Landscape Dynamics at Monticello: a geoarchaeological perspective

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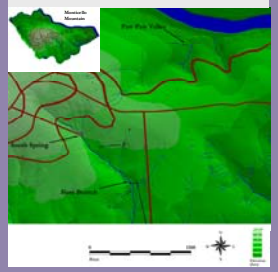
1. Introduction

This poster describes recent geoarchaeological research into historical landscape dynamics on Monticello Mountain, at the eastern edge of Virginia's Piedmont. We use information from multiple sources, including stratigraphy, gransize, sediment chemistry, and pollen to examine changes in agricultural land use and their ecological consequences during the 18th and 19th centuries.

The second quarter of the 18th century witnessed settlement by Europeans, enslaved Africans, and their descendents. Initially agricultural production for export focused on tobacco, which was typically grown using hoes, shallow plows, and swidden techniques. In the second half of the 18th century, changes in Atlantic markets attracted many slave owners to wheat, requiring more intensive plowing, permanent fields, and crop rotations. Jefferson moved from tobacco to wheat production at Monticello in the early 1790s.



2. The Sites

Monticello, like the rest of Virginia's Southwest Mountains, is underlain by the Catoctin formation, a mass of basalt metamorphosed to greenstone. Over hundreds of millions of years, weathering of this formation has produced clay-rich soils, whose erosion during the last two and a half centuries has had a major influence in the area. In a few places, where topography is flat or people have built barriers, transported sediment has accumulated. We have investigated three such places:

1. Paw Paw Valley Rock Alignment. The Paw Paw Valley drains an area known to Jefferson as the Ancient Field, on the north slope of Monticello Mountain. Documentary and archaeological evidence indicate the Ancient Field was cultivated as early as the 1740s. A 312-foot long rock alignment along the northern edge of the valley prevents sediment from being washed into a stream in the valley bottom.

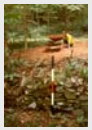
2. Slate Branch Rock Alignment. "South Spring" and "Slate Branch" denote two segments of a single stream that drains the southern slope of Monticello Mountain. The 75-foot long Slate Branch Alignment crosses above a second spring issuing from a bedrock ledge. This point marks the end of the South Spring and the beginning of the Slate Branch. The alignment prevents sediment from covering the springhead.

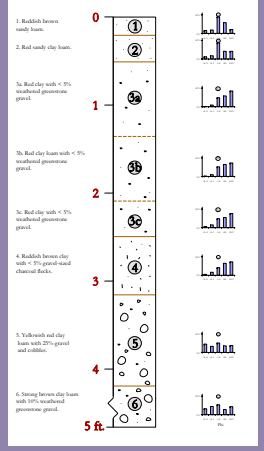
3. South Spring Check Dam. The South Spring stream channel is interrupted by a rock-faced dam, topped by an earthen berm. Just below the dam are two rock-edged pools. A trench excavated around the dam empties back into the channel below the pools. A shard of purple-transfer-printed whiteware from a test unit dug into the earthen berm provides a *TPQ* of *c.* 1830, after Jefferson's death. The dam and trench are engineered to prevent runoff from polluting stream water as it collects in the rock-lined pools.

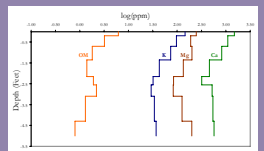
3. Paw Paw Valley: Unit 1

3.1 Gross Stratigraphy and Grain Size

Excavation at the Paw Paw Valley Alignment revealed six major layers. The earliest two layers (5, 6) displayed much higher gravel content, less silt and clay, and lighter hues, suggesting they represent a streambed. Above them lay two layers (3, 4), whose similar grain size profiles, with considerable gravel and modes in silt and clay, indicate they are colluvium that mixes A and B horizon from upslope. More clay and less gravel in the upper zones (3a, 3b) points to greater B horizon input, as erosion proceeded. The upper two layers (1 and 2) have more sand and less clay, a result of soil horizon formation on a more stable surface. Greater gravel content may be from an adjacent modern road.

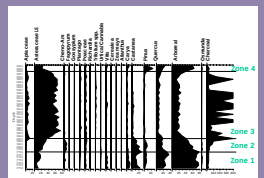






3.2 Chemistry

Organic matter (OM) percentages generally decline with depth from the surface. Fill deposited on the surface is moved downward by pedogenesis and decomposes over time. The OM pattern seen in Layers 3c and 4 (colluvium) suggests greater A horizon contribution to them, and lower A horizon contribution to the overlying colluvial layers (3a, 3b). Concentrations in parts per million (ppm) of exchangeable Ca, Mg, and K are roughly correlated. Levels are high in the modern A horizon, as a result of the breakdown of OM inputs on the surface, and steadily decline down the profile. Declines continue into Layers 3c and 4, but concentrations rebound slightly in the hypothesized stream bed (Layers 5 and 6), a pattern that contrasts with OM.



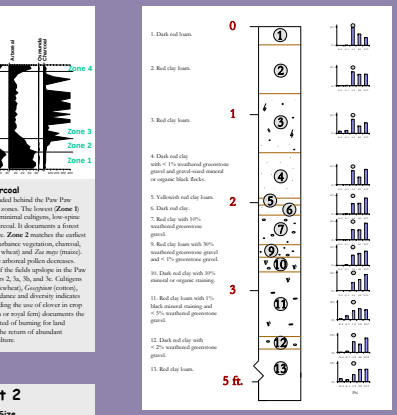
3.3 Paw Paw Unit 1 Pollen and Charcoal

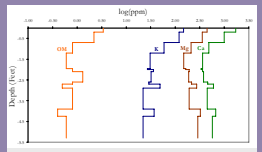
Sixty four pollen spectra from the sediment impounded behind the Paw Paw Valley Rock Alignment fall into four distinct pollen zones. The lowest (**Zone 1**) corresponds with Layer 5, a streambed. It contains minimal cultigens, low-spine *Asteraceae* (weeds indicating field clearance), and charcoal. It documents a forest environment only marginally impacted by agriculture. **Zone 2** matches the earliest colluvial layer (Layer 4). There is an increase in disturbance vegetation, charcoal, and cultigens including *Cerealia* (grain crops such as wheat) and *Zea mays* (maize). *Asteraceae* pollen and charcoal increase sharply while arboreal pollen decreases. Zone 2 represents initial clearance and cultivation of the fields upslope in the Paw Paw Valley. **Zone 3** corresponds with colluvial layers 2, 3a, 3b, and 3c. Cultigens in Zone 3 include *Zea mays*, *Cerealia*, *Fagopyrum* (buckwheat), *Gossypium* (cotton), and *Trifolium* (clover). The increase in cultigen abundance and diversity indicates agricultural intensification and diversification, including the use of clover in crop rotations. The disappearance of *Osmunda* (cinnamon or royal fern) documents the loss of forest canopy. Charcoal levels indicate repeated of burning for land clearance. **Zone 4** matches Layer 1 and represents the return of abundant arboreal pollen and the cessation of intensive agriculture.

4. Slate Branch: Unit 2

4.1 Gross Stratigraphy and Grain Size

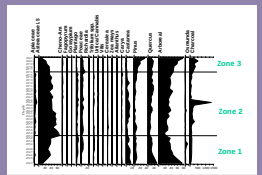
Unit 2 at the Slate Branch, excavated 20 feet upstream of the rock alignment, revealed a complex stratigraphic sequence. At the bottom, which coincided with the water table, Layer 13 displayed grain size distribution indicative of original B horizon. Bimodality in sand and clay suggest Layer 12 is transported. The high gravel content of Layer 12 and overlying Layer 11 betrays their colluvial origin. Above Layer 11, we encounter a sequence of thinner layers and lenses (6 through 10) with similar grain size distributions, which signal a shift in the dynamics of deposition. Higher clay content, relative to Layer 11, points to an increase in the importance of B horizon as a sediment source, while small amounts of gravel point to colluvial deposition. Layers 4 and 5 exhibited laminations, which point to deposition as alluvium from suspension in water trapped behind the rock alignment. Layer 4's bimodality in silt and sand suggests changing flow velocity, as water backed up behind the alignment and then spilled over the top. High gravel content and lack of laminations indicate Layer 5 is colluvium, while its striking sand-clay bimodality suggests that some of the Layer 5 sediment is redeposited alluvium (*cf.* Layer 12). Layer 1 is modern. A horizon, depleted in clay by elluviation into the underlying colluvial Layers 2 and 3.





4.2 Chemistry

OM percentage is lowest at the bottom of the profile, in original B horizon (Layer 13) and the overlying colluvium (Layer 12). OM increases in the first major colluvial layer (11), while Ca and Mg decline, a pattern we have also seen in the earliest colluvial layers of Paw Paw Unit 1 (3c and 4). Steady increase in OM begins in Layer 3 and continues up to the modern A horizon, Layer 1. K, Mg, and Ca concentrations follow suit. Alluvial layer 4 has depleted OM relative to most of the colluvial layers, perhaps a consequence of its mode of deposition.



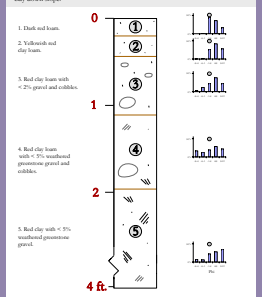
4.3 Pollen and Charcoal

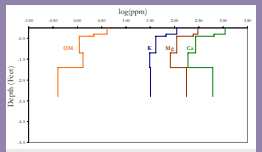
The pollen spectra from Slate Branch Unit 2 are divisible into three zones. **Zone 1** is rich in arboreal pollen and has a low incidence of low-spine *Asteraceae*, the taxon most indicative of land disturbance. Tree pollen, hardwoods in particular, decline during Zone 1, and counts of *Asteraceae* and ruderal plants rise. The presence of *Trifolium* (clover) in the lowest layers hints that crop rotation had begun during this initial phase of sediment accumulation. **Zone 2** corresponds to Layers 3-7, and 9. Zone 2 represents a period of greater agricultural activity and diversification. *Cerealia* (grain crops), *Fagopyrum* (buckwheat), *Gossypium* (cotton), and *Zea mays* (maize) are among the cultigens at this time. **Zone 3**, corresponding to Layers 1 and 2, has higher counts of arboreal pollen and a lower incidence of low-spine *Asteraceae*. This marks the end of intense cultivation on the mountain and the return of mixed forests.

5. Slate Branch: Unit 1

5.1 Gross Stratigraphy and Grain Size

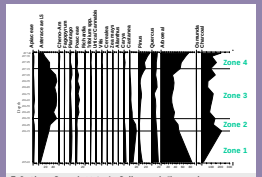
Unit 1 at the Slate Branch was excavated contiguous to the upstream edge of the rock alignment. Five major layers were encountered. The bottom layer (5) appears to be original B horizon, with grain size distribution identical to that in Slate Branch Unit 2, Layer 13. The mode in clay is the result of ancient illuviation, while the gravel is decomposing greenstone (bedrock). A mode in silt and high gravel content suggest a colluvial origin for layers 3 and 4. Greater clay content in Layer 2 suggests it is the result of illeviation into colluvium from Layer 1, the modern A horizon. Modest clay abundance in all layers but 5 may be a result of the gently sloping surface on which the colluvium was deposited: runoff continued moving clay down slope.





5.2 Slate Branch Unit 1: Chemistry

OM percentages decline with depth, although a modest increase in Layer 4 may betray a greater A horizon contribution to this colluvial layer from upslope. This matches the pattern for OM in Paw Paw Unit 1, Layers 3c and 4. K, Ca, and Mg also decline with depth and, in contrast with OM, declines continue into Layer 4, another parallel with Layers 3c and 4 in the Paw Paw sequence. Finally, OM drops, while K, Ca, and Mg increase in the hypothesized original B horizon (Layer 5), as they did in the lowest layers (5 and 6) of Paw Paw Unit 1, which may represent original streambed.



5.3 Slate Branch Unit 1: Pollen and Charcoal

The Slate Branch Unit 1 pollen relates the same story as Slate Branch Unit 2, in abbreviated and less well preserved form. **Zones 1 and 2** correspond to Layer 4, and the top of Layer 5. Together they document a decrease in trees, an increase in low-spine *Asteraceae*, and the appearance of cultigens, represented by *Trifolium* (clover). **Zone 3**, which corresponds to Layer 3, is a period of more intensive and diverse agricultural activity. Crops include *Zea mays* (maize), *Cerealia* (grain crops), and *Fagopyrum* (buckwheat). In addition *Trifolium* increases in frequency. **Zone 4** corresponds with Layers 1 and 2. Cultigens are present, but the decrease in low-spine *Asteraceae* and increase in arboreal pollen signal the demise of intensive agriculture and the return of the forest.

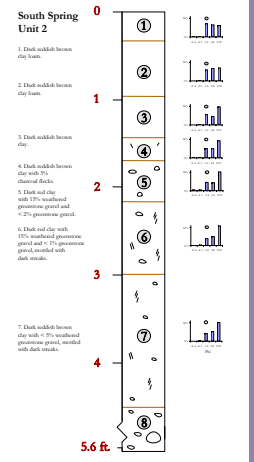
In contrast to the Paw Paw Valley, charcoal from the Slate Branch units does not show repeated large-scale burning for agricultural purposes. This might indicate that the Slate Branch units belong to a later period, when permanent fields had already been established.

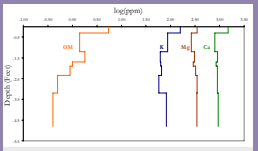
6. South Spring: Unit 2

6.1 Gross Stratigraphy and Grain Size

Unit 2 at the South Spring was excavated 30 feet upstream from a rock and earthen check dam in the center of the South Spring channel. A shard of purple transfer-printed whiteware was found in the fill of the check dam itself (Unit 1), yielding a *TPQ* of *c.* 1830 for the dam and the sediment trapped behind it. Thus the South Spring sequence postdates Jefferson's death.

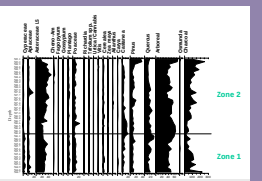
Unit 2 extended to the water table and the unsampled stream bed just below it. The five layers (3 through 7) overlying the stream bed have remarkably high modes in clay, the highest encountered in our samples, indicating a source dominated by B horizon. Mineral staining in the bottom layer attests to wet conditions. Modest amounts of gravel in these and the two immediately overlying layers suggest they are colluvium, impounded after the dam's construction. Increases in sand and silt in Layers 2 and 3 point to sources deeper than B horizon, presumably because most of the B horizon had already been eroded. The lack of evidence for clay illuviation in Layer 2 is the result of the recent use of this area as a source of fill dirt.





6.2 Chemistry

OM percentages decline down the profile. In contrast to OM, K, Ca, and Mg concentrations remain relatively high across the sequence and show only modest increases in the modern A horizon. High levels may reflect increased inputs of fertilizers containing these elements (e.g. ashes, lime, gypsum) or higher levels of these elements in their B horizon sources.



6.3 South Spring Unit 2 Pollen

Pollen spectra from South Spring Unit 2 fall into two similar zones. **Zone 1** corresponds with colluvial Layer 7 and is distinguished from Zone 2 by slightly less pollen from trees and low-spine *Asteraceae* and more pollen from *Cyperaceae* (sedges). **Zone 2** encompasses all of the upper colluvial layers (1-6). Cultigens are found in both zones, but are now limited to *Triticum*, *Cerealia*, and *Zea mays*. Both zones also share tree pollen frequencies greater than those seen in the middle portions of the Paw Paw and Slate Branch profiles. Both zones indicate a decline in the intensity of agricultural activity and considerable reforestation, although not to the modern levels reflected at the very top of the sequence. If the Check Dam was built before 1861, the increase in tree pollen at the Zone 1-Zone 2 boundary might represent the Civil War.

7. Conclusion

The Jefferson-period data align nicely with the picture of settlement dynamics that is emerging from archaeological survey and documents. Phase 1 saw the initial settlement of Monticello Mountain by a small group of slaves living on an outlying quarter farm that was part of Jefferson's father's Shadwell Plantation. Phase 2 represents Thomas Jefferson's initial development of Monticello Plantation, where tobacco was the staple crop, but other crops were grown. Phase 3 chronicles the transition to diversified agriculture based around wheat, which Jefferson initiated in the 1790s.

On some topics historical documents produce a contradictory perspective. Jefferson and his elite contemporaries understood the transition from tobacco to wheat as a triumph of "scientific" agriculture over more destructive traditional cultivation practices. Our data indicate plow-based farming was more destructive in the long term.

Phase	Date Range	Site and Unit	Layer	Pollen Zones	Dynamics
1.	1740s-1770s	Paw Paw 1	5	1	Minimal forest disturbance. Limited cultivation.
2.	1770s-1790	Paw Paw 1 Slate Branch 2 Slate Branch 1	4 11 6	2 1 1, 2	Deforestation as progress. Cultivation leads to modest erosion
3.	1790-1830	Paw Pae 1 Slate Branch 2 Slate Branch 1	2, 3a, 3b, 3c 3-10 2, 3	3 2 3	Extensive permanent fields. Crop diversification. Heavy erosion, a result of deeper and more extensive plowing.
4.	1830-1900	South Spring 2	2-7	1, 2	Spatial extent of cultivation declines. Heavy erosion continues.
5.	>1900	Paw Paw 1 Slate Branch 2 Slate Branch 1 South Spring 2	1 1 1 1	4 3 4 2	Reforestation complete. Tenants replace crops.

8. Some Questions

Among the questions our research raises are the following:

1. We suspect that the Paw Paw and Slate Branch alignments were constructed at the Phase 2-Phase 3 boundary to prevent pollution of drinking water sources as a result of intensive plow-based agriculture in Phase 3. Is this correct?
2. Does the higher average arboreal pollen frequency in Pollen Zone 2 at the Slate Branch Unit 2, relative to Pollen Zone 3 at the Paw Paw Valley truly represent spatial variation, or is there temporal disparity between these sites?
3. Most of the spikes in charcoal frequency during Phase 3 at the Paw Paw are associated with consistently low arboreal pollen frequencies. Does this mean they do not document field clearance, but other activities (e.g. charcoal burning)?
4. How can we more precisely characterize the differences in cultivation and land use strategies that are ultimately responsible for the lithological differences between sediment deposited during Phases 2 and 3?