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OCR Carbon Dating of the Watson Brake Mound Complex

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Abstract

Information concerning the age of mound construction at Watson Brake is critical to the interpretation of the site. Were the mounds and ridges constructed during the Middle Archaic Period as the artifacts suggest? Or were they constructed at a later time from soils which include Middle Archaic Period artifacts? These questions are critical in the interpretation of human behavior at the site. The OCR Carbon Dating procedure evaluates the pedogenic degradation of organic carbon, and thereby provides an in situ age estimate of the soil deposit. Over 200 OCR samples from three mounds and two connecting ridges provide detailed information about the age and sequence of mound construction at Watson Brake.

Introduction

The preceding papers have provided us with the physical, geomorphologic, and pedological contexts of the Watson Brake complex of mounds and connecting ridges. Later papers will provide details concerning the cultural material recovered during recent testing at this site. This paper addresses the temporal context of the mound and ridge construction and its abandonment using results obtained from the recently developed OCR carbon dating procedure. Uniquely spurious results from the mound and ridge fill deposits suggest certain human behavior at the Watson Brake complex.

Traditionally, mound construction has been considered a cultural expression restricted to the Woodland and later periods of Native American culture. Noted exceptions such as Poverty Point, a Late Archaic Period site, have proved both problematic and fundamental to hypothesis development. Detailed land architecture must have evolved from a less distinctive precursor, but examples of earlier mound constructions are not readily identifiable. Mounds containing artifacts from earlier time periods are known, but they lack in situ carbon containing cultural features that can be ^{14}C dated. Whether the mounds were constructed during earlier periods as the artifacts suggest, or were constructed from soils containing earlier artifacts has remained undetermined.

In situ hearth or garbage pit features are rare in and below mound fills. Their definition and existence is often doubted and subject to criticism as being only secondary fill deposits. Such unresolvable arguments are unnecessary. The mounds themselves are primary in situ cultural features that have undergone post-depositional changes. Understanding these changes provides a means to directly determine the temporal context of both their construction and abandonment.

The OCR Carbon Dating procedure, developed by the Archaeology Consulting Team, measures the site-specific rate of biodegredation of organic carbon, either as soil humic material or as charcoal. The biological recycling of organic carbon is fundamental to nearly all biological systems on this planet. While some forms of organic carbon, such as fresh organic matter, are quickly recycled, other more resistant forms, such as humus and charcoal, are recycled at a much slower rate. This recycling follows a linear progression though time when considered within the site-specific context, and includes the factors that influence biochemical degredation of organic carbon. Charcoal and soil humic material, once thought to be inert, are biologically recycled at a slow but measurable rate.

The effect of the biochemical degradation of charcoal and soil humic material is measured by a ratio of the total organic carbon to the readily oxidizable carbon in the soil sample. In general, as the total amount of organic carbon decreases though time due to recycling, the relative percentage of readily oxidizable carbon increases. This ratio is called the Oxidizable Carbon Ratio, or OCR. The rate of biochemical degradation will vary within the specific physical and environmental contexts of the sample. An age estimate of the organic carbon is determined through a systems formula that accounts for the biological influences of oxygen, moisture, temperature, carbon concentration, and the soil reactivity. Residual influences on this system are included through a statistically derived constant.

Methods and Procedures

A total of 200 soil samples, obtained at five-centimeter intervals below the surface, were analyzed to determine an age estimate for the construction and abandonment of three mounds and two ridges of the Watson Brake complex. Soil samples were obtained from Mound B and Ridge system A-K during the 1995 field season, and from Ridge C-B, Mound D, and the apron of Mound A during the 1996 field season. Sampling extended from the surface, through the mound and ridge fill soils, and into the buried original soil surface.

Soil samples weighing 100 grams were extracted at five-centimeter intervals by Dr. Saunders during test excavations. All samples were air-dried to arrest biochemical action, and shipped to our laboratories in Vermont. Soil texture was determined by dry screening, with the mean texture calculated by the percentage of weight for each fraction according to USDA standard mesh screen sizes. Soil pH was determined from a 1:1, soil/water paste. Total carbon was determined by the Ball Loss on Ignition procedure (Ball, 1964), and the readily oxidizable carbon was determined by the Walkley and Black wet combustion procedure (Walkley, 1935; Walkley and Black, 1934). Mean annual temperature and moisture were based on the National Oceanic and Atmospheric Administration (NOAA) Narrative Summaries for the period of 1941 to 1975 (Ruffner, 1978). All OCR_{DATE} age estimates are expressed as MRTs, or the mean residence time for all the organic carbon contained in the sample. As the actual age ranges and relative amounts of young and old carbon are not determined, statistically meaningful confidence intervals cannot be calculated.

Results

The soil is alive. By this statement I do not mean that individual grains of sand have sentience. Rather, the soil body with its interaction of microbial biology and atmospheric chemistry, may be seen as a system that is self-regulating, evolving and growing. As we look at the mounds and ridges at Watson Brake, we see soils, once alive in another spatial-temporal context, that have been mounded up into a dead heap of mineral and organic corpses. However, almost immediately after the last basket load of fill is applied to the pile, a new soil body is conceived and growth commences. Using the OCR-Ratio and the variables from which the OCR_{DATE} is calculated, the extent and duration of growth in this current soil body can be determined and separated from the corpses of the former soil bodies.

Post-abandonment biochemical pedogenesis, or soil growth, is evident within the upper portions of the mounds and ridges extending into the upper portions of the Bt horizon. This horizon slowly migrates downward and acts as a barrier to oxygen permeation and thus the biodegradation of carbon. OCR_{DATE} age estimates for the three mounds range from an average of 480 years before present at the surface, to an average age of 4866 years before present at the top of the Bt horizon. OCR_{DATE} age estimates for the two ridge systems range from 197 years before present at the surface, to an average age of 5229 years before present. The uppermost samples demonstrate an expected young MRT value due to the predominance of recent organic carbon from forest vegetation. The OCR_{DATE} of the samples from the upper portion of the Bt horizon represent the maximum depth of biochemical degradation of organic carbons post-mound construction.

The younger OCR_{DATE} estimates obtained from the uppermost levels of the ridge systems as compared to the mounds suggests that minor soil deflation has occurred on the topographically higher mounds. If so, then the actual age of the mounds are likely somewhat older than 4866 years before present, but younger than 5229 years.

Former pedogenically active soils are located below the mound and ridge fills. The age of the sub-mound soil horizons indicate a time prior to mound and ridge construction. The growth of these soils was arrested at the commencement of mound building. Extending our metaphor, these soils were suffocated by the overburden, and left in place dead. The OCR_{DATE} estimates for the buried surfaces range from 5289 to 5778 years before present.

These age estimates represent a time somewhat before the event of suffocation, as the organics within the sampled soil horizons consists of both young and old carbon that accumulated during the soil body's lifetime of active pedogenesis. We see a similar time-lag in the present soil surface of the mounds, and estimate that the event of mound-filling occurred about three hundred years after the OCR_{DATE} estimates for the buried surface. The average age estimate including the 300 year time-lag, for the event of burial for the sub-mound soil body is about 5180 years before present.

The age of the non-pedogenically active, or dead and transposed soils constituting the mound and ridge fills, may be expected to cover a range of dates both older and equivalent to the OCR_{DATE} age estimates obtained from the upper portions of the Bt horizon. The maximum age of the mound fill soils will depend on the depth of borrow excavations. If the mounds were constructed from sub-soils as well as surface soils, the age of the mound fill soils will pre-date the buried pedogenic soil horizon. The OCR_{DATE} age estimates for the fill soils range between 5087 and 6407 years before the present, with a mean of 5590 years.

Soils with abnormally high OCR-ratios were present in all five profiles, in different quantities and positions within the profile of non-in-situ-pedogenic mound and ridge fills. OCR-ratios greater than 5.5 are normal for soils obtained from an anaerobic context. The anaerobic characteristics of these high OCR-ratio soils cannot be explained as an in situ phenomenon because their positions vary within the profile. Rather, it is likely inherited from the soil body's place of origin prior to excavation and relocation to the mounds.

In summary, based on OCR data from 200 samples, the three mounds and two ridges at Watson Brake were constructed within 200 years of 5180 years before present, the average estimated age of death of the sub-mound soil body, and abandoned within 200 years of 5010 years before present, the average age of the growth, or pedogenesis, in the upper mound soil body.

Discussion

The information obtained from the detailed soil analyses at Watson Brake can provide more than simply a temporal context for the construction and abandonment of the Mounds and Ridges. Based on the varying characteristics of the mound fill soils, we conclude that both dry surface soils and wet subsurface soils were excavated to create the mounds. Mounds are traditionally perceived as intentional land architecture, or monuments. The orientation and diversity of styles exhibited by many, particularly the more recent mound complexes, supports this view. However, the architectural characteristics of early mounds may be secondary to the primary cultural purpose. Dry soils are much easier to excavate and transport than wet soils. This difference is magnified with finer soils such as the silts and clays composing the Watson Break complex. While the investment of energy used to build the mounds and ridges at Watson Break is obvious on the landscape, the investment in excavation activities may be easily overlooked. The presence of surface dry soils and subsurface wet soils within the mound and ridge fills suggests that relatively deep excavation pits exist within the adjacent flood plain. Evidence of these borrow areas are likely buried, as the time of hypothesized pit excavation pre-dates the levees and aggradation of the flood plain caused by the course changes of the Arkansas River.

The meanders and oxbows which have resulted from the diversion of the Arkansas River around 4,800 years ago, provided natural fish ponds. We hypothesize that prior to the presence of these natural exploitable niches, synthetic fish ponds, or channels, may have been intentionally excavated by the builders of Watson Brake to augment the existing riverine niche. The complex of mounds and ridges at Watson Brake, while likely serving some secondary cultural purpose, may also be viewed as spoil piles associated with the primary activity of habitat manipulation. Remote sensing and soil core studies within the adjacent flood plain area may reveal these hypothesized borrow areas beneath the more recent alluvial deposits of the Arkansas and Ouachita River.