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IDENTIFYING BURIED SOILS AND GEOMORPHIC SURFACES ON FLOODPLAINS

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ABSTRACT

Floodplains adjacent to loess bluffs are often the recipient of sediment eroded from those areas following a period of deforestation and cultivation. The removal of vegetation and the disruption of the soil surface decreases resistance and allows sheetwash, rill erosion, and gully development to proceed at accelerated rates. Streams draining the loess bluffs of West Tennessee are transporting and depositing vast quantities of sediment along their floodplains burying soils, modifying the topography, and damaging vegetation and wildlife habitats. A similar environment exists on the American Bottom, near East St. Louis, Illinois, site of the Cahokia Mounds, a major archaeological complex. Recent agricultural activities and overbank sedimentation have truncated or buried small Indian mounds masking the complete picture of mound distribution. Soil probing, pit excavation, and comparative analysis with known mounds suggest that several additional small mounds exist just north of Monks Mound. The distribution of overbank sedimentation has selectively buried significant portions of the geomorphic surface associated with this Mississippian-age Indian complex. The American Bottom at Cahokia and the floodplains in West Tennessee have received a great amount of sediment from neighboring loess bluffs since they were deforested and cultivated in the late-1800s.

INTRODUCTION

The dynamic nature of floodplains has long made them the focus of geomorphic research. Shifting stream channels create complex stratigraphic profiles and patterns of landforms that require careful interpretation. Frequent reworking of surface sediments and the variable patterns of erosion and deposition create a variety of surfaces of variable age, texture, drainage, and stability that affect vegetation and soil patterns. Geomorphologists often collaborate with archaeologists in reconstructing past environments at floodplain site excavations. The geomorphologist's experience in interpreting buried soils and stratigraphy, and in developing models for locating areas with a

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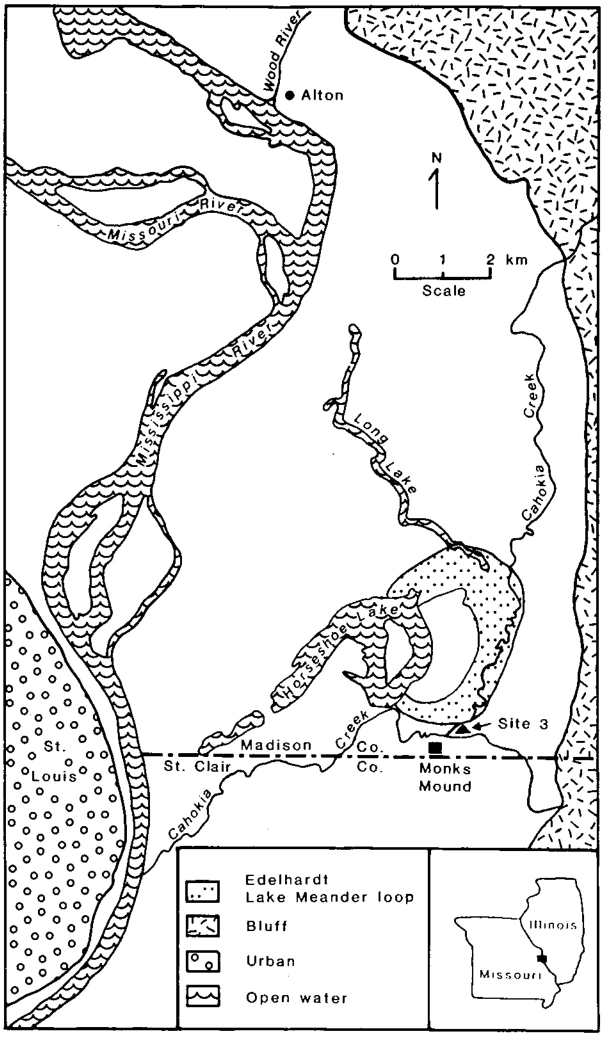

Figure 1. American Bottom in vicinity of St. Louis illustrating relationship of Site 3 study area to Monks Mound, former Mississippi River meanders, and loess bluff.

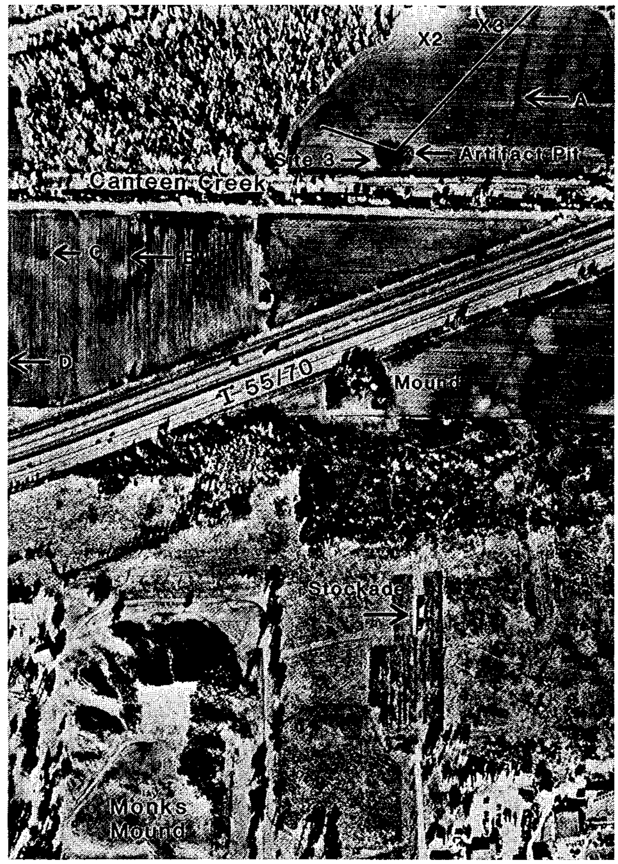

Figure 2. Infrared photograph of Monks Mound and Site 3. Circular drainage features B, C, and D are believed to be the Indian mounds previously located by McAdams in 1882. X2 and X3 are soil probe and pit sites located on Figure 4.

high probability of yielding archaeological materials, has aided in the interpretation of past geomorphic and pedologic environments (Follmer, 1985; Holliday, 1985a, 1985b).

AMERICAN BOTTOM STUDY AREA

The American Bottom (Figure 1) is a 114 km-long portion of the Mississippi River floodplain, located between Alton and Chester, Illinois, that includes the confluence of the Missouri River (Bareis and Porter, 1984). Archaeological evidence dating to at least 4000 B.C. (Late Archaic) has been recovered from some of the nearly 100 sites studied (Nassaney, *et al.*, 1983). Extensive geomorphological investigations accompanying these archaeological studies have provided detailed interpretations regarding environmental changes and fluvial activity in the American Bottom (White, 1982, 1983; White, *et al.*, 1984).

OBJECTIVES AND MATERIALS

This investigation began as a study of the comparative abilities of different air photo scales and film types to discriminate microtopographic floodplain features, especially those associated with archaeological disturbance. Aerial photography, centered on the Cahokia Mounds State Park and the prominent Monks Mound area (Figure 2) for the years 1932, 1933, 1941, 1963, 1973, 1977, and 1979, was used to locate and reconstruct drainage features subsequently destroyed by urbanization in the area. Infrared photography was especially useful in detecting surface and subsurface drainage conditions due to the absorption of infrared radiation by water. Black and white panchromatic photography was previously used by Fowler (1974) to locate the buried stockade east of Monks Mound. Upon locating several anomalous drainage features north of Monks Mound, a field investigation was initiated to couple the air photo evidence with field geomorphic and pedologic criteria with the goal of developing a search model for small Indian mounds on floodplains. Very recent sedimentation in West Tennessee gullies and stream valleys has already buried a variety of cultural features, suggesting that a similar methodology will apply in this area (Barnhardt, 1988a, 1988b).

Drainage Anomalies

Careful photographic examination reveals a variety of circular drainage anomalies readily accountable by current surficial conditions (see Figure 2, features A-D). The circular feature labeled Site 3 is not currently indicated as being a mound, even though its photographic "signature" is almost identical to Mound 65, a small Indian mound (less than one meter high) in Cahokia Mounds State Park about 1.7 km to the south. At both Mound 65 and Site 3 (the proposed mound), the dark, circular shape corresponds almost exactly to the slight topographic rise detectable on the surface, while the white circular "donut" feature is possibly related to the excavation of materials around the mound during its construction. Since infrared film was used, the darker area corresponds to slightly wetter conditions associated with the higher clay content in the mound although the darkness at Site 3 is also visible at ground level (Figure 3). This relationship between small mounds and drainage patterns suggests that other small mounds may also exhibit similar characteristics due to their remnant texture, bulk density, and subsurface morphology, even though they no longer exhibit surface morphology due to their burial by modern sediment or partial truncation by recent cultivation.

Figure 3. Site 3 looking northeast. The dark surface corresponds to the high clay, artifact-bearing surface shown on Figure 4.

Features B, C, and D in Figure 2 illustrate several of these "donuts" or halos, and occur in an area mapped by McAdams (1882) as containing three small Indian mounds. On more recent maps, however, only feature D is clearly indicated as being a mound. Using a zoom transfer scope to superimpose the McAdams map over the 1979 aerial photo, a very close correspondence was obtained for the three features B, C, and D and feature A (a former channel of Cahokia Creek). A feature we believe to be a truncated and partially buried Indian mound (Site 3) is also positioned near mounds located by McAdams. Since McAdams' map was constructed prior to extensive floodplain urbanization and cultivation, it is a valuable source for locating small mounds that have subsequently been plowed flat or buried by overbank sedimentation from Cahokia and Canteen Creeks.

The specific goal of this project is to determine whether Site 3 is an Indian mound that has lost its identity since McAdams produced his map, and if so, whether any diagnostic criteria exist that can be used to locate and test other sites of probable buried archaeologic features in this area and other similar floodplain sites.

Floodplain Soils

The four soil series occurring within the study area reflect the environmental diversity commonly found on floodplains. The Landes Varient and the McFain soils are minor series that have developed in stratified loams and sands along natural levees and in clayey alluvium along bottomlands, respectively. The Darwin series is the most widespread and exhibits a high frequency of archaeological sites (Norris, 1977). It is characterized by a very high clay content (>60% in places) and a very dark gray (10YR 3/1) surface horizon while the Dupo series is developed in recent silty alluvium derived from the nearby loess uplands. It exhibits a buried dark, silty clay A horizon at about 75 cm that appears to be a former Darwin soil, i.e., the geomorphic surface upon which the current Darwin series has developed. The spatial relationship of the Dupo and Darwin series lends credence to this statement and will be examined in greater detail later. The spatial distribution of these soils is important to the interpretation and location of both surficial and buried Indian sites on the American Bottom.

Evidence Supporting Buried Mounds

A field survey was undertaken to examine the geomorphic and pedologic characteristics of Site 3 (a probable mound) and a known mound (Mound 65). Since Mound 65 also exhibits the "donut" morphology on aerial photographs, it was used in a comparative analysis of the other features identified in Figure 2.

Mound 65

A short, east-west transect was established across the mound along which 2-cm diameter soil cores were extracted from various depths down to 122 cm. Subsequent laboratory analyses for texture, pH, organic matter, clay mineralogy, and other selected physical and chemical tests confirmed that the soil developed at this site is the Darwin (Vertic Haplaquoll). Its high clay content, dark color, and montmorillonitic mineralogy easily differentiate it from the other soils in the area. The Darwin series dominates the Cahokia area south of Monks Mound while the Landes and the Dupo increase in their spatial occurrence with increasing distance north of Monks Mound (Figure 2). Even though Mound 65 is a small mound with less than two meters of surface relief, its minimal surface expression makes it an excellent example for developing a model for locating other small, non-distinct mounds that seem to occur throughout the area.

Site 3 Mound Evidence

Within the immediate Monks Mound area, Site 3 (Figure 2) is the most obvious candidate for being a buried mound. Its morphology, surface expression, physical, chemical, and mineralogical properties, and spatial position relative to the McAdams map suggest that it is a partially truncated and buried Indian mound. A transect similar to that established at Mound 65 was repeated at this location and the results confirm the spatial relationship between the visual properties exhibited by the site in Figure 2 and its surface and subsurface properties (Figure 4). The terrain over which the transect line runs northeast from Site 3 toward soil pits X2 and X3 in Figure 2 is visible in Figure 3.

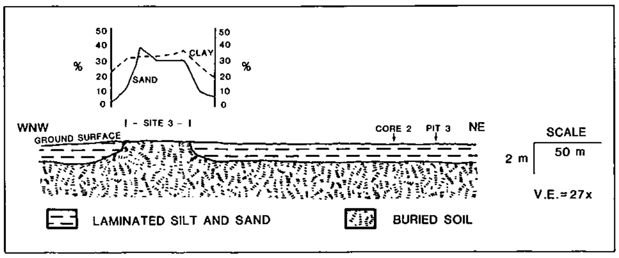

Figure 4. Transect across Site 3 illustrating the laminated sediments in which the Dupo soil is developing and the buried soil which is exposed at the mound site. Upper diagram shows the texture change across the site. Both Core 2 and Pit 3 exhibit a high-clay buried soil.

The surface texture of Site 3 varies directly with its spectral properties. The inner, darker zone is a clay loam, while the outer, lighter zone is generally a silt loam or silty clay loam. The surface texture of the field surrounding the site is a silt loam but with considerably less sand. The surface of the site also exhibits extensive cracking, many of the cracks ranging between 5 and 15 mm in width and 15 to 50 mm in depth, and exceeding 0.5 m in length. There is also an abrupt change in the site microtopography at the inner zone/outer zone contact that is displayed as a distinct reduction in the expression of the ridge and furrow pattern. This field was cultivated as recently as 1982 and the plow evidence is best retained in the darker, inner zone but is quickly reduced with distance from this area. This is most likely due to the higher clay content at the site. Additionally, the inner zone has a higher proportion of montmorillonite in its clay fraction than do the other zones. The heavier texture and the higher plasticity help retain the ridge and furrow morphology.

Site 3 lies within the area mapped as Dupo on the Madison County Soil Survey map; however, laboratory and field data classify the soil as the Darwin. In itself, this is not significant because all soil mapping classes contain inclusions of other soils. The importance lies in the fact that this site exhibits surface topography, texture, color, and clay mineralogy similar to that of Mound 65. Soil probes, taken along the same transect used to acquire the surface texture samples (Figure 4), reveal a significant subsurface morphology that corresponds closely with the dark/light zones visible on the aerial photographs.

Figure 4 illustrates two critical points. First, transects across Site 3 reveal the rapid increase in depth to which the soil probe must penetrate in order to locate the darker, high clay, high montmorillonite soil horizon that is exposed at the surface at Site 3. This rapid increase in depth suggests that Site 3 is an Indian mound and that the top of the mound generally conforms to the darker, inner zone of Site 3.

Second, the representative profile description for the Dupo soil in the St. Clair County Soil Survey report includes a reference to a "black silty clay (old buried soil) in the lower part" (Wallace, 1978: 22). It appears that this "old buried soil" is actually the geomorphic surface upon which a Darwin soil had developed. Historical overbank sedimentation has buried the Mississippian-aged landsurface at this location. Extensive erosion of the nearby loess uplands brought on by historical agricultural practices provided the sediment that became the alluvial parent material for the modern Dupo soil. The underlying Darwin geomorphic surface is exposed at the surface at Site 3 because the mound is not completely buried by the alluvium. The Darwin geomorphic surface emerges again south of Monks Mound (farther from the flooding effects of Canteen and Cahokia Creeks) where it dominates the landscape. Since it is the Darwin geomorphic surface that is related to the Mississippian-age Cahokia culture (ca. 1000 A.D.), it is this surface that will yield artifacts, not the Dupo. Soil probes were used to acquire additional samples of this buried surface and four soil pits were excavated near Site 3 to examine the pedology and stratigraphy. Subsequent laboratory analyses, including x-ray diffraction of the clay fraction, confirmed the similarities of the buried horizon with the Darwin soil.

The predominance of montmorillonite (a characteristic of the Darwin soil) at Mound 65, Site 3, and the buried horizons at features B and D (Figure 2) strongly support the thesis that the surface (and sediments) on which Site 3 and features B and D are constructed is actually a Darwin age-equivalent. In addition, the clay mineralogy of the overlying sediment, in which the Dupo soil is developing, is distinct in its lack of expandable clays and is useful in differentiating the various parent materials. Follmer (1985) has found similar relationships at the Rhoads Site near Lincoln, Illinois.

EXAMINATION OF THE DARWIN GEOMORPHIC SURFACE

Recognizing this buried surface as being Mississippian in age is not a trivial matter for archaeologists and geomorphologists working in the Cahokia area or other rapidly-aggrading floodplain locations. Much of the geomorphic fieldwork associated with the FAI-270 project involved identifying and dating geomorphic surfaces. It was only after the ages of these surfaces had been established that a more reliable and efficient archaeological search could begin. More importantly, Site 3 lies north of most of the FAI-270 project sites in an area where extensive, historical sedimentation has occurred. The artifact-bearing surface is now buried by a meter of recent sediment. It would be meaningless for archaeologists to conduct a surface survey of the Site 3 area because the majority of the current surface is modern, not Mississippian. An examination of the McAdams map indicates that several of these small mounds north of Monks Mound are no longer apparent because they are not located on any recent maps of the area. The evidence presented in this paper suggests that those mounds are still there, only they are buried along with the geomorphic surface upon which the Mississippian-age Indians lived about 1000 years ago.

Recovery of Artifacts from the Darwin Surface

A final piece of information was obtained while digging a small shovel pit at Site 3 to acquire bulk soil samples for laboratory analyses (Figure 2). While conducting the soil probe transects, a scattering of pottery and flakes intermixed on the surface with modern ceramics, glass, and building materials was noted. A building once stood on or near the site but was removed in the mid-1970s. The small shovel pit near the edge of the site revealed a 40-cm thick plow zone with considerable disturbance. However, at a depth of 64 cm, in undisturbed sediments, a small hearth was uncovered that contained three pot sherds, several areas of fired clay, a few flakes, and a bed of charcoal. The pot sherds fit together and all showed a darkening from being burned. These were rimmed sherds and later identified as being a variation of the Powell Plain type (Middle Mississippian, ca. 1100 A.D.). The charcoal sample dated at 890 70 B.P. (BETA-17906), or 1060 A.D., confirming the time frame suggested by the analysis of the sherds.

Summary and Conclusions

Circular drainage anomalies visible on black and white infrared aerial photographs were initially investigated to determine whether they might have archaeologic application related to buried cultural features. Field and laboratory evidence confirms that these drainage anomalies are small, partially truncated or buried Indian mounds located in areas that are subjected to overbank sedimentation from Cahokia and Canteen Creeks. These creeks drain agricultural areas on the adjacent loess bluffs and have, during the last century, transferred considerable quantities of sediment onto the American Bottom. The small mounds are subjected to truncation and mixing by plows in addition to receiving appreciable quantities of alluvial silts and sands. The aerial photographs provide an overview of the spatial distribution of mounds and unknown drainage anomalies that is not easily obtained from maps and ground surveys. The photographs assist the fieldwork by locating sites of interest that may not be readily observable on the ground.

Early maps of the Bottom by McAdams (1882) depict several small mounds in the vicinity of the research area but recent maps failed to locate them. This suggests that either McAdams mislocated or misidentified them, or that subsequent researchers could not find them due to their destruction by agricultural methods and overbank sedimentation. This research suggests that these mounds still exist, only under a layer of recent sediment. Locating and identifying this buried surface is the key to locating Mississippian-age artifacts in the area between Monks Mounds and Cahokia Creek. As many as five mounds may be buried in this area, and their locations are visible on the aerial photographs. Even though these are small mounds, and are probably of minor significance, their geomorphic occurrence exemplifies the need to carefully examine the stratigraphy and subsurface geomorphology in order to fully understand the depositional environment during and after the emplacement of the artifacts. To do otherwise would be to possibly miss significant vertical and spatial components useful in reconstructing local environments. The considerable sedimentation that is occurring along the bluffs and floodplains of rivers draining West Tennessee is causing a similar burial of artifacts and historical surfaces, especially in the Obion-Forked Deer River drainage. The air photo, geomorphic, and pedologic techniques discussed here are also useful in conducting archaeological searches and sedimentation/erosion studies in West Tennessee where recent gully development is damaging considerable upland and bottomland properties.

Literature Cited

Bareis, C. J. and J. W. Porter. 1984. Research Design, *In* C. J. Bareis and J. W. Porter, Eds., *American Bottom Archaeology*, pp. 1-14. Urbana, IL: University of Illinois Press.

Barnhardt, M. L. 1988a. Historical sedimentation in West Tennessee gullies. *Southeastern Geographer*. 28(1):1-18.

Barnhardt, M. L. 1988b. Recent gully activity in Meeman-Shelby State Park, Southwest Tennessee. *Jour. Tennessee Acad. Sci.* 63(3):61-64.

Follmer, L. R. 1985. Surficial geology and soils of the Rhoads Archaeological Site near Lincoln, Illinois. *American Archeology* 5:150-160.

Fowler, M. L. 1974. The Cahokia Site, *In* M. L. Fowler, Ed., *Explorations into Cahokia Archaeology*, Bull. 7, pp. 1-30. Urbana, IL: Illinois Archaeological Survey.

Holliday, V. T. 1985a. Early and Middle Holocene soils at the Lubbock Lake Archeological Site, Texas. *Catena* 12:61-78.

Holliday, V. T. 1985b. Morphology of Late Holocene soils at the Lubbock Lake Archeological Site, Texas. *Soil Science Society of America* 49:938-946.

McAdams, W. 1882. Antiquities, *In* History of Madison County, Illinois, pp. 58-64. Edwardsville, IL: W. R. Brink and Company.

Nassaney, M. S., N. H. Lopinot, B. M. Butler, and R. W. Jefferies. 1983. *The 1982 Excavations at the Cahokia Interpretive Center Tract, St. Clair County, Illinois.* Research Paper No. 37, Southern Illinois University at Carbondale Center for Archaeological Investigations, 132 pp.

Norris, F. T. 1977. Prehistoric settlement patterns and subsistence systems in Western St. Clair County, Illinois. Ph.D. dissertation, Southern Illinois University, Carbondale, Illinois, 289 pp.

Wallace, D. L. 1978. *Soil Survey of St. Clair County, Illinois.* USDA-SCS, Illinois Agricultural Experiment Station, 114 pp.

White, W. P. 1982. *Geomorphic Investigations at the Mund Site (11-S-435).* Geomorphological Report 9, Department of Anthropology, University of Illinois at Urbana-Champaign, FAI-270 Archaeological Mitigation Project, 81 pp.

White, W. P. 1983. *Geomorphological Research Conducted at the Fish Lake Site (11-Mo-608).* Geomorphological Report 10, Department of Anthropology, University of Illinois at Urbana-Champaign, FAI-270 Archaeological Mitigation Project, 27 pp.

White W. P., S. Johannessen, P. G. Cross, and L. S. Kelly. 1984. Environmental Setting. *In* C. J. Bareis and J. W. Porter, Eds., *American Bottom Archaeology*, pp. 15-33. Urbana, IL: University of Illinois Press.