An Assessment of Prairie Mound Origin Theories at University of Arkansas Experimental Farms

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Abstract

Prairie mounds are common geomorphic features in floodplains throughout the western United States and Canada, but their origin is still disputed after more than a century of study. Most studies date prairie mound formation to the Early or Middle Holocene, and with a few possible exceptions, no prairie mounds appear to be forming today. This makes them good candidates for proxy indicators of past environments, because they were formed under conditions no longer present. Each theory of prairie mound origin holds different implications for past environments. This study examines soil, sediment, and topographic data from two prairie mounds at the University of Arkansas Experimental Farms to evaluate aeolian, seismic, fossorial rodent, and fluvial origin hypotheses. The evidence from these mounds argues strongly against an aeolian or fluvial deposition origin, weakly for a fluvial or aeolian erosion origin, and is equivocal in respect to seismic and fossorial rodent origins.

Introduction

Prairie mounds, also known as pimple mounds, "hog-wallows", and Mima mounds (after the type locality at Mima Prairie in Washington State), are poorly understood geomorphic features whose origin has been debated for more than a century. Most theories of mound origin fall into the categories of seismic shaking, dune formation, periglacial processes, fluvial erosion and/or deposition, and fossorial rodent burrowing. Studies of prairie mounds have revealed a diversity of internal structures from region to region, and it is possible that they were formed by different means in different places. They are usually situated in floodplains and are often reported to have a hard or impenetrable horizon shallowly buried beneath them. Prairie mounds are generally considered to have formed during the Early or Middle Holocene (Washburn, 1988; McFaul, 1979). There are no reports that any mounds are forming today, with the possible exception of a mound field in southwest Arkansas (Larry Ward, personal communication). This mound field is not apparent on any but the latest of aerial photographs. The site has not yet been visited for the purpose of mound studies, however, and they may simply have been obscured in the earlier photographs.

The relict nature of prairie mounds makes study of their origin difficult, but it also affords an opportunity for study of past geomorphic processes. Prairie mounds were formed by processes no longer operating or operating under conditions different from today, and therefore they may serve as proxy environment indicators. If the mounds were formed through aeolian processes, for example, they would reveal something of past prevailing wind patterns and ground cover. If they were formed through seismic shaking, dating their formation would help reconstruct the seismic history of the regions in which they occur. If they were formed through fluvial processes, they would reveal something of the history of floodplains and ground cover. If they were formed by the burrowing activity of rodents, they would indicate the range of the animals that made them, and raise the interesting question of why few or none appear to be forming today.

In this study I examine the evidence gathered from two prairie mounds at the University of Arkansas Experimental Farms in Fayetteville, Arkansas, and assess the hypotheses of aeolian, seismic, fossorial rodent, and fluvial origins. I do not include the periglacial hypothesis because the known climatic history of northwest Arkansas precludes such an origin. I primarily examine the origin hypotheses in light of evidence gathered from this study. For further discussion of origin hypotheses involving other lines of evidence see Butler (1995) or Washburn (1986).

The mounds I chose for study are located at the University of Arkansas Experimental Farms near the eastern edge of a mound field that stretches at least three kilometers northeast to southwest and at least two kilometers northwest to southeast (Fig. 1). Construction has obliterated many of the mounds, but 1941 aerial photographs reveal mound densities of about 6 to 8 per hectare. All of the mounds appear to be situated within a floodplain landform.

Figure 1. Prairie mounds clearly expressed in 1941 aerial photograph. Study area is near center of image.

The mound field occurs in a narrow northeast to southwest trending valley on overbank alluvium overlying channel deposits. It is unknown at this time whether the overbank alluvium is the result of several small streams similar to the ones currently situated in the valley, or a previous, larger stream that deposited the coarse channel sediments (Margaret Guccione, personal communication). The two studied mounds occur on the mapped soil of Leaf silt loam (Harper, 1969). Other soils present in the mound field are Captina silt loam, Pickwick gravelly loam, Cherokee complex mounded, and Johnsburg silt loam (Harper, 1969).

Methods

Fieldwork was conducted at the University of Arkansas Experimental Farms on 10 October 1998. Many of the prairie mounds appeared to be truncated from plowing. Two mounds of relatively high relief were chosen for study.

Three soil cores were recovered with a Giddings-rig core machine. One core was taken from the estimated center of each mound, and one core was taken from the lowest point of the saddle between the mounds. Mound topography and core locations were mapped with an alidade and plane table as a series of three transects with points at two meter intervals, the first transect crossing both mounds, and the second two at right angles to the first (Fig. 2).

Soils were described at the University of Arkansas soils laboratory (Appendix A). Methods employed for the description of these cores follow the procedures of the U.S. Soil Conservation Service (Soil Survey Staff, 1996, 1981). Samples were taken from the cores at 20 cm intervals for grain size analysis (Appendix B). The sand fractions were separated by wet sieving into the following grain sizes: very fine sand (2 microns to 0.0063 mm), fine sand (0.0063 mm to 0.013 mm), medium sand (0.013 mm to 0.25 mm), coarse sand (0.25 mm to 0.5 mm), very coarse sand (0.5 mm to 1.0 mm), and gravel (>2 mm). The silt and clay fractions were analyzed by the pipette method (Day, 1965). Draws were taken at 4, 6, 8, and 9 phi to determine percentages of coarse silt (62.5 to 15.6 microns), medium silt (15.6 to 3.9 microns), fine silt (3.9 to 2.0 microns), and clay (<2 microns).

Aerial photographs taken in 1941 and USGS digital orthophoto quads were examined to determine the position and extent of the mound field. Construction has leveled many of the mounds, however, and ground observation reveals that some extant mounds are not well expressed in the aerial views.

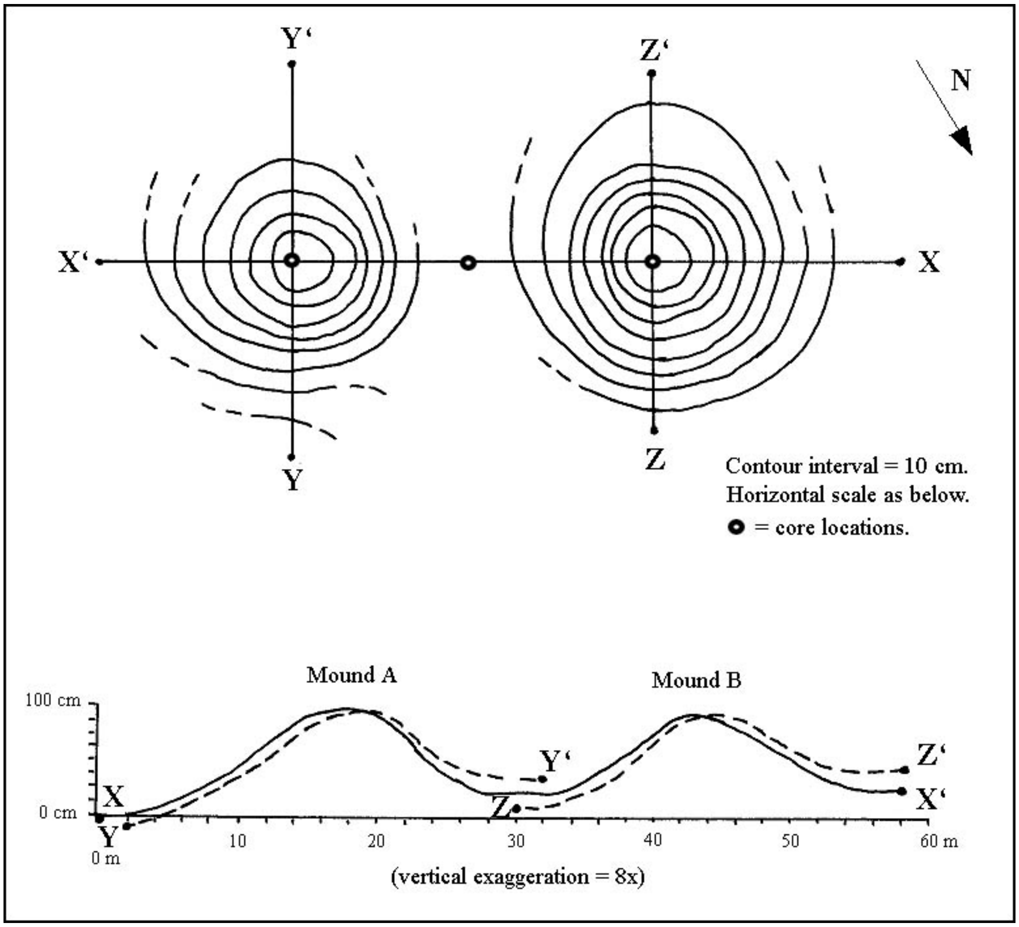

Figure 2. Topography and profiles of mounds studied.

Results

Sediment, soil, and topographic data from this study reveal four basic characteristics of these prairie mounds which may afford insights into various mound origin hypotheses. Soil stratigraphy was inferred from soil descriptions and particle size data. Sediment and parent material information was inferred from the clay-free fraction of particle size data.

Soil-forming processes primarily affect the finer components of sediment, weathering and moving clay and fine silt grains down through the profile over time. Coarser components are thus better indicators of the nature of parent material. Comparison of the relative percentages of the clay-free fraction throughout the profiles (Fig. 3, Total % sand and silt) reveals a similar parent material for both mounds and the inter-mound area. The sand percentage, especially, is nearly the same in all cores at all depths analyzed, averaging 18%. Thus the mounds appear to be composed of the same parent material as the underlying sediment without significant modification. The gravel recovered was primarily composed of rounded pebbles and concretions, with a maximum diameter of about 5 mm.

Comparing sand, silt, and clay percentages (Fig. 3, Total % <2 mm) reveals an accumulation of translocated clay, representing a textural B horizon, at about the same elevation across the study site. The horizontal nature of this soil horizon, in contrast to the mounded topography of the surface, implies that it is a relict feature. If the surface had been mounded when this horizon formed, this horizon would have contoured the surface elevations, as the A horizon does. The soil is therefore polygenetic, and the textural B horizon may be considered a paleosol, in the sense that it was formed under soil-forming conditions different from those existing today.

The A horizon is nearly twice as deep within the mounds as in the inter-mound area: 60 cm as opposed to 33 cm (Fig. 4). It is not apparent from this study whether the A horizon is deeper within the mounds simply because of the topography, or because the underlying clay-rich B horizon is impeding deeper development of overlying horizons between the mounds.

The mounds roughly approximate sphere segments in shape, but both are skewed very slightly to one side, and in the same direction (Fog. 2). The skew is approximately 85 cm to the south or southwest (the north or northeast sides are steeper). This may be a result of mound genesis, or it may be an artifact of subsequent weathering. It is interesting to note also that the direction of skew is roughly equivalent to the lengthwise direction of floodplain in which the mounds lie, northeast to southwest. It is unclear at this time, however, whether the floodplain formed as a result of one large channel or several small streams similar to the ones currently situated in the valley (Margaret Guccione, personal communication). The direction of water flow may or may not have paralleled the valley. Further topographic study of mounds in the region would reveal whether they are uniform in orientation or not. If they are not uniform across the mound field, this would imply that the skew is not an artifact of uniform weathering along the same aspect. Guccione et al. (1991) trenched and mapped several prairie mounds in the same mound field as the preset study. Of the seven mounds topographically mapped, six are slightly elongated and generally oriented in a north-to-south direction.

Because of modern disturbances, inferring the distribution and landscape position of the original mound field from aerial photographs is problematic. All of the mounds observed on the ground and from the aerial photographs, however, occur in the floodplain.

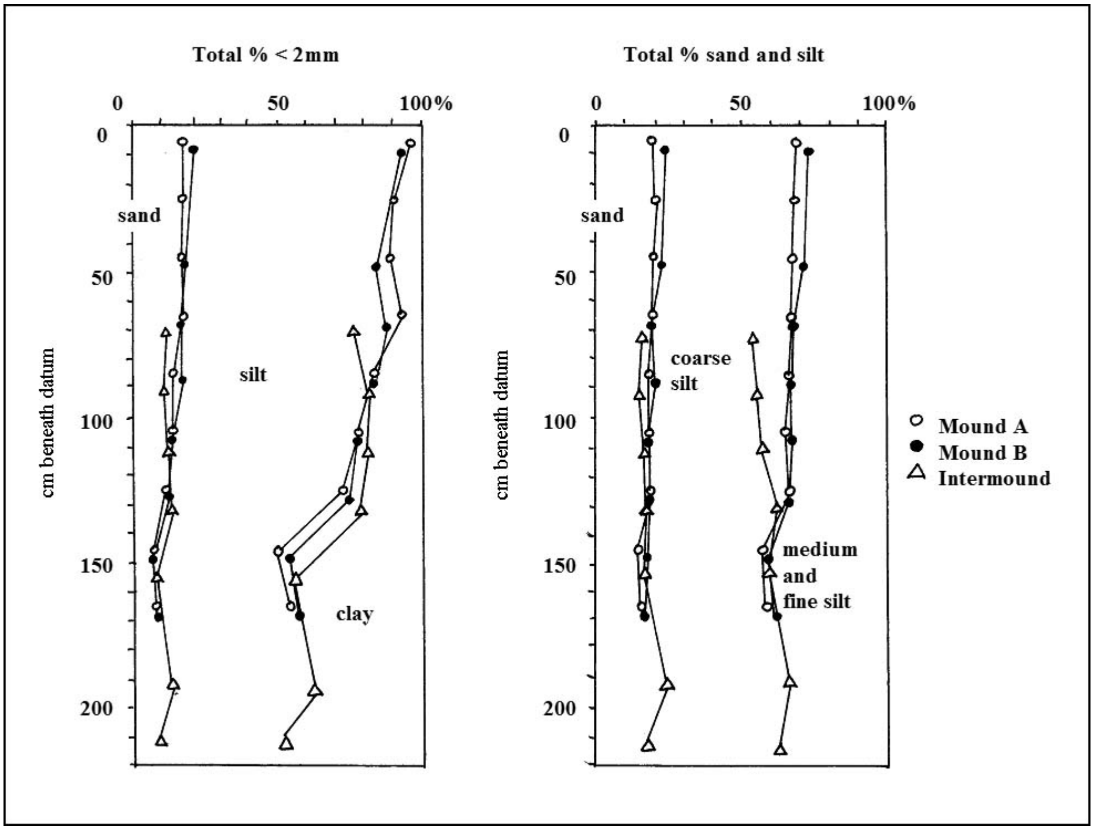

Figure 3. Particle size by depth. Elevations in arbitrary cm beneath datum.

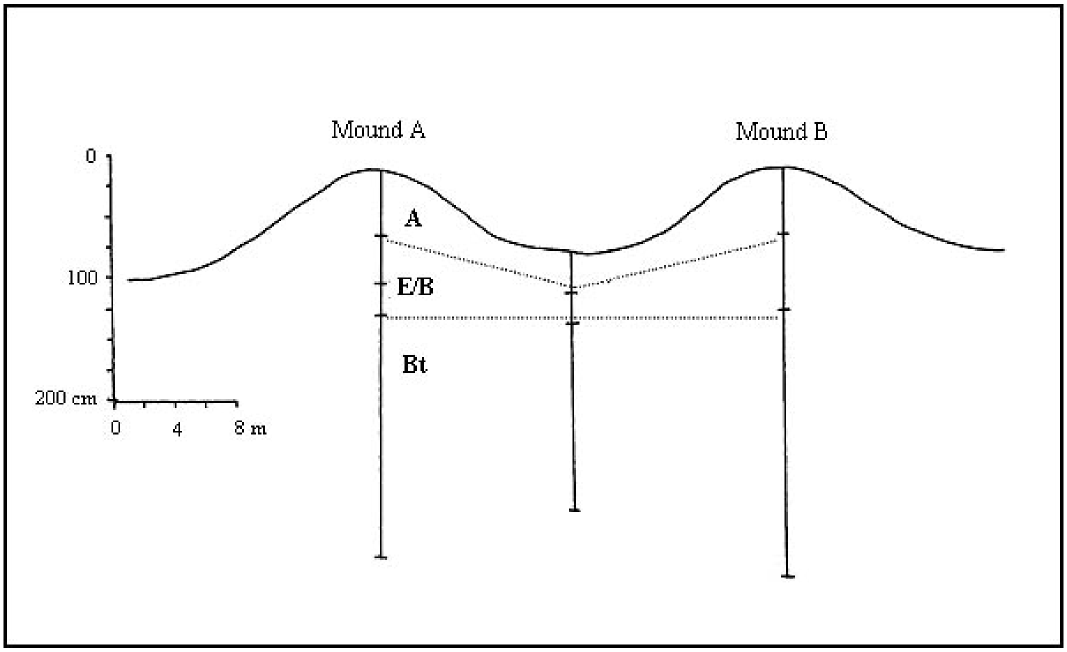

Figure 4. Soil profiles. Vertical exaggeration 8x. Arbitrary datum same as in Figure 3.

Discussion

Soil horizons within and between the mounds demonstrate that the mounded topography is younger than the surface that existed at the time the textural B horizon formed. Whether the A horizon has reached equilibrium and will form no deeper is not apparent at this time. If it has, this implies that the textural B horizon is impeding its development in the inter-mound areas, or that the topography of mounds is the primary soil forming factor governing depth of soil development in some way.

Studies of prairie mounds invoking the fossorial rodent hypothesis (Cox, 1990a; Cox and Allen, 1986; Dalquest and Scheffer, 1942) generally concentrate upon such mound features as distribution, presence or absence of pebbles and cobbles, presence or absence of active rodent burrows or krotovina, depth to a hard surface, and the distribution of past or present rodents. This study sheds little light on any of these features, except to confirm the presence of a hard surface (channel deposits or bedrock) at around 330 cm beneath the tops of the mounds, and 217 cm beneath the surface of the inter-mound area. No active or relict burrows were observed. The fossorial rodent hypothesis stipulates that burrowing rodents (often thought to be gophers) differentially move soil nearer the center of their burrowing territory, although this is disputed (Berg, 1990). If an impenetrable surface exists at a depth less than the maximum normal burrowing depth of the animals, successive generations are alleged to preferentially center their territories in areas with an accumulation of soil from previous inhabitants, due to the increased depth of soil available. In this view, prairie mounds are the result of many generations of rodents centering their burrowing territories around the same spot.

A useful test of the rodent hypothesis might be accomplished through size analysis of larger clasts. Bocek (1986) found that intensive rodent activity affected the distribution of artifacts at archaeological sites in predictable ways. Burrowing activity of fossorial rodents displaces clasts that are larger than the burrows down through the soil, and mixes clasts which are smaller than the burrows throughout the active burrowing zone. Soil cores offer too small of a sample to adequately test the displacement of >2 mm clasts throughout a profile. A hand-excavated bulk density column through a prairie mound containing a significant number of larger clasts might reveal whether or not intense rodent burrowing activity had occurred. The clasts need not be archaeological; naturally occurring pebbles would be affected the same way by burrowing. An accumulation of large clasts at a level consistent with the deepest zone of burrowing activity may or may not signify intense occupation by rodents, but lack of such an accumulation would indicate that an area had not been intensely modified by rodents.

Studies of prairie mounds testing the seismic shaking hypothesis (Berg, 1990; Cox, 1990b) generally concentrate upon such features as uniformity of mounds within a mound field, depth to a hard surface, and correlations of mound occurrences with areas of seismic activity. The seismic hypothesis requires a hard surface shallowly buried in order to transmit seismic energy of high enough force to shake the looser overlying sediment on top into mounds (Cox, 1990). No minimum depth for this surface has been determined.

This study confirms the presence of a hard surface shallowly buried beneath the mounds, as bedrock or gravelly channel deposits at about 330 cm beneath the tops of the mounds, and at 217 cm beneath the surface of the inter-mound area. Mounds at Mima prairie, Washington, are underlain by basalt bedrock at about 180 cm beneath the inter-mound areas (Washburn, 1988). Presumably the magnitude of the seismic event and nature of the loose upper material would affect the minimum depth to a hard surface necessary to form mounds in this manner.

Correlations of mounds to areas of seismic activity have been disputed (Berg 1990, Cox, 1990b). Prairie mounds are found in areas with little or no current seismic activity, such as the southeast coast of Texas. A few isolated pockets of prairie mounds also occur in mid-continent regions with little seismic activity, and they do not always occur in areas where seismic activity is high. Northwest Arkansas is currently a low risk seismic area. Paleo-seismicity is often invoked by proponents of this origin theory (Berg, 1990).

Studies of prairie mounds testing fluvial hypotheses generally concentrate upon such features as mound distribution, elongation, location within floodplains, and stratigraphy. Soils within and beneath the mounds in this study indicate that the mounded topography is younger than a previous, roughly horizontal surface under which the textural B horizon formed. The mounds are composed of the same parent material as the sediment beneath them.

Archuleta (1974) argued that prairie mounds in Arkansas were deposited in floodwaters beneath eddies. In the current study area, the clay content and thickness of the textural B horizon imply that it was formed under a surface with an elevation at least as high as the tops of the mounds. Since the mound bases are lower than the original, horizontal surface, a fluvial deposition origin would demand uniform removal of the upper portion of the soil horizon (above the Bt), and subsequent deposition of virtually indistinguishable sediment in the form of mounds. All fluvial deposition hypotheses oblige the same unlikely scenario in this mound field.

Quinn (1961) and Jenks (1960) proposed an aeolian depositional origin for mounds in northwest Arkansas, concluding that they formed as coppice dunes anchored by vegetation in a desert environment during the Hypsithermal. Aeolian and fluvial forces sort sediments differently, however, and the uniform nature of the sediments within and beneath the mounds makes this scenario unlikely.

Evidence from this study weakly supports a fluvial or aeolian erosion hypothesis. Studies by Cain (1974), Cox (1994), and Guccione et al. (1991) argue that prairie mounds are erosional remnants of fluvial action. The uniformity of parent material within and beneath the mounds in this study is in accordance with this theory. The contouring of the A horizon to the ground surface, as opposed to the horizontal nature of the relict textural B horizon, also fits well within this scheme. The B horizon would have formed under the formerly flat surface, with the A horizon subsequently imposed upon and contouring the mounded topography.

Cain (1974) elaborates a scenario of trees anchoring soil against erosion in a period of dry climate punctuated by flooding events. Although erosional and depositional features are generally strongly oriented in respect to flow direction, anchoring by trees or other vegetation would explain the nearly circular form of prairie mounds.

The presence of a shallowly-buried surface impenetrable to water (bedrock), also lends support to a fluvial erosion origin. A surface impeding the downward movement of water raises the water table. Surface sediment in such an area is likely to be saturated more often than sediment in areas where no such surface exists, and saturated sediment is generally more susceptible to erosion.

Further study of mound micro-stratigraphy, possibly through the use of thin-sections, might further support an erosional origin hypothesis. If mounds were formed through erosion, there may be some horizontal stratigraphy left that would be common to most or all mounds within a mound field – relict from the previous, horizontal surface. This study suggests, however, that such stratigraphy is not resolvable with the methods used here.

Conclusions

The evidence from this study is equivocal in regard to the seismic shaking and fossorial rodent hypotheses, except to confirm a shallowly buried hard or impenetrable surface. The lack of such a surface would have argued strongly against both theories as they are currently articulated, because they both demand that such a feature be present. The presence of such a surface merely fails to discredit these hypotheses for mounds in this area.

Sediment size analysis in this report argues strongly against the hypotheses of aeolian or fluvial deposition. The mound bases occur at a lower level than the surface under which the textural B horizon formed, and parent material within and beneath the mounds is identical.

Soil and sediment evidence from this study lends weak support to a fluvial or aeolian erosion hypothesis. Uniformity of parent material and the contouring of soil horizons are consistent with such origins. The presence of a shallowly buried surface impenetrable to water also lends support to a fluvial erosion origin.

Subsequent studies of prairie mounds in this region might further test these hypotheses through bulk density sampling and thin section analysis. Evidence of accumulation of larger clasts at a depth consistent with the maximum depth of rodent burrowing would lend support to the fossorial rodent hypothesis. Lack of such accumulation in mounds that contain larger clasts would serve to largely discredit this hypothesis. Evidence of horizontal stratigraphy consistent between mounds would indicate that they are relics of a former, higher ground surface, and thus lend support to an erosional origin hypothesis.

Further studies of mound orientation and landscape position might help evaluate the fluvial and aeolian erosion hypotheses. Uniform mound orientations in a wide area not conforming to water flow direction would lend support to an aeolian erosion origin, as would the presence of mounds above present or former floodplains. Mound orientations consistent with water flow direction over a wide area would lend further support to a fluvial erosion origin.

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Appendix A: Core Descriptions

All Munsell colors taken moist. Core diameters ca. 4.3cm, cores recovered in plastic tubes.

(UAFPM-1) Taken from the center of mound A.

Depth in cm	Horizon	Description
0-30	A	Brown (10YR4/2) silt loam; fine medium granular structure; common fine roots; few fine biopores; noneffervescent; clear boundary.
30-60	A2	Brown (10YR4/3) silt loam; weak medium blocky to granular structure; common fine roots; few fine biopores; noneffervescent; clear boundary.
60-70	AE	Grayish brown (10YR5/2) silt loam; weak medium angular blocky structure; few fine roots; common fine biopores; noneffervescent; clear boundary.
70-93	E	Predominantly dark yellowish brown (10YR4/4) and very pale brown (10YR7/3) silt loam; weak medium angular blocky structure; few fine roots; common fine biopores; noneffervescent; clear boundary.
93-121	B	Brown (10YR4/4) silt loam; moderate medium angular blocky structure; common fine biopores; few fine roots; discontinuous cutans of dark grayish brown (10YR4/2); noneffervescent; clear boundary.
121-210	Bt	Predominantly gray (10YR5/1) silty clay loam; few irregular films of dark gray (10YR4/1); common (ca. 30%) small, distinct, redox concentrations of strong brown (7.5YR5/8) and (7.5YR4/6); strong fine angular blocky structure; few fine biopores; noneffervescent; clear boundary.
210-260	Bt2	Predominantly red (2.5YR4/6) and yellowish brown (10YR5/6) silty clay; moderate fine angular blocky structure; common distinct small redox depletion features of gray (10YR5/1); noneffervescent; gradual boundary.
260-289	Bt3	Highly mixed gray (10YR6/1) and yellowish brown (10YR5/8) silty clay; weak fine granular structure; friable; common small manganese concretions; noneffervescent; clear boundary.
289-310	Bt4	Predominantly light brownish gray (10YR4/2) and gray (10YR6/1) silty clay; moderate medium angular blocky structure; common small angular black manganese concretions; common cutans of dusky red (2.5YR3/2) and slightly darker; noneffervescent; clear boundary.
310-325	Bt5	Predominantly light brownish gray (10YR6/2) silty clay; moderate fine to medium angular blocky structure; common small irregular redox concentrations of yellowish brown (10YR5/8); few discontinuous cutans of dusky red (2.5YR3/2); noneffervescent; boundary not observed.

Refused on gravel or bedrock at 323cm, no rock sample recovered.

(Uafpm-2) Taken between mounds 1 and 2.

Depth in cm	Horizon	Description
0-33	A	Predominantly very dark grayish brown (10YR3/2) silt loam; weak fine granular structure; common faint small irregular redox concentrations of dark yellowish brown (10YR4/4) and black; common fine roots; few fine biopores; noneffervescent; gradual boundary.
33-60	E	Predominantly brown (10YR5/3) silt loam (clay content increasing with depth); weak medium angular blocky structure; few fine roots; common fine biopores; noneffervescent; common (ca. 30%) small distinct irregular redox concentrations of yellowish brown (10YR5/6); gradual boundary.
60-85	Bt	As above but common (ca. 15%) small irregular redox concentrations of red (10YR4/6) from 77-85cm; abrupt boundary.
85-120	Bt2	Predominantly dark yellowish brown (10YR3/4) silty clay; moderate medium angular blocky structure; common fine biopores; few small distinct irregular redox concentrations of yellowish brown (10YR5.8) and brown (7.5YR4/4), increasing in frequency with depth; noneffervescent; gradual boundary.
120-145	Bt3	Highly mixed gray (10YR5/1) and yellowish brown (10YR5/8) silty clay; strong fine angular blocky structure; few fine biopores; noneffervescent; clear boundary.
145-168	Bt4	As above but predominantly (ca. 80%) gray (10YR5/1); also contains a pebble ca. 1 cm diameter, rounded, of low sphericity; gradual boundary.
168-195	Bt5	Predominantly yellowish brown (10YR5/8) silty clay; strong fine angular blocky structure; few small distinct redox concentrations of gray (10YR5/1); common discontinuous black cutans from 180-190cm; noneffervescent; clear boundary.
195-214	Bt6	Mixed gray (10YR5/1) and yellowish brown (10YR5/8) silty clay; strong fine angular blocky structure; few fine biopores; noneffervescent; clear boundary.
214-217	Bt7	Mixed dark gray (10YR4/1) and yellowish brown (10YR5/8) silty clay; strong fine angular blocky structure; few fine biopores; noneffervescent; contains at bottom a pebble of light yellowish brown (10YR6/4) sandstone, friable, fine sand; boundary not observed

Refused on gravel or bedrock at 217cm.

(UAFPM-3) Taken from the center of mound B.

Depth in cm	Horizon	Description
0-29	A	Very dark grayish brown (10YR3/2) silt loam; moderate fine granular structure; common fine roots; few fine biopores; noneffervescent; clear boundary.
29-58	A2	Brown (10YR4/3) silt loam; weak medium to granular structure; few fine roots; common fine biopores; noneffervescent; clear boundary.
58-85	E	Predominantly brown (10YR5/3) silt loam; weak medium blocky structure; few fine biopores; few faint small irregular redox concentrations of yellowish brown (10YR5/6) increasing with depth; noneffervescent; clear boundary.
85-120	EB	Highly mixed light gray (10YR7/1), grayish brown (10YR5/2), and yellowish brown (10YR5/8) silt loam; moderate fine angular blocky structure; common fine biopores; gradual boundary.
120-134	Bt	As above but silty clay; gradual boundary.
134-196	Bt2	Mixed gray (10YR5/1), (10YR6.1), and yellowish brown (10YR5/8) silty clay; common small roundish redox concentrations of strong brown (7.5YR4/6); strong fine angular blocky structure; few small irregular black manganese concretions; few rounded pebbles ca. 0.5-2.5cm diameter, count increasing with depth; noneffervescent; few fine biopores; gradual boundary.
196-258	Bt3	Predominantly gray (10YR5/1) and yellowish brown (10YR5/8) silty clay; strong fine angular blocky; common distinct small irregular redox concentrations of strong brown (7.5YR4/6); common small black round manganese nodules; noneffervescent; clear boundary.
258-284	Bt4	As above but yellowish brown (10YR5/1) dominates; one small patch (2.0cm diameter) of light greenish gray (5GY8/1) "powder"; clear boundary.
284-333	Bt5	Same as Bt2.

Stiff resistance on clay or rock, no rock sample recovered, ended at 333cm.

Appendix B: Particle Size Analysis

(UAFPM-1) Center of mound A.

Depth (cm)	% Total Gravel	% SAND						% SILT				% CLAY
		VC	C	M	F	VF	Total	C	M	F	Total	Total
5	1	1	1	2	8	7	18	48	26	4	78	4
25	0	1	1	2	8	8	18	43	24	5	72	10
45	0	1	0	2	7	7	17	43	25	4	72	11
65	0	0	1	2	8	8	18	45	26	5	75	7
85	0	0	0	1	6	6	14	41	24	4	68	17
105	0	0	0	1	6	6	14	38	23	4	65	21
125	1	0	0	1	5	5	12	35	21	4	60	28
145	0	0	0	1	3	3	7	22	17	5	44	49
165	0	0	0	1	4	4	8	24	18	4	47	45

(UAFPM-2) Between mounds A and B.

Depth (cm)	% Total Gravel	% SAND						% SILT				% CLAY
		VC	C	M	F	VF	Total	C	M	F	Total	Total
5	0	0	0	1	4	5	11	31	28	7	66	23
25	1	0	0	1	5	5	11	33	30	7	70	19
45	0	1	1	1	5	5	13	34	29	6	69	18
65	1	1	0	1	5	6	14	36	25	6	67	20
87	1	0	0	1	4	4	9	24	18	5	48	43
125	5	2	2	2	4	5	15	27	17	4	48	37
145	3	0	0	1	4	5	10	23	16	4	43	47

(UAFPM-3) Center of mound B.

Depth (cm)	% Total Gravel	% SAND						% SILT				% CLAY
		VC	C	M	F	VF	Total	C	M	F	Total	Total
8	3	4	1	2	8	8	22	46	21	3	71	7
48	2	1	1	2	7	8	19	42	21	4	66	15
68	1	1	1	1	7	7	17	43	24	4	71	12
88	0	1	1	1	6	8	17	40	23	4	67	16
108	1	1	0	1	5	7	14	38	21	4	63	22
128	1	1	0	1	5	6	14	37	21	4	62	24
148	0	0	0	1	4	4	9	24	19	4	47	45
168	0	0	0	1	4	4	10	26	19	3	48	42