 and TU7 were examined by excavation level to determine the presence or absence of size sorting, and to determine the cultural stratigraphy. No debitage was examined above Level 11, as that was the first level screened for both units. For the purpose of examining size sorting, debitage greater than ½" is considered large, and anything under ½" is considered small enough to be affected by argilliturbation. Many debitage analyses only count debitage under 1 cm^2 in size. As ½" is slightly larger than $1cm^2$ ($1.27cm^2$), this size and larger was considered a reasonable separation between the small and large fractions of debitage for this analysis.

Test Unit 3. TU 3 contained a total of 378 pieces of debitage. Figure 23a shows debitage by depth and the four size grades, and Figure 23b shows the large vs. small fractions by depth. Argilliturbation often is indicated by the occurrence of small artifacts lower in profile and larger artifacts higher in the profile (Mandel et al. 2017). As the soil shrinks, cracks open, and small artifacts fall into them, leaving larger materials at or near the original depth of deposition.

The results of debitage analysis for TU 3 suggest that small artifacts have, in fact, migrated vertically in profile. The presence of large clasts between levels 13 and 15 suggests that a cultural component occurs at a depth of 120-150 cmbd. It is likely that some mixing of artifacts has occurred through bioturbation in the cultural component, but it appears that argilliturbation was a significant process affecting debitage in TU 3, which is further supported by the previously discussed $COLE_{rod}$ results. Small debitage is consistently present in higher numbers below peaks in the large debitage.

The debitage counts indicate at least one cultural component in TU 3, between levels 13 and 15. This corresponds to the highest density of larger debitage. Also, there are 11 pieces of debitage (eight smaller than ½", and three larger than ½") between levels 24 and 26. These 11 pieces of debitage may represent a cultural component, or they may be artifacts that were translocated downward by pedoturbation.

Test Unit 7. TU 7 contained 737 pieces of debitage. Figure 24a shows debitage by depth and the four size grades, and Figure 24b shows the large vs. small fractions by depth. TU 7 seems to indicate some vertical displacement of small artifacts, likely due to

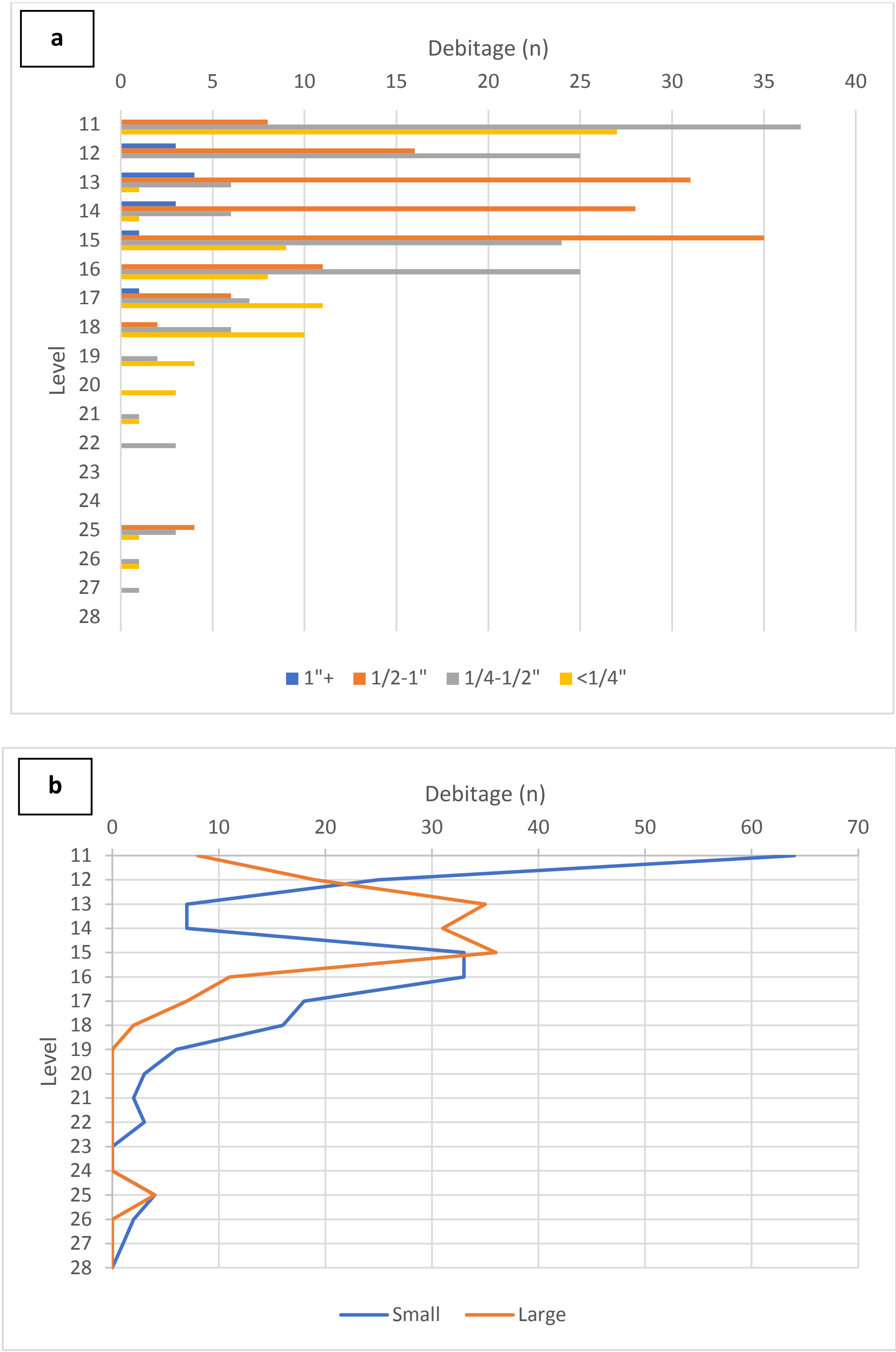

Figure 23. TU 3 debitage by level. (a) debitage counts by size and depth; (b) debitage by size grouping. The limited occurrence of larger materials low in profile is suggestive of argilliturbation.

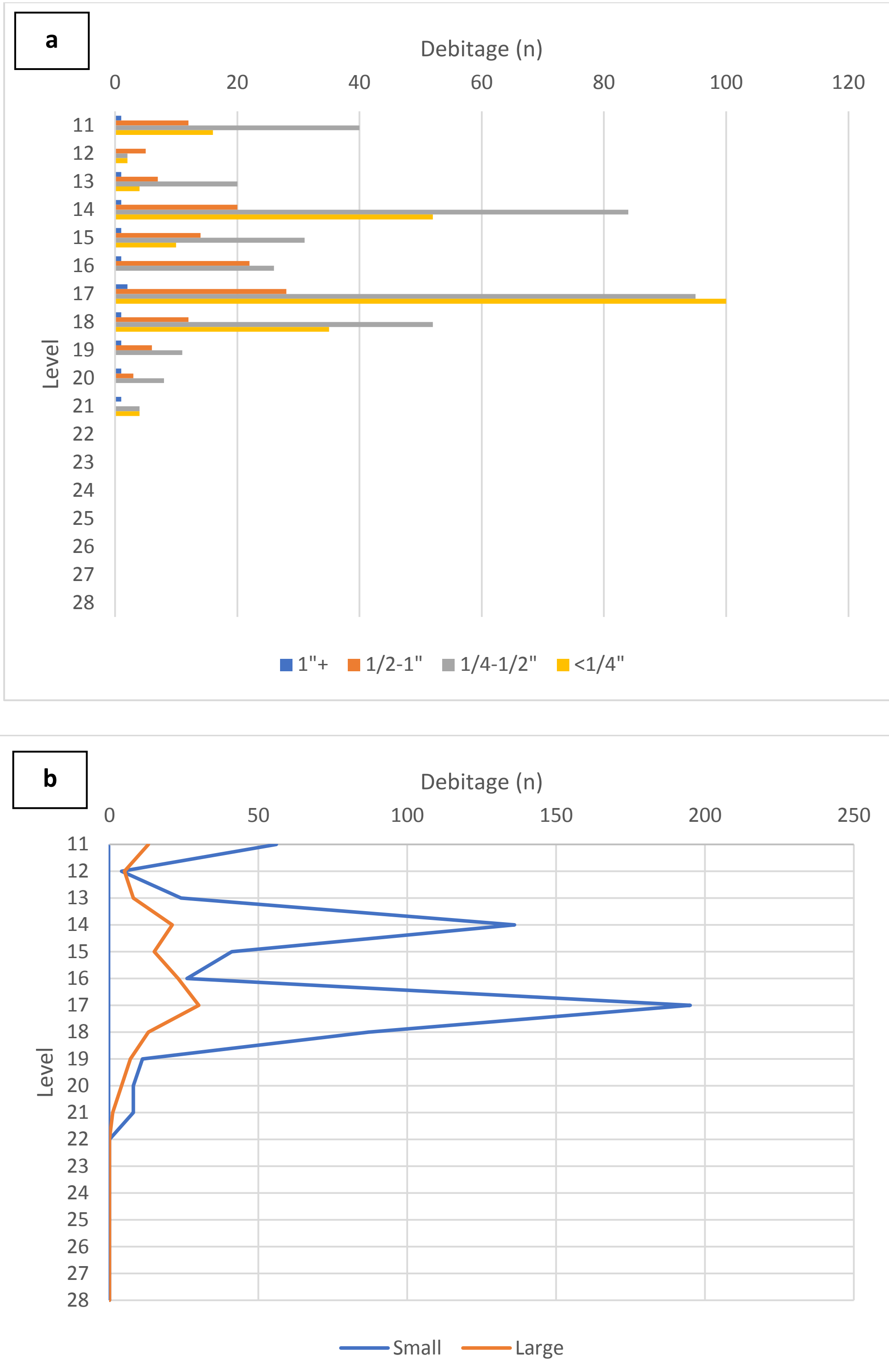

Figure 24. TU 7 debitage by level. (a) debitage counts by size and depth; (b) debitage by size grouping. The limited occurrence of larger materials low in profile is suggestive of argilliturbation.

argilliturbation. However, the translocation of smaller materials is not as pronounced in TU 7 as in TU 3, suggesting that the debitage in TU 7 was less affected by argilliturbation compared to debitage in TU 3. Argilliturbation would affect the surficial assemblage of a site in a similar manner if it was the primary pedoturbation process. Since the artifact assemblages of the two excavation units appear to have been differentially modified, it is likely that argilliturbation and other forms of pedoturbation, especially bioturbation, have affected the assemblages.

Spatial Analysis

The distribution of several Dalton diagnostic artifacts, including hafted bifaces and adzes, and the presence of Features 1 and 2 are suggestive of a Dalton occupation surface in the northern and central portions of the excavation block. The surface is found in TUs 1 through 8, and TU 17. The surface was not present in excavated portions of TUs 11 through 16. While some Dalton diagnostic artifacts appear to have migrated vertically or horizontally, probably due to bioturbation, many appear to follow a sloped surface that probably represents a buried lobe of the co-alluvial fan (Figure 25). Hence, Dalton artifacts on that former surface have largely maintained their spatial and stratigraphic integrity.

Refit Case 1 further supports the presence of the buried Dalton surface. The two fragments of a Dalton biface seem to follow the general dip of this surface. The proximal portion was recovered in TU 3 at a depth of 113 cmbd and the distal fragment was recovered in TU 6 at a depth of 131 cmbd.

Features 1 and 2 are likely indicative of the lowest points of the Dalton occupation surface. Feature 1 was associated with a Dalton adze and a radiocarbon age of 8992±44 ^{14}C yr B.P. No diagnostic artifacts were associated with Feature 2, but the associated radiocarbon age of

8916±41 ^{14}C yr B.P. overlaps with the age of Feature 1, suggesting use and construction of both features at or near the same time. Of note for the reconstruction of the Dalton occupation surface, the surface recorded for Feature 2 is approximately 20 cm lower than that of Feature 1 but is only approximately 8 cm deep according to Total Station data. The feature is either remarkably shallow, or was not recognized by excavators until much of the feature had already been excavated. Based on the reconstruction of the Dalton occupation surface, the apparent surface dips 73.1 cm over 4.79 m for a slope of 15.3 cm/m. The peak in large artifacts that occurs between levels 13 and 15 in TU 3 and at level 17 in TU 7 corresponds to this reconstructed surface.

Refit Case 2, debitage analysis, and middle-stage preforms recovered at 23CT389 suggest a second preserved occupation surface (Figure 26). The second buried occupation surface is 10 to 20 cm higher than the Dalton occupation surface, indicating it is Archaic in age. The Archaic surface is present at least partially in every test unit except for TU 16.

The Archaic surface is defined by Refit Case 2, which includes a Taney biface, a Searcy biface, and several preforms. The presence of the preserved Archaic surface is further supported by debitage counts for TU 3 and 7. Level 11 in TU 3 and Level 14 in TU 7 correspond to peaks in the total debitage of in their respective units, and these peaks are at similar elevations to the Archaic surface. The apparent Archaic occupation surface dips 62.2 cm over 4.9 m to the southeast, indicating a slope of 12.7cm/m. An age between 7800-7100 ^{14}C yr B.P. is proposed for the surface based on the presence of the Taney and Searcy hafted bifaces.

When all cultural materials are plotted, there is evidence of substantial mixing of temporally diagnostic artifacts in parts of TUs 5, 7, 13, and 14 (Figure 27 and Figure 28). Near the bottom of this mixed zone, a Gainey hafted biface was found in association with a charred nutshell fragment that yielded a radiocarbon age of 8282±38 ^{14}C yr B.P. Gainey is associated with a time span of ca. 10,800-10,500 ^{14}C yr B.P., suggesting that the biface or the charred nutshell were translocated from their original depositional locations. Alternatively, the Gainey biface may not represent a discrete Middle Paleoindian occupation, but rather a curated artifact deposited at the site by a later group.

Above the Gainey biface, Early Archaic and Dalton materials are mixed together. The association of a Gainey biface with a charred nutshell that yielded an age over 2,000 years too young, and the mixed composition of the Dalton and Early Archaic materials suggest pedoturbation in the southeastern portion of the excavation.

As fossorial animals construct their burrows, they often mix cultural materials over a broad area, translocating artifacts (Bocek 1986; Erlandson 1984; Ohel 1987). In addition, tree throws can vertically and horizontally displace artifacts well over a meter from their original locations (Holmes 1893; Rapp and Hill 2006; Schaetzl et al. 1990; Waters 1992). Excavations revealed an abundance of krotovinas in the southeastern portion of the excavation block where the artifacts of multiple ages were mixed. The mixed cultural stratigraphy and krotovina indicate that this area of the site has been extensively bioturbated either through burrowing action of fossorial animals or by tree-throw.

As co-alluvial fans aggrade, they prograde away from the valley wall. Younger cultural materials are often found along the distal portions of the fan, while older deposits are closer to the valley walls (Ferring 2017). The relative position of the Taney and Searcy hafted bifaces in relation to those of the Dalton occupation surface appear to represent gradual progradation of the co-alluvial fan's surface through time. The Dalton occupation was present along a relatively level surface closer to the valley wall and was gradually buried by overbank deposition from episodic flooding of the Current River, alluvium deposited by Spring Valley Branch, and colluvial inputs from the adjacent wall. Between 7,800-7,100 ^{14}C yr B.P., Early Archaic bands visited the locale and engaged in intensive preform manufacture. After site abandonment, bioturbation mixed some of the Dalton and Early Archaic occupations, resulting in mixed cultural stratigraphy in part of the site.

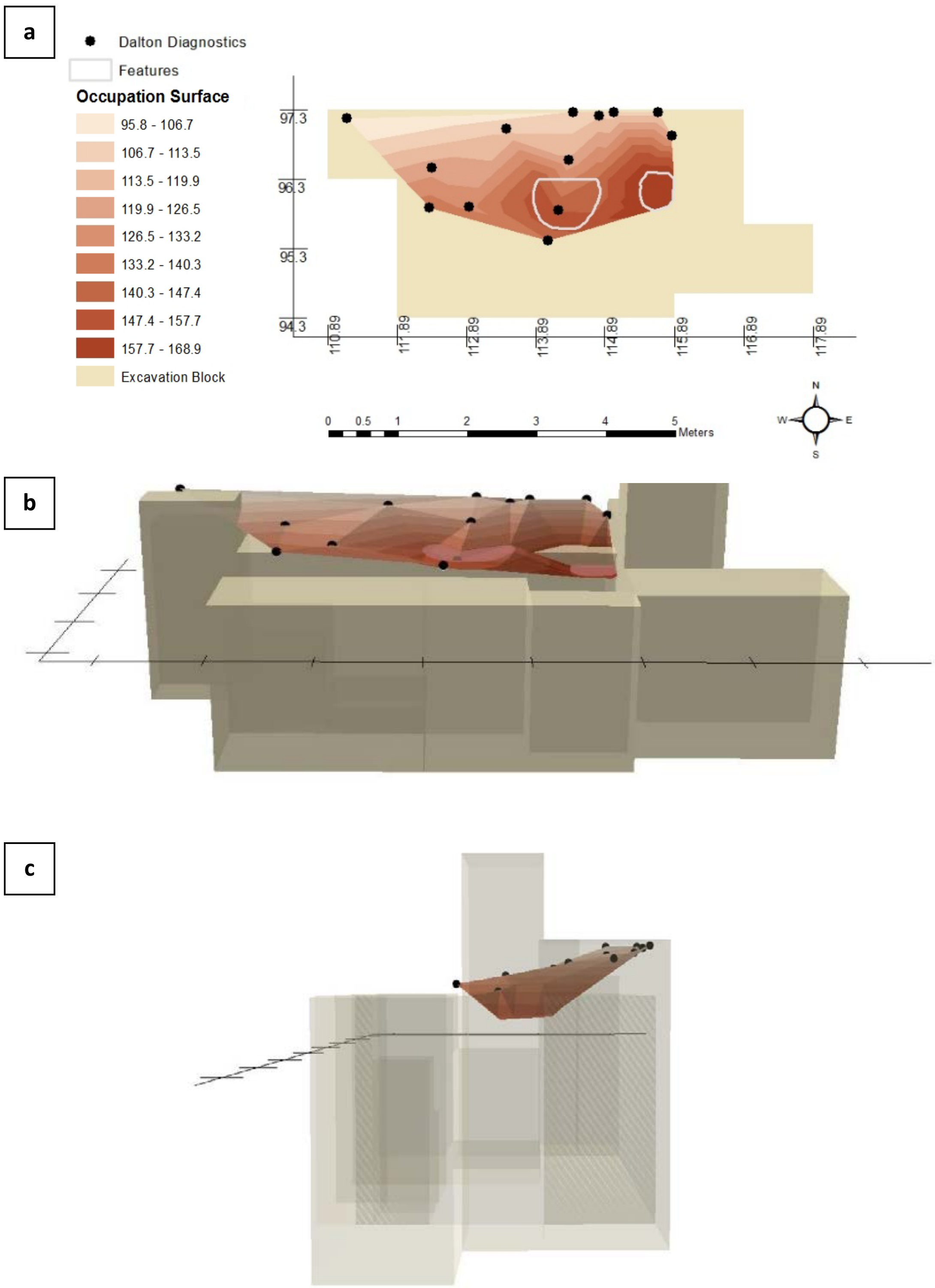

Figure 25. The proposed Dalton occupation surface at 23CT389. (a) Plan view showing the elevations based on diagnostic materials, debitage, and Features 1 and 2; (b) 3-dimensional view of the excavation block and the surface. The view is to the northwest; (c) 3-dimensional view of the excavation block and the surface. The view is to the west.

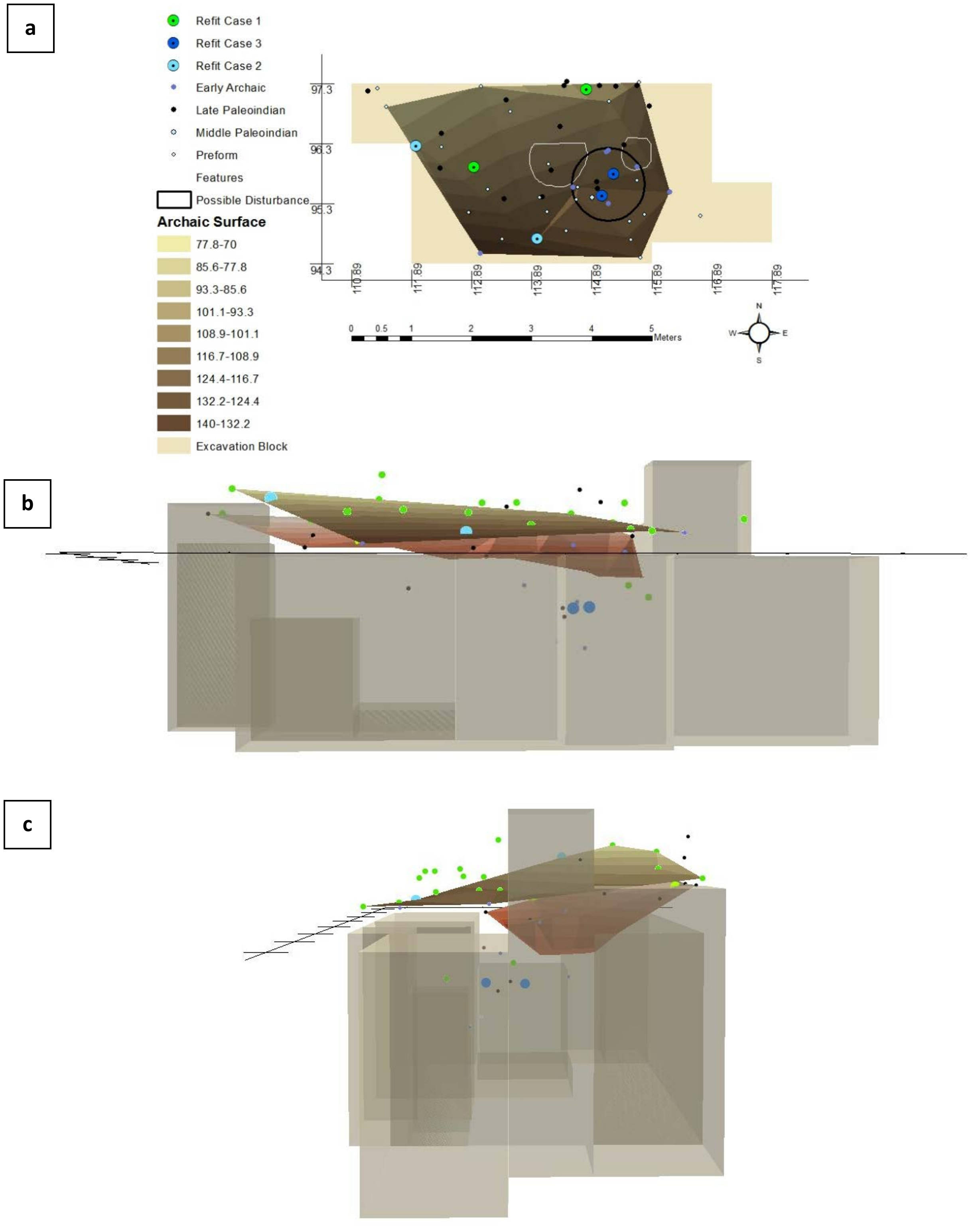

Figure 26. The proposed Early Archaic surface overlying the Dalton occupation surface. (a) Plan view showing the Archaic surface, refit cases 1-3, diagnostic materials, and preforms; (b) the Early Archaic surface overlies the Dalton occupation. The view is to the north; (c) the Early Archaic surface overlying the Dalton surface. The view to the west.

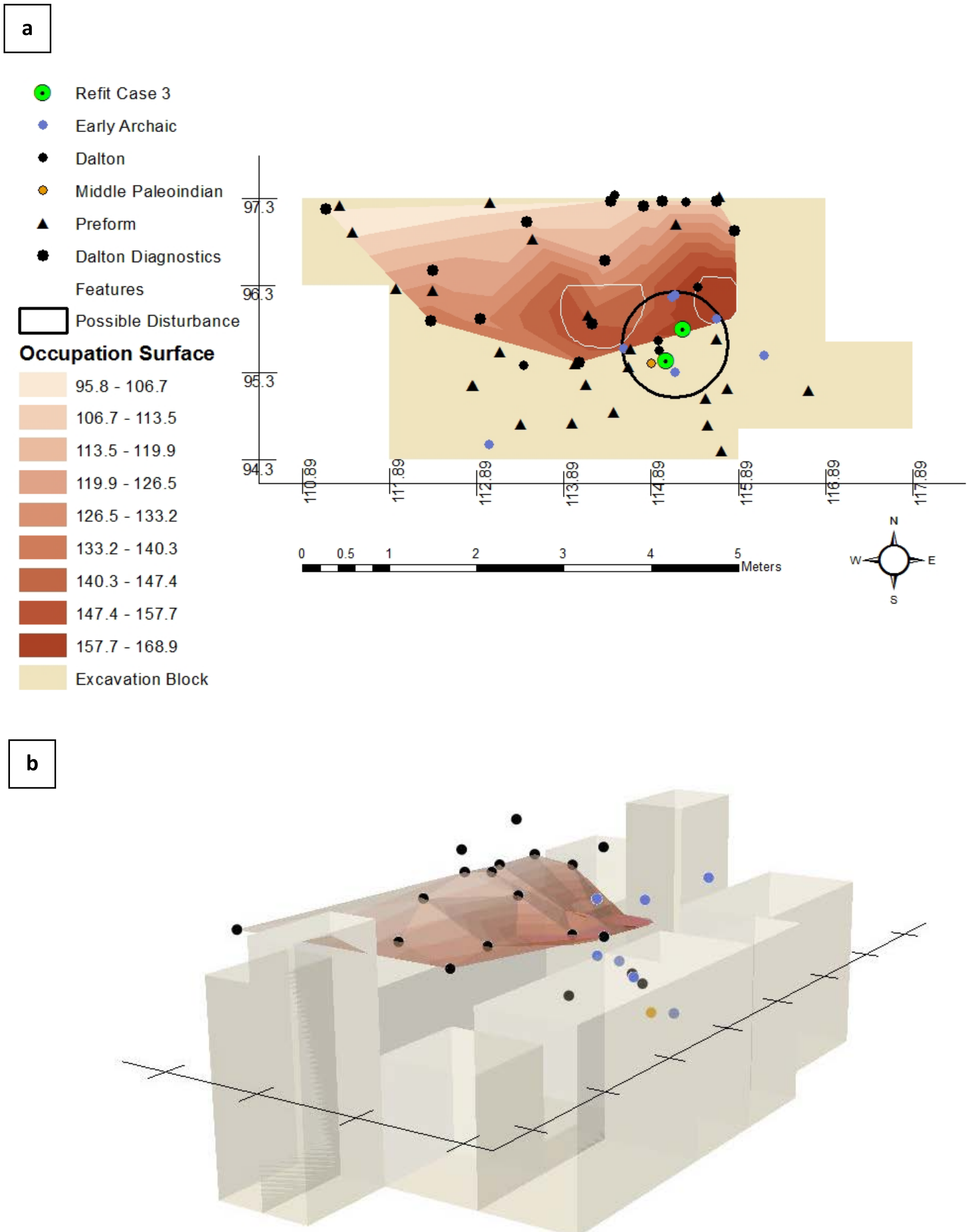

Figure 27. The Dalton surface and Early Archaic diagnostics. (a) Plan view showing the location of a possible disturbance; (b) Image of disturbed materials. The view is to the northeast

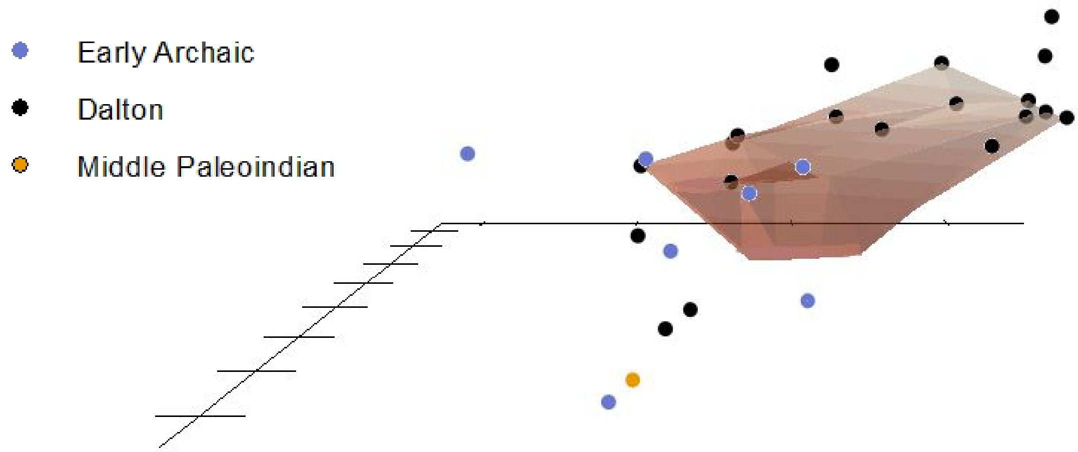

Figure 28. Image of mixing in the southeastern portion of the excavation block. The Dalton occupation surface is represented. View is to the west.

Discussion

The Spring Valley site is an important multicomponent site associated with a co-alluvial fan. The cultural assemblage has been affected by pedoturbation, but there are at least two discrete occupation surfaces: one dating to the Dalton period and the other dating to the Early Archaic.

Four hypotheses were tested in this thesis. The first hypothesis is that the landform at Spring Valley aggraded rapidly due to complex interactions between alluvial and colluvial processes. Key to addressing this hypothesis was the radiocarbon chronology. The radiocarbon ages, however, are in inverted stratigraphic order. As a result, it is unclear how rapidly the Spring

Valley co-alluvial fan aggraded. The preservation of at least two occupation surfaces suggests rapid burial of those individual components but does not address how rapidly the fan aggraded. The lack of buried A horizons indicates consistent landscape instability in the study area at least during the period of occupation at Spring Valley (i.e. 10,800-5,500 ^{14}C yr B.P.). The co-alluvial fan was leveled in 1935 during CCC-era construction; hence it is impossible to determine when the fan became stable. Nevertheless, the presence of a White River biface in the upper part of the excavation suggests that the co-alluvial fan became stable soon after 5,500 years ago.

The second hypothesis asserts that rapid aggradation resulted in rapid burial of archaeological occupations. The preservation of at least two occupation surfaces and cultural features in co-alluvial deposits indicates rapid burial of cultural materials during Dalton and Early Archaic periods, supporting the second hypothesis.

The third hypothesis contends that post-depositional processes have differentially translocated artifacts from their original depositional locations based on size. Despite the preservation of Dalton and Early Archaic surfaces, argilliturbation has been significant in affecting the archaeological record at 23CT389. $COLE_{rod}$ values indicate moderate to high shrink-swell capacity in the soil at Spring Valley, hence it is likely that argilliturbation is an important site formation process. Size-sorting of debitage in TU 3 demonstrates that argilliturbation has been significant, affecting smaller cultural materials at 23CT389. Larger artifacts, such as bifaces, cores, and preforms, have been subjected to minor movement by pedoturbation, but have largely remained in situ. However, in the southeast portion of the excavation block, significant pedoturbation, likely bioturbation, has resulted in extensive translocation of all sizes of cultural materials.

The final hypothesis is that occupations could only be defined by temporally and culturally diagnostic materials. This hypothesis was rejected. The co-alluvial fan at Spring Valley was visited repeatedly by prehistoric bands. The Gainey hafted biface was recovered in an extensively pedoturbated portion of the site. Due to the post-depositional movement of this biface, there are two possibilities to explain the presence of the Gainey biface. The first is that the Gainey hafted biface represents an ephemeral Middle Paleoindian occupation. The second possibility is that the Gainey hafted biface represents a curated item found and carried by later groups to Spring Valley, where it was deposited. Without further testing, it is unclear whether or not this biface represents a discrete occupation.

A buried Dalton occupation surface represents at least a single, intensive occupation. Based on culturally and temporally diagnostic hafted bifaces, there are at least five episodes of occupation during the Early Archaic, although there has been translocation of some of these materials through bioturbation. A White River biface indicates an ephemeral occupation during the Middle Archaic that was heavily affected by CCC and modern activity. Debitage peaks in TU 3 and TU 7 are suggestive of at least three cultural components. One component determined through debitage is Early Archaic in age based on spatial analysis, while the cultural and temporal connections could not be determined for the remaining two components. A Gainey hafted biface either represents a discrete occupation or a curated artifact brought to Spring Valley by a later group. To summarize, the Spring Valley site witnessed at minimum eight and possibly nine different occupations of varying intensity.

A generalized model of site formation at Spring Valley was developed (Figure 29 and Figure 30). The first stage begins with the Dalton occupation at Spring Valley (Figure 29). A Dalton band occupied the surface, leaving behind diagnostic cultural materials. A combination of alluvial deposition by Spring Valley Branch, overbank sedimentation from the Current River, and colluvial inputs from the adjacent slope led to rapid burial after Dalton peoples abandoned the site. Artifacts from the Dalton occupation were subjected to argilliturbation processes from the expansion of clay minerals, preferentially translocating artifacts under ½" in size downwards in profile. Over the next several thousand years, Early Archaic groups occupied the landform which prograded away from the valley wall, burying occupations. Between 7,800-7,100 ^{14}C yr B.P., Searcy and Taney bands occupied the same surface and rapid burial of this occupation occurred shortly thereafter. As sediment continued to accumulate at Spring Valley, the shrink-swell action of expandable clays led to translocation of small artifacts in the upper part of the co-alluvial fan. Sediment continued to be deposited until sometime soon after 5500 ^{14}C yr B.P., when landscape stability occurred, allowing for the development of a thick surface soil at Spring Valley (Figure 30). During this period of stability, extensive bioturbation mixed multiple archaeological components in the southeast portion of the site, either through fossorial animal burrowing or through tree-throw. CCC construction in 1935 led to the removal of the surface of the co-alluvial fan and widening of Spring Valley Branch truncated the distal portion. During this process, part of the archaeological record was removed, and historic fills were deposited on the surface, burying the strongly developed soil.

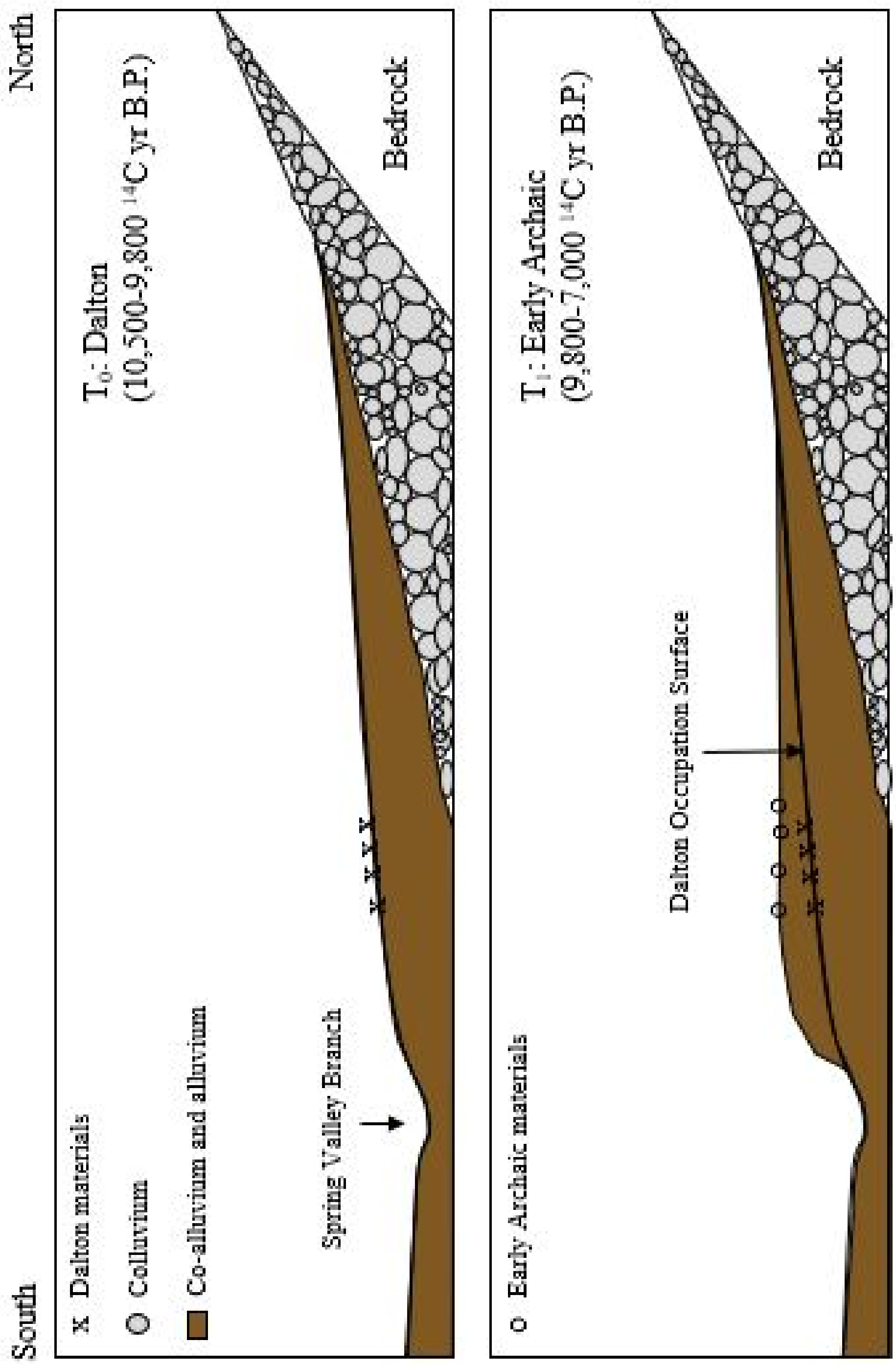

Figure 29. Generalized model of site formation at 23CT389. T_0 represents the Dalton occupation and T_1 represents the Early Archaic occupations.

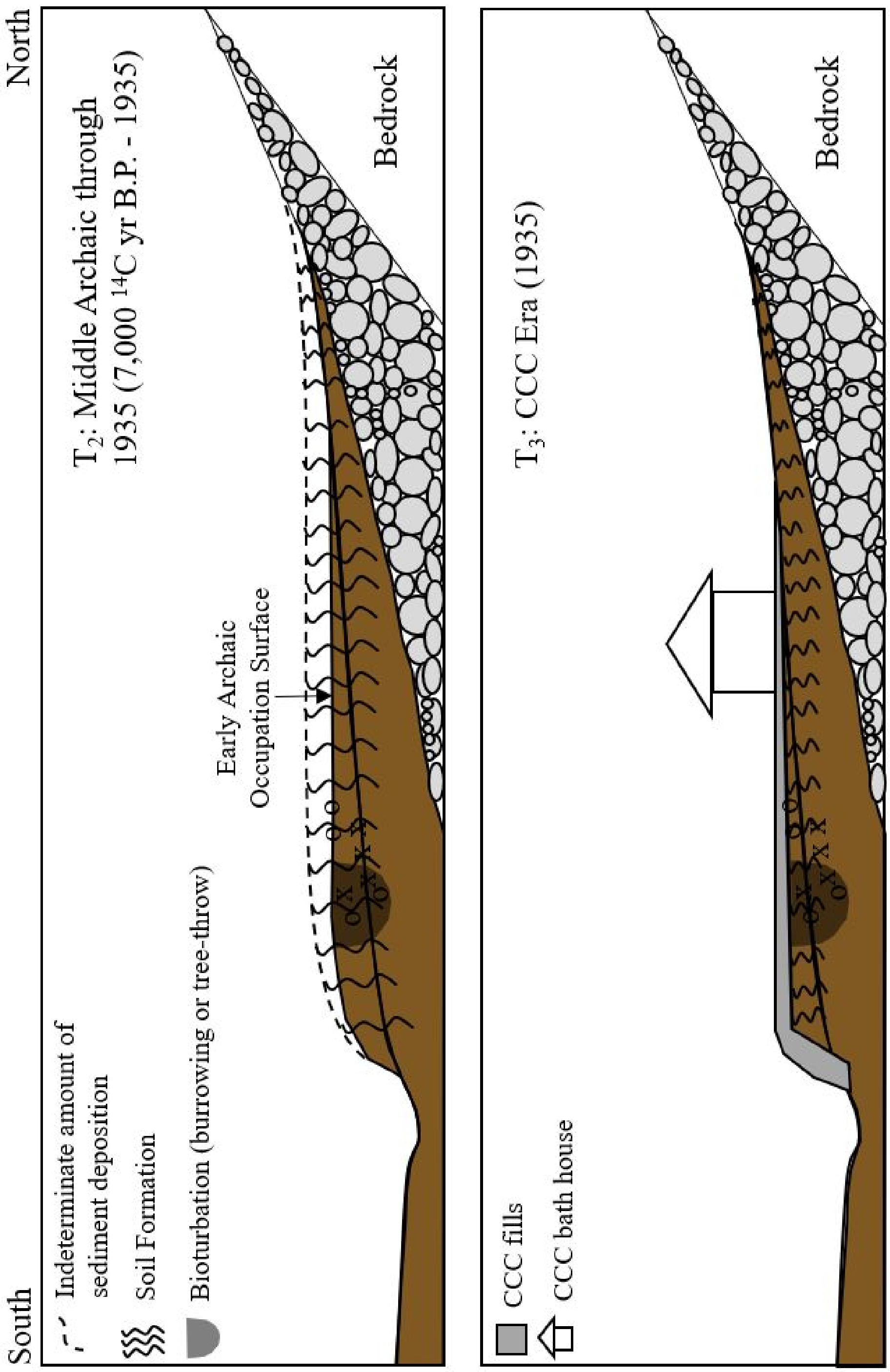

Figure 30. Generalized model of site formation at 23CT389. T_2 depicts the Middle Archaic through the early 1900's. T_3 depicts the CCC-era activity.

CHAPTER 6

CONCLUSIONS

The Spring Valley site (23CT389) is a multicomponent site with a significant Dalton component. Furthermore, 23CT389 is one of the few stratified Dalton sites that has been tested in the Ozarks. Therefore, the site has potential to address questions about the behavior of Dalton peoples, but that potential relies on the stratigraphic integrity of cultural deposits. My thesis has demonstrated that although multiple processes (e.g., bioturbation and argilliturbation) have affected the vertical and horizontal integrity of cultural deposits, there is definable stratigraphic integrity of artifacts and features as well as the preservation of two significant occupation surfaces.

Three primary questions guided the present study:

1. How did the site form and what post-depositional processes have occurred?
2. How did post-depositional processes affect the archaeological record?
3. Is it possible to identify discrete cultural components?

All three questions were addressed by using multiple methodologies and considering multiple lines of evidence.

The co-alluvial fan on which the site is situated formed through a combination of (1) alluvial deposition from Spring Valley Branch, (2) episodic flooding and associated overbank deposition from the Current River, and (3) colluvial inputs from the adjacent valley wall. At least two episodes of rapid burial are indicated by the preservation of two occupation surfaces that are separated by 10 to 20 cm. The fan stopped aggrading and soil formation was underway sometime after the Early Archaic.

The presence of a surface soil with a thick, strongly developed argillic (Bt) horizon suggests that the fan has been stable for at least 4,000 years. During the period of soil development, argilliturbation and bioturbation have affected some of the cultural record, as evidenced through debitage size-sorting, and mixed cultural stratigraphy in the southeastern portion of the excavation block. Smaller artifacts, such as debitage under 1/2" in size, have been translocated vertically in the site. For example, in the screened portions of TUs 3 and 7, peaks in debitage counts indicate multiple cultural components. Below these peaks are varying amounts of <1/2" debitage, indicating downward movement of those artifacts due to pedoturbation. Some large artifacts, such as bifaces, have also been translocated, either through animal burrowing or tree-throw. Nevertheless, some of the record is remarkably intact, including Dalton and Early Archaic occupation surfaces.

The site witnessed many occupations including, at a minimum, an extensive Dalton occupation, at least five Early Archaic occupations, and minimally, a single Middle Archaic occupation. Of the Early Archaic components, Breckenridge, Graham Cave, Hardin, Taney, and Searcy are present in the Bt horizons, implying that there may be more of these occupations immediately to the south of the excavation block. A Jakie projectile point was recovered from disturbed overburden, suggesting a possible Jakie occupation that has been disturbed. Debitage in TUs 3 and 7 indicate two, and possibly three cultural components. In sum, there are at least eight identifiable occupation episodes at 23CT389.

Recommendations for future research

While my thesis has addressed several questions about site formation and occupation at the Spring Valley site, there are many avenues for future research. Currently, it is unclear if

Spring Valley contains a Middle Paleoindian component. Debitage counts decline rapidly after the Dalton occupation in both TU 3 and TU 7. It is unclear if debitage deep in the excavation (below level 22) is the result of translocation or represents an intact cultural component. The Gainey biface was recovered in level 24, but the biface appears to be in a disturbed context. Furthermore, the Gainey biface could represent a curated item found elsewhere and brought to Spring Valley by a later group.

As mentioned above, co-alluvial and alluvial fans prograde through time; hence older occupations tend to be buried closer to the valley margins. Excavations below the northern bench of the excavation block and to the north of the excavation block might uncover additional Middle Paleoindian cultural deposits as well as earlier cultural components. The Middle Paleoindian period is not well understood in the Current River valley, and revealing a more extensive Middle Paleoindian record at Spring Valley would help to understand these groups and refine the cultural history of the area. Further excavations could provide information about Middle Paleoindian use of Spring Valley.

One goal of this study was to determine the extent of horizontal and vertical mixing of the assemblage at 23CT389. While three refit cases were discovered, this sample was not large enough to determine the extent of vertical and horizontal movement of materials at the site. Expansion of the refit analysis to the rest of the units at the site would likely prove useful, particularly in delineating other occupation surfaces and assisting in further defining known occupations at the site. Another useful methodology, minimum analytical nodule analysis (MANA), could be used to better understand the organization of lithic technology employed by site occupants through time (Larson and Ingbar 1992; Larson and Kornfield 1997). Furthermore, MANA is useful for addressing questions of artifact translocation, like refitting, and could help determine the extent of vertical and horizontal movement of artifacts.

Identification of lithic materials for each cultural component would provide insight into changing mobility patterns in the Current River valley. The relative proportions of local vs. exotic materials in assemblages can provide insight into differential practices of mobility and curation, aiding our understanding of how local indigenous groups used the landscape.

Debitage analysis in my study has proven to be useful in identifying archaeological components at Spring Valley. However, further analysis of the debitage from Spring Valley would prove useful to identify differences in patterned behavior through time. In TU 3, for example, there was more debitage recovered in the non-screened portion of the unit than there was in the screened portion, suggesting differences in behavior across space at 23CT389 (see Appendix II). Examining debitage recovered from all test units and determining the density of debitage with depth would be useful in addressing questions of intra-site use.

X-ray diffraction (XRD) is a technique that can determine clay mineralogy, and would be useful at Spring Valley. While $COLE_{rod}$ and debitage size-sorting demonstrate that argilliturbation is an active process at 23CT389, the type of clay is unclear. Defining the clay mineralogy at Spring Valley would help determine the potential effects of expandable clays on the integrity of the cultural deposits.

$COLE_{rod}$ has been shown in this study to be useful in addressing the potential effects of argilliturbation on archaeological assemblages. While scales have been generated to examine shrink-swell potential in soils (i.e. Schafer and Singer [1976] and Simon et al. [1987]), the relationship between scales and the movement of artifacts is unknown. By developing a method to examine assemblages that have been affected by argilliturbation, $COLE_{rod}$ can be used to classify potential for shrink-swell capacity to affect the archaeological record. As $COLE_{rod}$ requires inexpensive materials that are easily purchased and transportable, the technique has potential to assist archaeologists rapidly determine site-forming processes and guide field methods. For example, if an excavation reveals artifacts in slightly tilted positions, $COLE_{rod}$ tests can be used to determine if clays with high shrink-swell capacity are present. If expandable clays are abundant, the archaeologists can adapt field methods to closely examine for in-filled cracks.

My thesis has addressed questions related to site formation and occupation history at the Spring Valley site. The site has potential to inform on the cultural history of the Current River valley, but that potential relies on the stratigraphic integrity of archaeological materials. I have shown that while the site has been affected by bioturbation and argilliturbation, some of its stratigraphic integrity is intact. Future research at 23CT389 must consider the effects of site formation when interpreting past human behavior.

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APPENDIX I

SOIL AND SEDIMENT DESCRIPTIONS

Depth (cmbd*)	Soil Horizon	Txtr [a]	Structure [b]	CNSTNCY [c]	LB [d]	CLR [e]	Comments
Profile 1							
14-41	Fill A	SiL	1 f sbk ~ 1 f gr	friable	a, s	10YR 3/1 d 10YR 2/1 m	Many fine to coarse roots; many subangular pebbles; many worm casts; many open pores.
41-52	Fill B	SCL	1 f sbk ~ 1 f gr	firm	a, s	10YR 5/3 d 10YR 3/3 m	Very many fine to medium subangular and subrounded pebbles, many subrounded cobbles; many fine to medium roots.
52-85	Fill C	SCL	1 m sbk ~ 1 f sbk	firm	a, s	10YR 5/4 d 10YR 3/2 m	Few, distinct 7.5YR 6/6 mottles (dry), 10YR 4/6 (moist); many fine to medium pebbles, many subrounded cobbles; many fine to medium roots.
85-124	Bt1b	SCL	1 m pr ~ 1 f sbk	friable	g, s	10YR 6/4 d 10YR 4/4 m	Common, distinct, continuous clay films; few fine and medium roots; common worm casts; few open worm burrows; common krotovina.
124-144	Bt2b	SCL	1 m pr ~ 1 f sbk	friable	g, s	10YR 5/4 d 10YR 3/4 m	Few angular pebbles; common, distinct, discontinuous clay films; few fine and medium roots; common worm casts; few open worm burrows; common krotovina.

Depth (cmbd[*])	Soil Horizon	Txtr[a]	Structure[b]	CNSTNCY[c]	LB[d]	CLR[e]	Comments
Profile 1 (cont.)							
144-210	Bt3b	SCL	1 m pr ~ 1 f sbk	friable	g, s	10YR 5/4 d 10YR 3/3 m	Common, distinct, continuous clay films; common pressure faces; few fine and medium roots; common worm casts; few open worm burrows; common krotovina.
210-300	Bt4b	SCL	1 m pr ~ 1 f sbk	friable	-	10YR 5/4 d 10YR 3/3 m	Common, distinct, continuous clay films; common pressure faces; few to common magnesium and iron films on ped surfaces; few fine and medium roots; common worm casts; few open worm burrows; common krotovina.

Depth (cmbd[*])	Soil Horizon	Txtr[a]	Structure[b]	CNSTNCY[c]	LB[d]	CLR[e]	Comments
Profile 2							
34-52	Fill A	SiL	1 f sbk ~ 1 f gr	friable	a, s	10YR 3/1 d 10YR 2/1 m	Many fine to coarse roots; many subangular pebbles; many worm casts; many open pores.
52-62	Fill B	SCL	1 f sbk ~ 1 f gr	firm	a, s	10YR 5/3 d 10YR 3/3 m	Very many fine to medium subangular and subrounded pebbles, many subrounded cobbles; many fine to medium roots.
62-84	Fill C	SCL	1 m sbk ~ 1 f sbk	firm	a, s	10YR 5/4 d 10YR 3/2 m	Few, distinct 7.5YR 6/6 mottles (dry), 10YR 4/6 (moist); many fine to medium pebbles, many subrounded cobbles; many fine to medium roots.
84-108	ABb	SiL	1 m sbk ~ 1 f sbk	friable	g, s	10YR 5/3 d 10 YR 3/3 m	Many fine to very fine roots; few worm casts; common very fine pores.
108-240	Bt1b	SCL	1 m pr ~ 1 f sbk	friable	g, s	10YR 5/4 d 10YR 3/4m	Common, distinct, discontinuous clay films; few very fine to medium roots; common worm casts; few open worm burrows; few angular pebbles; common krotovina.

Depth (cmbd[*])	Soil Horizon	Txtr[a]	Structure[b]	CNSTNCY[c]	LB[d]	CLR[e]	Comments
Profile 2 (cont.)							
240-334	Bt2b	SCL	1 m pr ~ 1 f sbk	friable	-	10YR 5/4 d 10YR 3/4 m	Common, distinct, continuous clay films; few very fine to medium roots; common worm casts; few open worm burrows; few angular pebbles; common krotovina.

Depth (cmbd[*])	Soil Horizon	Txtr[a]	Structure[b]	CNSTNCY[c]	LB[d]	CLR[e]	Comments
Profile 3							
95-115	Fill C	SCL	1 m sbk ~ 1 f sbk	firm	a, s	10YR 5/4 d 10YR 3/2 m	Few, distinct 7.5YR 6/6 mottles (dry), 10YR 4/6 (moist); many fine to medium pebbles, many subrounded cobbles; many fine to medium roots.
115-175	Bt1b	SCL	1 m pr ~1 f sbk	friable	g, s	10YR 5/4 d 10YR 3/4 m	Common, distinct, discontinuous clay films; few angular pebbles, few fine to coarse roots; many worm casts; few open pores; common krotovina.
175-244	Bt2b	SCL	1 m pr ~ 1 f sbk	friable	g, s	10YR 5/4 d 10YR 4/3 m	Common, distinct, continuous clay films; few angular pebbles; few fine to coarse roots; many worm casts; few open pores; common krotovina.
244-288	Bt3b	SCL	1 m pr ~ 1 f sbk	firm	g, s	10YR 5/4 d 10YR 4/3 m	Common, distinct, continuous clay films; few pressure faces; few angular pebbles; few fine to coarse roots; many worm casts; few open pores; common krotovina.
288-329	Bt4b	SCL	1 m pr ~ 1 f sbk	firm	-	10YR 5/4 d 10YR 3/3 m	Common, distinct, continuous clay films; few pressure faces; few magnesium and iron coats on ped surfaces; few angular pebbles; few fine to coarse roots; many worm casts; few open pores; common krotovina.

Depth (cmbd[*])	Soil Horizon	Txtr[a]	Structure[b]	CNSTNCY[c]	LB[d]	CLR[e]	Comments
Profile 4							
11-32	Sidewalk	-	-	-	-	-	-
32-37	Fill D	SiL	1 f sbk ~ 1 f gr	friable	a, s	10YR 4/2 d 10YR 2/2 m	Few distinct 10YR4/2 mottles; many fine pebbles, common subrounded to rounded gravels; many fine to medium roots.
37-44	Fill E	SL	1 f sbk ~ 1 f gr	friable	a, s	10YR 6/4 d 10YR 4/4 m	Many fine to medium pebbles, common subrounded to rounded gravels, common subangular gravels; many fine roots.
44-54	Fill B	SCL	1 f sbk ~ 1 f gr	firm	a, s	10YR 5/3 d 10YR 3/3 m	Very many fine to medium subangular and subrounded pebbles, many subrounded cobbles; many fine to medium roots.
54-64	Fill C	SCL	1 m sbk ~ 1 f sbk	firm	a, s	10YR 5/4 d 10YR 3/2 m	Few, distinct 7.5YR 6/6 mottles (dry), 10YR 4/6 (moist); many fine to medium pebbles, many subrounded cobbles; many fine to medium roots.

Depth (cmbd[*])	Soil Horizon	Txtr[a]	Structure[b]	CNSTNCY[c]	LB[d]	CLR[e]	Comments
Profile 4 (cont.)							
64-81	Bt1b	SCL	1 m pr ~ 1 f sbk	very hard	g, s	10YR 4/6 d 10YR 4/3 m	Common, distinct, discontinuous clay films; few to common fine pebbles; few very fine to fine roots; common krotovina.
81-109	Bt2b	SCL	1 m pr ~ 1 f sbk	friable	g, s	10YR 4/6 d 10YR 3/3 m	Few fine to medium distinct dark brown (7.5YR 3/3) moist mottles; common, distinct, discontinuous clay films; few to common fine pebbles; few very fine to fine roots; common krotovina.
109-174	Bt3b	SCL	1 m pr ~ 1 f sbk	friable	g, s	10YR 4/6 d 10YR 4/3 m	Common, distinct, discontinuous clay films; few to common fine pebbles; few very fine to fine roots; common krotovina.
174-225	Bt4b	SCL	1 m pr ~ 1 f sbk	friable	g, s	10YR 4/6 d 10YR 4/4 m	Common, distinct, continuous clay films; few to common fine pebbles; few very fine to fine roots; common krotovina.
225-257	Bt5b	SCL	1 f pr ~ 1 f sbk	friable	g, s	10YR 3/6 d 10YR 4/3 m	Common, distinct, continuous clay films; few distinct iron and manganese coats on ped surfaces; few pressure faces; few to common fine pebbles; few very fine to fine roots; common krotovina.

Depth (cmbd[*])	Soil Horizon	Txtr[a]	Structure[b]	CNSTNCY[c]	LB[d]	CLR[e]	Comments
Profile 4 (cont.)							
257-303	Bt6b	SCL	1 f pr ~ 1 f sbk	friable	g, s	10YR 4/6 d 10YR 3/3 m	Common, distinct, continuous clay films; few pressure faces; few distinct iron and manganese coats on ped surfaces; few pressure faces; few to common fine pebbles; few very fine to fine roots; common krotovina.
303-326	Bt7b	SCL	1 f pr ~ 1 f sbk	friable	-	10YR 3/6 d 10YR 3/3 m	Common, distinct, continuous clay films; few pressure faces; few distinct iron and manganese coats on ped surfaces; few pressure faces; many subrounded and angular pebbles and few large subrounded boulders; few very fine to fine roots; common krotovina.

Depth (cmbd*)	Soil Horizon	Txtr[a]	Structure[b]	CNSTNCY[c]	LB[d]	CLR[e]	Comments
Profile 5							
51-88	Fill B	SCL	1 f sbk ~ 1 f gr	firm	a, s	10YR 5/3 d 10YR 3/3 m	Very many fine to medium subangular and subrounded pebbles, many subrounded cobbles; many fine to medium roots.
88-110	Fill C	SCL	1 m sbk ~ 1 f sbk	firm	a, s	10YR 5/4 d 10YR 3/2 m	Few, distinct 7.5YR 6/6 mottles (dry), 10YR 4/6 (moist); many fine to medium pebbles, many subrounded cobbles; many fine to medium .
110-125	ABb	SiL	1 m pr ~ 1 f sbk	friable	g, s	10YR 4/4 d 10YR 3/3 m	Few faint brown 7.5YR 4/4 mottles; many distinct, discontinuous clay films; many fine to medium roots; common worm casts; few open worm burrows.
125-151	Bt1b	SCL	1 m pr ~ 1 f sbk	friable	g, s	10YR 5/4d 10YR 4/3 m	Many distinct, discontinuous clay films; many fine to medium roots; friable; common worm casts; few open worm burrows; few angular pebbles; few krotovina.

[*] cmbd = centimeters below datum.
[a] Textural Classes: SL = Sandy loam; SiL = silt loam; SCL = silty clay loam; CL = clay loam
[b] Structure: 1 = weak; 2 moderate; f = fine; m = medium; ~ = parting to; pr = prismatic; sbk = subangular blocky; gr = granular
[c] Consistency
[d] Lower Boundary: g = gradual; a = abrupt; s = smooth
[e] Munsell Color: d = dry; m = moist

APPENDIX II

SUMMARY OF DEBITAGE IN TEST UNITS 3 AND 7

TEST UNIT 3

Level	Non-screened Portion					Screened Portion					Total
	<1/4"	1/4-1/2"	1/2-1"	1"+	Total	<1/4"	1/4-1/2"	1/2-1"	1"+	Total	
7	15	24	17	1	57	0	0	0	0	0	57
8	4	28	11	0	43	0	0	0	0	0	43
9	0	33	18	0	51	0	0	0	0	0	51
10	9	30	15	0	54	0	0	0	0	0	54
11	2	7	7	0	16	27	37	8	0	72	88
12	0	3	0	8	11	0	25	16	3	44	55
13	0	1	2	0	3	1	6	31	4	42	45
14	0	1	5	0	6	1	6	28	3	38	44
15	2	9	10	0	21	9	24	35	1	69	90
16	6	29	22	0	57	8	25	11	0	44	101
17	2	21	15	2	40	11	7	6	1	25	65
18	0	10	16	0	26	10	6	2	0	18	44
19	0	6	4	0	10	4	2	0	0	6	16
20	1	0	2	0	3	3	0	0	0	3	6
21	0	3	0	0	3	1	1	0	0	2	5
22	0	2	0	0	2	0	3	0	0	3	5
23	0	2	0	0	2	0	0	0	0	0	2
24	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	1	3	4	0	8	8
26	0	1	0	0	1	1	1	0	0	2	3
27	0	0	0	0	0	0	1	0	0	1	1
28	0	0	0	0	0	0	0	0	0	0	0
Total	41	210	144	11	406	77	147	141	12	377	783

TEST UNIT 7

	Non-screened Portion					Screened Portion					
Level	<1/4"	1/4-1/2"	1/2-1"	1"+	Total	<1/4"	1/4-1/2"	1/2-1"	1"+	Total	**Total**
9	7	77	16	0	100	0	0	0	0	0	100
10	3	30	20	0	53	0	0	0	0	0	53
11	3	16	11	0	30	16	40	12	1	69	99
12	0	23	25	0	48	2	2	5	0	9	57
13	0	1	3	0	4	4	20	7	1	32	36
14	0	13	9	0	22	52	84	20	1	157	179
15	0	3	3	2	8	10	31	14	1	56	64
16	0	8	5	0	13	0	26	22	1	49	62
17	0	13	5	0	18	100	95	28	2	225	243
18	0	12	15	1	28	35	52	12	1	100	128
19	0	14	12	0	26	0	11	6	1	18	44
20	0	12	21	1	34	0	8	3	1	12	46
21	0	41	8	0	49	4	4	0	1	9	58
22	0	18	11	0	29	0	0	0	0	0	29
23	0	10	4	0	14	0	0	0	0	0	14
24	0	2	3	0	5	0	0	0	0	0	5
25	0	8	2	0	10	0	0	0	0	0	10
26	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0
28	0	3	0	0	3	0	0	0	0	0	3
Total	13	304	173	4	494	223	373	129	11	736	1230

APPENDIX III

COEFFICIENT OF LINEAR EXTENSIBILITY (ROD) RESULTS

Horizon	Depth	Sample	l_m[a]	l_d[b]	$COLE_{rod}$	Average	Horizon Average	Average Shrink-swell class[c]
Bt1b	64-81	1	102.78	101.08	0.01682	0.03599	0.03599	Slight
		2	93.73	90.79	0.03238			
		3	97.46	92.05	0.05877			
Bt2b	81-109	1	79.81	73.08	0.09209	0.07759	0.07759	Moderate
		2	78.81	72.6	0.08554			
		3	92.24	87.42	0.05514			
Bt3b	109-135	1	86.62	77.45	0.1184	0.11808	0.08638	Moderate
		2	74.41	67.14	0.10828			
		3	80	70.95	0.12755			
	135-161	1	86.72	82.49	0.05128	0.08151		
		2	79.47	71.68	0.10868			
		3	85.42	78.76	0.08456			
	161-174	1	87.97	81.56	0.07859	0.05956		
		2	92.81	87.42	0.06166			
		3	102.15	98.37	0.03843			
Bt4b	174-201	1	88.51	80.74	0.09623	0.08499	0.11806	Moderate
		2	87.11	82.01	0.06219			
		3	79.51	72.51	0.09654			
	201-225	1	79.22	69.14	0.14579	0.15113		
		2	78.8	66.85	0.17876			
		3	81.31	72.03	0.12884			
Bt5b	225-257	1	66.98	59.27	0.13008	0.11006	0.11006	Moderate
		2	71.51	63.9	0.11909			
		3	75	69.38	0.081			
Bt6b	257-281	1	78.76	66.7	0.18081	0.17803	0.15385	High
		2	69.92	57.59	0.2141			
		3	81.11	71.2	0.13919			
	281-303	1	93.14	80.35	0.15918	0.12967		
		2	92.27	83.14	0.10981			
		3	92.01	82.15	0.12002			
Bt7b	303-326	1	69.15	60	0.1525	0.16038	0.16038	High
		2	84.22	72.13	0.16761			
		3	75.64	65.15	0.16101			

$COLE_{rod} = (l_m - l_d)/l_d$

[a]: l_m = moist rod length

[b]: l_d = dry rod length

[c]: According to Simon et al. (1987)

APPENDIX IV

PIECE PLOT CORRECTIONS

Piece Plot	Original		Calculated		Drawn in Plan?
	Northing	Easting	Northing	Easting	
1	95.4353	112.411	-	-	Y
2	102.108	115.41	-	-	Y
3	95.5368	113.163	-	-	Y
4	99.567	115.842	-	-	Y
5	95.4533	113.676	-	-	Y
6	101.119	113.349	-	-	Y
7	93.5851	86.6931	-	-	Y
8	100.029	112.54	96.27	111.97	-
9	99.7578	113.274	97.03	112.94	-
10	97.9349	115.224	94.85	114.47	Y
11	101.735	115.379	97.00	115.18	-
12	97.1932	112.309	97.19	112.31	-
13	95.1669	114.151	95.17	114.15	-
14	95.0074	115.516	95.01	115.52	-
15	96.957	115.327	96.96	115.33	-
16	101.792	113.06	97.19	112.87	-
17	99.9591	113.606	95.55	112.85	-
18	102.722	114.439	97.27	114.43	-
19	103.322	115.566	97.32	115.68	Y
20	97.2467	113.054	97.25	113.05	-
21	97.3419	114.48	97.34	114.48	-
22	97.274	115.654	97.27	115.65	-
23	97.6835	113.54	95.15	112.85	Y
24	99.378	113.204	94.53	112.03	-
25	100.925	114.729	95.40	114.02	Y
26	100.049	114.408	94.71	113.40	Y
27	101.883	112.614	97.08	112.41	-
28	102.138	114.61	96.58	114.36	Y
29	100.079	112.687	96.93	112.31	-
30	102.752	114.818	97.21	114.80	Y
31	102.651	114.709	97.16	114.66	Y
32	101.662	114.572	95.04	113.08	Y
33	101.318	114.354	95.14	113.33	Y
34	97.3341	112.319	97.33	112.32	-
35	96.2389	112.393	96.24	112.39	-

Piece Plot	Original		Calculated		Drawn in Plan?
	Northing	Easting	Northing	Easting	
36	102.862	113.607	96.83	113.53	-
37	100.224	114.114	97.08	113.81	-
38	100.095	113.785	97.03	113.46	-
39	97.2361	112.211	97.24	112.21	Y
40	97.2304	112.074	97.23	112.07	Y
41	101.492	115.195	97.27	115.02	Y
42	98.1766	115.29	95.63	114.76	Y
43	97.1603	115.05	95.57	114.66	-
44	100.331	114.739	95.96	114.17	Y
45	98.2596	113.459	94.55	112.43	Y
46	98.9481	115.324	95.37	114.64	Y
47	96.9285	115.851	96.93	115.85	Y
48	95.8014	113.864	96.14	113.84	Y
49	99.3455	115.311	95.24	114.56	Y
50	99.9598	112.883	96.47	112.39	Y
51	102.799	115.647	97.02	115.61	Y
52	93.5846	115.11	94.70	115.54	Y
53	104.093	116.169	94.41	115.70	Y
54	100.909	113.975	95.91	112.93	Y
55	100.733	113.468	95.52	112.92	Y
56	109.599	111.497	94.72	113.99	-
57	100.134	113.195	95.89	112.36	Y
58	99.4528	115.6	96.17	115.13	Y
59	99.4717	114.148	94.47	113.03	Y
60	101.174	114.636	95.87	114.08	Y
61	100.737	114.781	95.42	114.07	-
62	97.1868	111.638	97.19	111.64	-
63	98.6427	115.236	95.14	114.50	Y
64	101.08	111.838	96.91	111.47	-
65	101.063	114.182	95.90	113.61	-
66	101.41	111.634	97.13	111.35	-
67	95.8573	114.212	95.86	114.21	Y
68	116.218	99.5011	95.92	115.64	Y
69	96.1931	114.417	96.19	114.42	Y
70	95.4652	117.74	95.47	117.74	-
71	95.4586	111.995	95.46	112.00	Y
72	94.9793	117.735	94.98	117.73	-