Geomorphology and Site Burial Potential

for

TVA Property

along

Clinch River Miles 14.6 to 18.9

by

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by

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Introduction

The geomorphic settings and associated site burial potentials of the alluvial deposits along the Clinch River between river miles 14.6 and 18.9 were evaluated on December 3rd and 4th, 1999. The objective of this analysis was to determine the extent of alluvial landforms that contain terminal Pleistocene and Holocene sediments. Terminal Pleistocene and Holocene sediments are relevant to archeological site burial because their age range (<13,000 calendar years) includes the time period of human occupation of North America, and they could potentially contain cultural artifacts. The assessment of the potential for buried archeological sites based on the age of the sediment says nothing about whether or not a buried site actually exists. It simply states whether or not the age of the sediment and landscape setting would have been appropriate to contain buried sites. If archeological materials are found buried within the sediments (as is the case in the project area), then the indication of the potential for buried archeological materials is greatly strengthened. Results of these investigations revealed very high potential for deeply buried archeological materials in the Clinch River valley. A sampling strategy is suggested, which involves augering and sieving for microartifacts, in combination with more traditional deep testing strategies.

Landscape Setting

The Clinch River valley drains Paleozoic sedimentary rocks (limestone, dolomite, sandstone, shale) of the Ridge and Valley Province of the Appalachian Highlands. The drainage area above the study area is about 8770 km^2, and the Clinch River channel is about 150 m wide along the study area. The alluvial bottomland ranges from about 20 to 250 m wide on the right bank of the river in the study area, and it stands at 3 to 5 m above the water surface. The flow is regulated by dams further downstream in the watershed. Soils in the alluvial valley primarily are mapped as Pope very fine sandy loam with small patches of Wolftever silt loam (Swann et al., 1942). The Pope series is described as young well-drained soils that lie in the "first bottoms" of streams, which are subject to periodic flooding. Soils of the bottomlands, including the Pope series, are described as "parent materials that have undergone little change since deposition." In the project area the Pope series appears as the top stratum of historical sediment, whereas more weathered soil with a Bw or Bt horizon occurs as a buried soil. The Wolftever series is described as soils on low terraces that are subject to flooding only during exceptionally high floods.

Slight variations in surface elevation of the floodplain probably results from different lobes of sedimentation, rather than subtle terrace sequences embedded in the deposits of the valley floor. That is, natural levees and scroll bars are inherently at higher elevations than surrounding terrain, while the age of the different alluvial depositional units is approximately the same.

Methods

This analysis involved pedestrian reconnaissance of landforms and examination of soil profiles in erosional riverbank exposures and in samples from 7.6 cm diameter auger holes. Soil profiles were closely examined and described at six localities that were representative of landscape settings the valley (Figure 1). Six soil profiles(Appendix A) were described according to the terms of the USDA Soil Survey Manual (Soil Survey Division Staff, 1993) using moist Munsell colors. Their UTM coordinates were recorded with a hand held global positioning system, which may not correspond exactly to the map grid (Figure 1). Age estimates of the sediments are based on the degree of soil development in a manner consistent with that described by Foss and Segovia (1984), Foss and Timpson (1995), and Leigh (1996), which largely depends on the level of argillic (Bt) horizon development. That is, weak argillic horizons (Bt horizons with thin clay films and 10YR hues) can form in as little as 3,000 to 5,000 years, whereas a well developed argillic horizon (Bt with thick clay films and 7.5YR hues) typically requires several to tens of thousands of years. In addition, the relative height of alluvial floodplain and terrace surfaces is indicative of the relative age of alluvial sediments.

Results

Virtually the entire valley within the study area appears to be composed of relatively recent alluvium that is probably less than 13,000 calendar years old, and thus has clear potential to contain buried archeological materials, based on its age. Furthermore, three of the six soil profiles contained buried artifacts (Appendix 1, profiles 1, 3, & 4) [Exempted from Disclosure by Statute] Buried archeological materials (including a shell midden) also were noted [Exempted from Disclosure by Statute] These lines of evidence indicate very high potential for buried cultural materials within the sediment of the Clinch River valley. The[Exempted from Disclosure by Statute]may be more conducive to burial of artifacts than the back-levee swales, because of their more well drained landscape position.

Stratigraphy and Soils

Most of the valley is composed of floodplain deposits (Figure 1), and only small patches of terrace remnants are preserved along the margin of the valley. The term "floodplain" infers that this surface is (or was prior to the dam) the active alluvial surface undergoing sedimentation by the modern regime of the river. However, the floodplain deposits probably correlate with the first terrace (T1) deposits described in the Little Tennessee River valley by Delcourt (1980) and in the Duck River valley by Brackenridge (1984), based on their composition and level of soil development.

The Clinch River floodplain deposits contain high potential for site burial, whereas the alluvium within the terrace remnants probably is too old to contain buried artifacts. A typical stratigraphic profile of the floodplain alluvium is composed of about 5 to 6 m of silty and fine sandy overbank sediment that overlies channel sands, which is illustrated by profile #3 (Figure 2). Slight variation occurs in the texture, color, and degree of stratification of the alluvial sediment, but the overall stratigraphy is similar throughout the valley. Slightly thicker and sandier strata of overbank deposits occur in places that have favored vigorous sedimentation (i.e. natural levees), whereas thinner, clay-rich sediments occur in backlevee floodbasins. A sandy top strata, typically composed of 10YR 5/4 fine sandy loam, covers much of the surface (0.2-1.5 m thick) and buries a finer textured and darker substrate. The sandy top strata probably is historical in age (<200 years old) , whereas the finer and darker substrate probably is the prehistoric sediment.

All of the soil profiles studied exhibit only slight to moderate levels of soil development, which is consistent with a youthful age of sedimentation (<13,000 years ago). The most well developed soil profiles exhibit 10YR hues in the midst of their weak Bt horizons, where 10YR 4/4 to 10YR 4/6 are the reddest colors. Incipient levels of Bt horizon development are the norm, with only thin to nonexistent clay films on ped faces, indicating minimal argillic horizon development. In one case (Profile #2) thick clay films were noted at 250-275 cm depth, but they appeared to belong to a buried paleosol that predated the bulk of sedimentation that makes the prevailing stratigraphic unit in the valley.

The physical characteristics of the Clinch River floodplain soils and sediments are consistent with the T1 deposits of Delcourt (1980) and Mills and Delcourt (1991) along the Little Tennessee River, which were dated to about 15,000 to 3,500 years old. The physical characteristics are also consistent with the T1 deposits of Brackenridge (1984) along the Duck River, which were dated to about 10,000 to 150 years old.

A relatively distinct levee exists along much of the Clinch River bank in the project area. Profiles #5 and #6 suggest that the planimetric position of the river has not shifted very much during the last several thousand years. That is, the entire stratigraphic section of Profile #5 (on the natural levee) consists of sandy textures that reflect proximal levee depositional settings, whereas Profile #6 consists largely of clay-rich distal levee and backswamp facies. It is not clear whether this pattern is widespread throughout the entire project area, but such facies associations could aid in later phases of geoarcheological survey to identify the higher and drier landscape settings of levees. Presumably, the higher and drier landscape positions would be more favorable for human activity than the lower and more poorly drained landscape positions (i.e. backlevee swales).

Artifacts in Soil Profiles

Profiles #1, #3, and #4 (Figure 1, Appendix A) contained artifacts at considerable depths. Profile 1 contained pot sherds and lithic flakes at depths [Exempted from Disclosure by Statute]
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The presence of these artifacts in the subsoil strongly confirms the age assignment of the valley floor deposits as <13,000 years old. [Exempted from Disclosure by Statute]
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It is conceivable that artifacts could occur throughout [Exempted from Disclosure by Statute] because typical sedimentation rates on floodplain sedimentation are about 0.25 to 1.0 mm/year (Ritter et al., 1995, p. 239, Leigh, 1998). Assuming that the deposition on the surface is historical in age, then 5.0 m of sediment would have taken about 10,000 years to accumulate, given an average rate of 0.5 mm/year.

Suggestions for Future Sampling

The high potential for site burial throughout the [Exempted from Disclosure by Statute] Clinch River valley presents formidable problems associated with adequately surveying the subsurface for archeological sites. Indeed, early Archaic and Paleoindian artifacts could be presen [Exempted from Disclosure by Statute] in the study area. Strategies to survey for such deeply buried artifacts are typically inferior to surface shovel testing surveys. Stafford (1995) thoroughly discusses various subsurface survey techniques to deal with this problem, and it is recommended that those techniques be reviewed to develop the most appropriate survey strategy for the Clinch River valley.

In my opinion, a good approach would involve a preliminary subsurface survey that involves sieving of auger-hole samples for micro- and macroartifacts in conjunction with backhoe trenching to explore areas where buried artifact zones already have been identified. A preliminary objective should be to establish the maximum depth to which archeological materials occur. [Exempted from Disclosure by Statute] Preliminary geomorphic analysis reported here suggests that the Clinch River has remained in about the same position throughout much of the Holocene. [Exempted from Disclosure by Statute] [Exempted from Disclosure by Statute] [Exempted from Disclosure by Statute] [Exempted from Disclosure by Statute] Sieving of auger-hole samples will provide a safe, simple, nondestructive, and economical way of exploring the deep subsurface.

Stafford (1993) reports that quantification of microartifacts (1-4 mm) recovered from a 10 cm (4") diameter bucket auger provides a reliable technique for identifying and tracing buried cultural horizons, while eliminating the need for a large sample. In silt dominated sediments, similar to Clinch River bottomlands, Stafford (1993) found close correlation between microartifact and macroartifact distributions.

A strategy for sampling the subsurface with auger holes is suggested below (Table 1). Microartifacts should be reliable, because virtually all of the Clinch River overbank alluvium appears to be smaller than 1 mm. Therefore, sieving for microartifacts through a 1 mm mesh should yield only cultural debitage and flotsam of charcoal. In a few cases, sporadic deposits that resulted from extremely large floods may contain >1 mm sand and artifacts may have to be separated from sediment in such cases. The low energy depositional environment of the terminal Pleistocene and Holocene sediments should not have been conducive to remobilization and transport of microartifacts away from their original site. It may be desirable to link the auger survey with shovel testing, so that a certain number of samples (>50) could be collected using both shovel testing and augering to establish the reliability of the auger testing method.

Results of a preliminary auger hole survey can be used to confirm the presence and vertical extent of buried sites, and then sampling strategies for more comprehensive coverage of the landscape can follow. Buried sites can be followed-up with more traditional types of systematic backhoe trenching (i.e. 5 m trenches spaced 20 to 30 m apart) to reveal the cultural contexts and stratigraphic associations. It would be advisable to have a geomorphologist present during the trenching to record the soil and stratigraphic conditions. Trench walls should be scraped to look for features and artifacts. A 1x1 m column of sediment should be sieved from the center of the backhoe trench. In the case of dangerously deep trenches, the backhoe operator should carefully obtain samples for sieving from depths that are below those that can safely be reached by a person. Finally, the potentially significant sites should be followed-up with hand excavated test units that are aided (for safety) by backhoes to slope back hazardously deep test units.

Summary and Conclusions

In summary, geomorphic analysis reveals very high potential for buried archeological sites [Exempted from Disclosure by Statute the Clinch River. [Exempted from Disclosure by Statute] [Exempted from Disclosure by Statute] A subsurface survey strategy involving sieving of auger samples prior to more traditional trenching strategies is recommended.

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Appendix A: Soil Profile Descriptions

Profile #1
-located on [Exempted from Disclosure by Statute]
-UTM (NAD27) coordinates:[ ]Exempted from Disclosure by Statute

Depth (cm)	Horizon	Description
0-144	C	10YR 5/4 (top) graded to 10YR 4/4 at base, sandy silt loam at top graded to fine sandy loam at base, somewhat stratified, weak coarse subangular blocky, [Exempted from Disclosure by Statute] abrupt boundary.
144-185	ABb	10YR 3/2 sandy loam to loam, strong medium subangular blocky, faint very thin clay films on ped faces, abundant charcoal flecks, gradual boundary.
185-230+	Btb	10YR 4/4 to 10YR 3/4 fine sandy loam to sandy clay loam, moderate medium to coarse subangular blocky, moderately thick clay films on ped faces, pot sherd fragments and lithic artifacts at Exempted from Disclosure by Statute base of outcrop.

Profile #2
-located on [Exempted from Disclosure by Statute]
-UTM (NAD27) coordinates:[ ]Exempted from Disclosure by Statute

Depth (cm)	Horizon	Description
0-40	AC	10YR 5/4 fine sandy loam, weak coarse subangular blocky, clear boundary.
40-60	A	10YR 4/4 fine sandy loam, weak coarse subangular blocky, clear boundary.
60-90	E	10YR 5/4 fine sandy loam, weak coarse subangular blocky, clear boundary.
90-210	Bt1	10YR 4/4 fine sandy loam, moderate medium subangular blocky, thin clay skins on ped faces, diffuse boundary
210-250	Bt2	9YR 4/4 sandy clay loam, strong medium subangular blocky to angular blocky, moderately thick to thick clay films on ped faces, gradual boundary.

250-375	2Bt	10YR 4/6 sandy clay loam with thick 7.5YR 4/4 clay films on ped faces, strong medium to coarse subangular blocky to angular blocky, gradual boundary.
375-460	2BC	10YR 4/6 fine sandy loam, weak coarse subangular blocky, no clay films, augured boundary.
460-540+	2C	saturated 10YR 5/4 to 10YR 5/5 fine sandy loam, weak coarse subangular blocky to massive, abrupt refusal on friable rock at 540 cm.

Profile #2

-located [Exempted from Disclosure by Statute]

-UTM (NAD27) coordinates:[ ]

Depth (cm)	Horizon	Description
0-30	AC	10YR 5/4 fine sandy loam, weak coarse subangular blocky to massive, historical sediment, clear boundary.
30-70	A	10YR 3/2 loam, moderate medium subangular blocky, augured boundary.
70-100	AB	10YR 4/3 silt loam, moderate medium subangular blocky, artifacts including chert flakes [Exempted from Disclosure by Statute] augured boundary.
100-140	Bt1	10YR 4/4 silt loam, moderate medium subangular blocky, faint very thin clay films on ped faces, traces of burned earth, augured boundary
140-240	Bt2	10YR 4/4 to 10YR 4/5 heavy silt loam, moderate medium subangular blocky, thin clay films on ped faces, augured boundary.
240-420	BC	10YR 4/4 heavy silt loam, moderate medium subangular blocky, no clay films, augured boundary.
420-560	C1	10YR 4.5/4 somewhat stratified silt loam and fine sandy loam, charcoal flecks noted at [Exempted from Disclosure by Statute] augured boundary.
560-640	C2	10YR 5/4 fine loamy sand to sand, massive to single grain, charcoal flecks noted [Exempted from Disclosure by Statute] becomes graded to pure sand with depth.

Profile #4

-located[ ]Exempted from Disclosure by Statute

-UTM (NAD27) coordinates:[ ]Exempted from Disclosure by Statute

Depth (cm)	Horizon	Description
0-40	AC	10YR 5/4 fine sandy loam to loamy sand, weak medium subangular blocky clear boundary.
40-100	A	10YR 4/2 fine sandy loam, weak medium subangular blocky, augured boundary.
100-140	2A	10YR 4/2 loam, mottled with common medium 10YR 5/8, moderate medium subangular blocky, fire cracked rock artifact [Exempted from Disclosure by Statute] augured boundary.
140-160	2Bw1	10YR 4/4 loam, mottled with few medium 2.5Y 5/2, moderate medium subangular blocky, augured boundary.
160-280	2Bw2	10YR 4/5 fine sandy loam, somewhat stratified with silt loam, weak to moderate medium subangular blocky, no clay films, augured boundary.
280-330	2Bw3	10YR 4.5/4 sandy silt loam, weak to moderate medium subangular blocky, somewhat stratified with fine sandy loam, base of hole.

note: [Exempted from Disclosure by Statute]

Profile #5

-located[ ]Exempted from Disclosure by Statute

-UTM (NAD27) coordinates:[ ]Exempted from Disclosure by Statute

Depth (cm)	Horizon	Description
0-20	AC	10YR 5/4 fine loamy sand, massive to single grain, augured boundary.
20-60	A	10YR 4/3 fine sandy loam, weak medium subangular blocky, augured boundary.
60-90	Bw1	10YR 4/4 sandy loam, moderate medium subangular blocky, augured boundary.

90-120	Bw2	10YR 5/5 fine sandy loam, moderate medium subangular blocky, augured boundary.
120-160	C1	10YR 5/4 fine sandy loam stratified with 10YR 5/5 fine sandy loam, weak medium subangular blocky to massive, augured boundary.
160-220	Bw1b	10YR 5/5 loam, moderate medium subangular blocky, augured boundary.
220-300	Bw2b	10YR 5/5 sandy loam, weak medium subangular blocky to massive, augured boundary.
300-420	C1b	10YR 5/6 sand stratified with 10YR 4/4 sandy loam, massive, augured boundary.
420-540	Bw3b	10YR 5/5 sandy loam, moderate medium subangular blocky, few charcoal flecks, augured boundary.
540-560	C2b	10YR 5/5 loamy sand, massive, augured boundary.
560-600+	C3b	10YR 5/4 sand, single grain, base of hole.

Profile #6
-located [Exempted from Disclosure by Statute]
-UTM (NAD27) coordinates: [ ] Exempted from Disclosure by Statute

Depth (cm)	Horizon	Description
0-25	A	10YR 5/4 silt loam, moderate fine subangular blocky, augured boundary.
25-85	Bg1	2.5Y 6/2 mottled with common medium 10YR 5/8 silt loam to heavy silt loam, moderate medium subangular blocky, augured boundary.
85-120	Bg2	2.5Y 6/3 and 10YR 5/8 silt loam to heavy silt loam, moderate medium subangular blocky, augured boundary.
120-200	Bg3	2.5Y 7/1 and 10YR 5/8 silt loam to heavy silt loam, moderate medium subangular blocky, augured boundary.
200-250+	Bg4	10YR 5/8 and 2.5Y 5/2 silt loam, moderate medium subangular blocky, base of hole.

Exempted from Disclosure by Statute – Withheld Under 10 CFR 2.390(a)(3)

Figure 1. Map showing the [Exempted from Disclosure by Statute] portion of the project area that is subject to high site burial potential to depths [Exempted from Disclosure by Statute] (shaded area) and the location of soil profile samples (numbered squares) described in Appendix A.

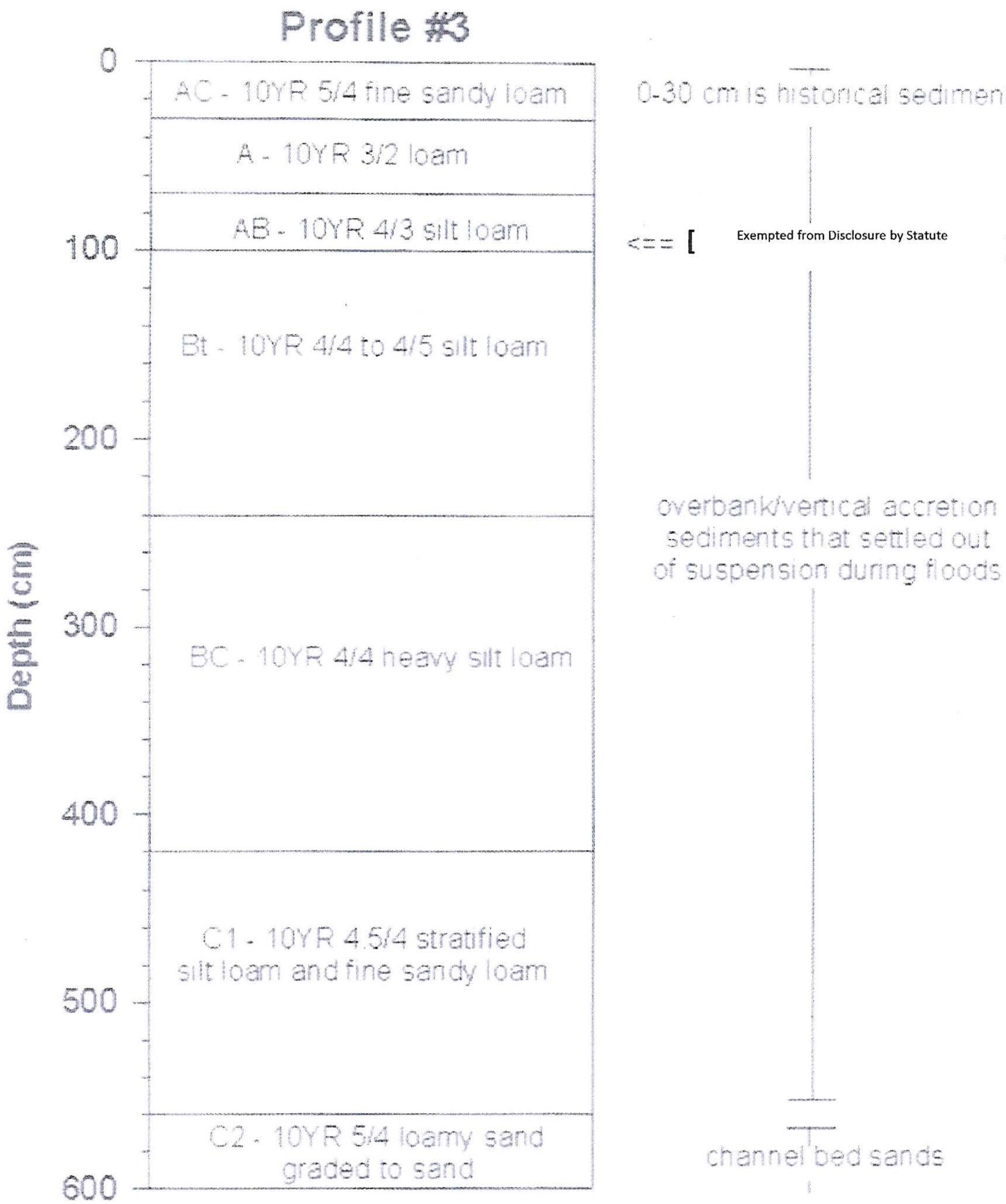

Figure 2. Stratigraphic diagram of Profile #3, which is fairly representative of the entire floodplain.

Table 1. Auger hole sampling for microartifacts.

Step	Procedure
1	Lay out a grid or transect of sample points for auger holes within the bottomland of the Clinch River valley. A 100 m spacing on a linear transect on the natural levee and one in the backswamp may suffice for a preliminary survey. Results may indicate the need for closer spacing for a more comprehensive survey.
2	Use a 4" bucket auger to obtain and bag samples at regular intervals (levels) down to the depth at which a strata of pure sand is consistently encountered (>40 cm strata of sand), which will typically be found at around 5 to 6 m depth. Be careful to remove the top cuttings of the auger sample in order to avoid sampling sediment that slumped or was scraped down into the hole.
3	Air dry the bulk samples, obtain their weight, and then disperse the samples in sodium metaphosphate (or some other detergent) to completely break apart the soil aggregates.
4	Rinse the sample through a 1 mm sieve. Dry and weigh the archeological debitage retained on the sieve. Count and record the no./kg and mg/kg by level on a data sheet. It may be desirable to separate the micro- and microartifacts with a nest of different size sieves.