DEEP SAND: SOIL AND LANDSCAPE RELATIONSHIPS AT THE BLUEBERRY SITE (8HG678), HIGHLANDS COUNTY, FLORIDA

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Soil chemical and physical analyses were conducted at the Blueberry site (8HG678) in Highlands County, Florida, to address two questions: 1) the relationship between a sand-buried Belle Glade Period midden (A.D. 1410-1455) and a much older but more superficially situated Archaic Period (4500 to 2500 B.P.) fiber-tempered locus, and 2) the nature and origin of the charcoal-laden sand layer covering the Belle Glade midden. A significant increase in coarse sand and the condition and quantity of organic carbon deep in the central part of the site imply that that area was formerly a stream or seep drainage separating the two older, more stable landforms that supported the archaeological deposits. Soil morphology, color, and chemistry, and charcoal and organic carbon distributions present evidence of past cycles of area-wide fires, episodic erosion onto the site from adjacent higher sand ridges, and partial recovery of the vegetative cover in the intervening periods between fires.

Key words: archaeopedology, Florida Archaic, geomorphology, landscape change, soils

The Blueberry site (8HG678) in Highlands County, Florida, is buried within the deep sands of the Lake Wales Ridge. It contains artifacts from two cultural periods: the Late Archaic (5000 to 2500 B.P.) and the Belle Glade (2500 to 300 B.P.) (Milanich 1994:291-297). The two assemblages are located within 20 m of each other on the flank of a sand ridge bordering a large wet prairie. The Belle Glade midden was found approximately 70 cm below the modern soil surface, associated with a former soil surface now covered by gray, charcoal-laden sand. The older, fiber-tempered sherds characteristic of Late Archaic culture were in a topographically higher position than the Belle Glade midden and closer to the modern soil surface. Two questions regarding the spatial and temporal relationships between these assemblages and their surroundings are addressed in this report. First, what is the physical relationship between the buried Belle Glade midden and the locus that yielded fiber-tempered sherds and second, what is the nature and origin of the charcoal-laden sand covering the Belle Glade midden.

The Site and Area Soils

The Blueberry site is located in south central Florida (Fig. 1), at the boundary between the southern tip of the Central Lakes region and the Eastern Flatwoods region (Brooks 1981). It lies on a small sand ridge projecting from the southeast margin of the Lake Wales Ridge (Fig. 2), a Pleistocene beach ridge that runs parallel to the Atlantic coast (White 1970). From that vantage point, it overlooks Indian Prairie Basin, a wide swath of wetland that drains Lake Istokpoga into Lake Okeechobee and was once part of the Everglades. A deep drainage ditch at the base of the sand ridge intersects sand-covered peat, undoubtedly once part of the wet prairie (Fig. 3). South of the southern terminus of the site, a seep spring issues from the lower flank of the ridge, flowing in a small channel through fern, swamp bay, and palmetto toward the prairie to the east. To the west, a larger sand ridge, planted in citrus, parallels the long axis of the site. A perched pond surrounded by palmettos is situated on the western flank of this ridge.

The archaeological remains were unearthed in a series of test units arrayed in a north-south line along the ridge flank (Fig. 3). The units lie in a narrow swath of relatively level land between the margin of the citrus grove to the west and a mixed oak/palm woodland descending to the seep spring to the east. The buried Belle Glade midden was located at the south end of the test array, the fiber-tempered material at the north end. Belle Glade potsherds were also found close to the modern soil surface at the south end of the site.

Local soils in the vicinity of the Blueberry site have developed from two different parent materials: sand and

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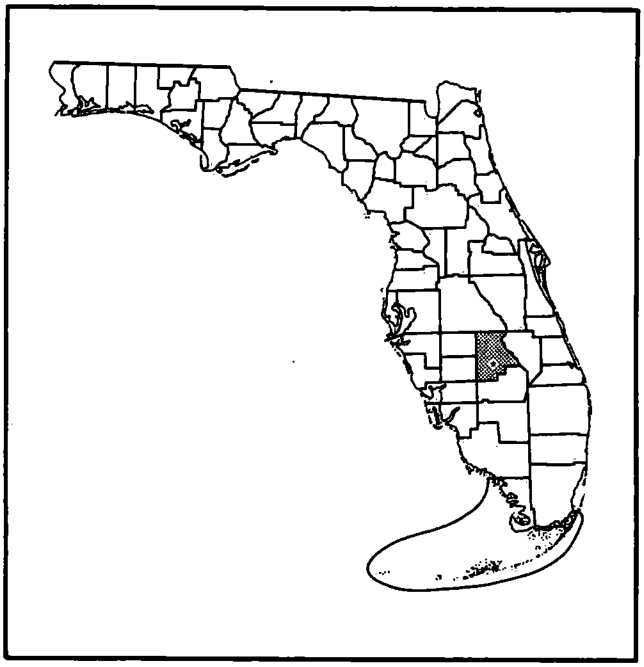

Figure 1. Approximate location of the Blueberry site in Highlands County, Florida.

the organic matter that accumulated in the wet prairie basin and smaller wetlands. The deep sandy soils of the ridges and less-well drained "flatwoods soils" of the lowlands and swamp edges all developed in marine-derived beach-ridge sediments deposited during the Pleistocene.

Soils evolving from organic material are commonly known as mucks and peats. They occur on wet prairies, lake margins, and anywhere that large quantities of plant material accumulate and degrade under anaerobic conditions (Soil Survey Staff 1975). Organic soils in the vicinity of the Blueberry site once occurred as surface soils at the base of the sand ridge on which the site is situated, as exemplified by the ditch profile mentioned above. Today, those soils occur in Indian Prairie, east of the site, where in some places they are covered by more than a meter of sand. The plant communities supported by these wetlands soils range from open marsh and swamp to forested wetlands and, when combined with the upland habitats of the sand ridge areas, would have provided aboriginal inhabitants with a wide variety of resources.

Archaeopedology: Approaches to Studying "Old Soils"

Human effects on natural soils and landscapes can be detected using the basic tools of soil science: soil morphological descriptions and interpretations, particle-size distribution analysis, and patterns of chemical element accumulation. One of the most widely used techniques to describe soils physically is particle-size analysis, which is used to determine grain-size class distributions with depth and to relate those distributions to soil-forming processes and the dynamics of landscape evolution (Farrand 1975; Hassan 1985).

Chemical analyses are used to measure the soil content of such elements as phosphorus, calcium, magnesium, and some trace minerals that accumulate as a result of human habitation, then to compare those levels with residual levels of the same elements in local, native (non-human-impacted) soils (Conway 1983; Eidt 1985; Lillios 1992; Lippi 1988; Woods 1977). These patterns of element accumulation can be used to delineate site boundaries and to locate and interpret the function of such intrasite features as hearths, storage pits, and burials. The actual quantitative differences between native and anthropogenic soil-element contents are a measure of habitation duration and intensity. Measurement of pH (acidity) of the soil can be used to explain the physical condition or absence of bone, the presence or absence of pollen or phytoliths, and the preservational status of artifacts.

MATERIALS AND METHODS

Field Sampling

Soil samples were removed from the center of each natural horizon and midden layer of the south profile of test unit 985N/1004E, which exposed the Belle Glade midden. Manually augered samples were taken adjacent to the other test units, which had been back-filled prior to general soil sampling, and at higher elevation on the ridge at the northern end of the site (Fig. 3). Individual samples of approximately 300 to 400 g were removed in 10-cm increments, bagged, labeled by soil test (ST) number and depth, and transported to the Florida Museum of Natural History in Gainesville for further preparation and curation. Field descriptions of augered soils included soil horizon designation, color, texture, and relative moisture. The descriptions also included the approximate depths at which these characteristics changed.

Laboratory Procedures

Soil samples were air-dried and sieved through 2 mm screen in the Environmental Archaeology laboratory at the Florida Museum. Catalog numbers were assigned and two sets of 50 g subsamples were removed from

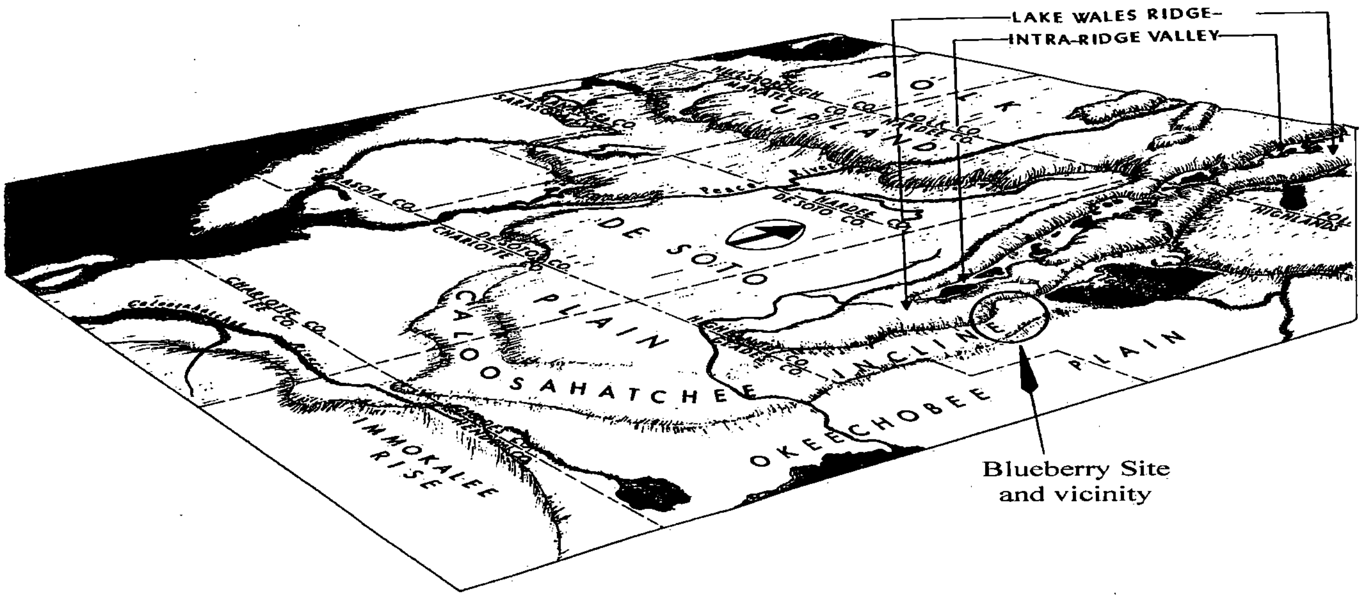

Figure 2. Regional physiographic features in the vicinity of the Blueberry site (after White, 1970).

bulk samples. One set was sent to the Environmental Pedology laboratory in the Soil and Water Sciences Department, University of Florida (UF), for particle-size distribution analysis using the pipette method outlined by Day (1965). Samples judged to have greater than 1% organic carbon (estimated by a gray or dark gray color) were pre-treated with hydrogen peroxide and heat to digest the organic material before particle-size analysis proceeded. The second set of subsamples was sent to the Analytical Research laboratory on the UF campus for analysis of extractable soil elements. That procedure uses a filtrate extracted with 0.05 N hydrochloric acid in 0.025 N sulfuric acid. The extractant was analyzed using inductively coupled argon plasma (ICAP) spectroscopy.

RESULTS

Particle-size Distribution Analysis

The ridge soils at the Blueberry site are from 92 to 99.7% sand, which identifies their parent material as "coarse marine sediments" (Carter et al. 1989). The overwhelming proportion of total sand in the soil tells us little more than that. To understand more about internal relationships among sub-areas of the site, the individual sand-size classes were studied, as well as size-class ratios that compare "fine" sizes (very fine and fine designations) with "coarse" ones (coarse and very coarse designations). These ratios are clarified by not including medium-sized sand, the most abundant fraction in the Blueberry site soils.

Table 1 summarizes particle-size distribution and particle-size ratios among natural horizons in all soils sampled. Medium sand dominated virtually all horizons in all tests, with a range of 50.6 to 79.5% by weight. The second most abundant size class, fine sand, ranged from 10.6 to 28.4% in all but four samples. The relationship between fine- and medium-sand content changed with depth over the site: medium-sand content generally decreased with depth at each test, while fine-sand content increased with depth.

Most horizons contained from 4 to 8% coarse sand. Exceptions were found in the two deepest subhorizons of ST #4, which contained 15.4 and 12.2% coarse sand. Subsurface horizons of ST #5 and #6 also showed increased coarse sand content, up to 21%.

Silt content varied considerably over the site area, ranging from <1.0 to 6.9%. There was no discernable pattern of accumulation or depletion with depth. In some tests, silt content and coarse sand content varied inversely—when one fraction was well-represented in a particular horizon, the other was scant. Conversely, in some tests the increase in coarse sand was accompanied by an increase in silt. Clay content across the site was generally less than 1%.

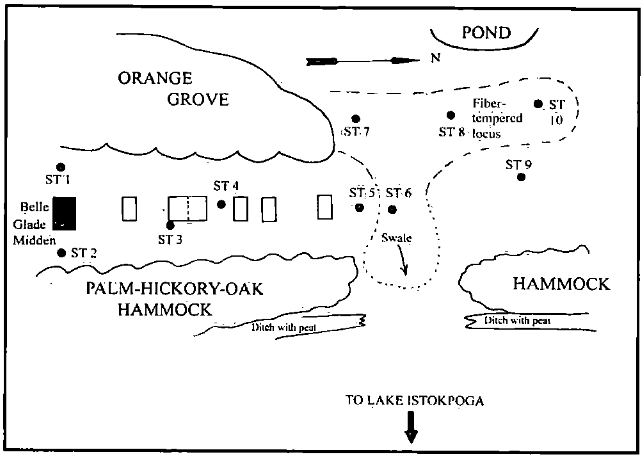

Figure 3. Blueberry site test units and soil test (ST) localities.

Charcoal Distribution

The highest charcoal content occurred in the A through Ab horizons—the modern soil surface—and in the E horizons and the buried midden level. Charcoal content of the subhorizons of the soil buried below the midden was minimal, except the fraction of very fine sand in the buried E horizon.

Soil Morphology

All the soils at the Blueberry site have an A horizon composed of a mixture of organic matter and mineral sand. This horizon varies in darkness and thickness over the site, reflecting differences in organic inputs from vegetation and, in some cases, a partial mantling by cleaner aeolian and colluvial sands. A cross-section of the south end of the site perpendicular to the long N-S axis is shown in Fig. 4. The buried A horizon with midden (designated Ab/midden) can be seen in the ST #2 and 985N columns, with the suggestion that the dark A3 horizon of ST #1 may be a continuation of that former surface horizon. Soil tests 3 through 6 showed no evidence of buried surfaces. The soil color lightened with depth, indicating that the densest accumulation of organic material was on the soil surface. Soil test #7 contained a thin, intermittent Ab horizon at approximately 130 to 140 centimeters below surface (cmbs).

The leached E (eluvial) horizon underlying the A horizon varied in thickness and depth across the site. At the south end, it was underlain by a light brown to dark brown B horizon (zone of accumulation). At the north end, the very deep and well-developed soil at ST #10 had two E horizons separated by B horizons that darkened with depth (Fig. 5). The second E horizon began at 400 cmbs and was the last sample possible to take without losing the auger to the forces of friction and gravity. What underlies this remains an unanswered question. In the central tests, no dark horizon was encountered beneath the E horizon, although samples taken from close to the water table in the zone of saturation contained small black flecks of organic matter suspended in the soil water. These flecks were not attached to the clear quartz sand grains that comprised the pale matrix of the soil—as they would be in a darkly colored horizon—rather, they settled out in the liquid portion of the samples.

The B horizon also varied across the site. As mentioned above, it was absent, or at least not encountered at the depths augered, in the central tests. In these areas, stripped white sands with black particles suspended in the soil water were encountered below the A horizon. A Bw horizon (beginning of color development) occurred in tests 1 through 5 and again in 10. A Bh horizon (containing dark humus), articulating with the water table, was evident at tests 1 through 4 and in non-saturated conditions at test 10.

The morphology of the soil encountered at ST #9 differed from all other areas and represented the margin of wetland organic-soil development. This soil had a gray sandy A horizon and an intermediate, mixed organic and mineral AE horizon, all underlain by a blackish-red peat.

Chemical Analyses

Table 2 summarizes chemical element contents and pH measurements for all samples. Measurement of pH indicate that the soils at the Blueberry site are mildly to moderately acidic, becoming more acidic with depth. The lowest surface acidity (highest pH, or alkalinity) was generally associated with the high calcium content of midden deposits.

Organic carbon (OC) content was generally less than 1% and highest in the dark surface horizons, the buried A/midden horizon, and in BwBh or Bh horizons. Across the site, organic carbon content was lowest in the E horizon and decreased with depth.

Highest soil calcium (Ca), magnesium (Mg), and phosphorus (P) contents were found in the A horizon of ST #2, 3, 4, and 5, and in the Ab/midden horizon of unit 985N. Soil Ca and Mg decreased irregularly with depth to the deepest levels sampled, then increased again as soil moisture increased, except in tests 8 and 10, and in unit 985N. Soil P content was lowest in E horizon samples and increased in subadjacent Bw and BwBh horizons.

Table 1. Particle-size distribution analysis (wt.%), Blueberry site (8HG678).

unit/test	horizon	depth (cm)	sand size* VC	C	M	F	VF	total sand	silt	clay	F:C ratio
ST #1	A1	20	0.0	6.0	72.4	20.0	1.0	99.4	0.6	0.0	3.5
	A3	70	0.0	6.0	73.2	19.4	0.8	99.4	0.6	0.0	3.4
	E	150	0.0	4.8	66.2	25.8	1.4	98.2	1.7	0.1	5.7
	BwBh	290	0.0	5.4	68.4	24.0	0.8	98.6	1.4	0.0	4.6
ST #2	A	20	0.0	6.8	73.2	16.4	0.6	97.0	2.0	1.0	2.5
	El	60	0.0	5.0	74.8	18.4	0.8	99.0	1.0	0.0	3.8
	AB1	80	0.0	6.4	75.4	16.6	1.0	99.4	0.4	0.2	2.8
	Mid/Eb	140	0.0	5.8	71.0	21.2	0.8	98.8	0.8	0.4	3.8
	Eb	160	0.0	6.2	71.6	20.6	1.0	99.4	0.6	0.0	3.5
	BhBw	300	0.0	6.8	67.6	22.2	0.8	97.4	2.5	0.1	3.4
ST #3	A1	20	0.0	2.2	20.2	68.8	0.8	92.0	6.9	1.1	31.6
	A2	80	0.0	6.0	72.0	19.0	0.2	97.2	2.6	0.2	3.2
	E	150	0.2	6.0	53.2	35.6	1.8	96.8	2.1	1.1	6
	Bh	260	0.0	3.4	50.6	45.2	0.2	99.4	0.4	0.2	13.4
ST #4	A1	25	0.0	7.0	73.2	14.2	0.4	94.8	4.5	0.7	2.1
	AE	75	0.0	5.4	74.0	19.8	0.4	99.6	0.2	0.2	3.7
	E	115	0.2	4.6	42.2	48.0	0.4	95.4	3.7	0.9	10.5
	EBw	155	0.2	15.4	55.4	27.4	0.4	98.8	0.3	0.9	1.8
	BwBh	205	0.6	12.2	55.2	28.4	1.2	97.6	2.0	0.4	2.4
ST #5	A1	20	0.0	9.2	76.6	10.6	0.4	96.8	2.4	0.8	1.2
	El	80	0.0	7.8	76.0	14.4	0.6	98.8	1.2	0.0	1.9
	EBw	130	0.2	21.2	52.6	15.2	2.0	93.0	6.8	0.2	0.7
	E	210	0.0	5.2	65.2	26.6	2.0	99.0	1.0	0.0	5.2
ST #6	A1	20	0.0	7.4	72.2	16.6	1.0	97.2	2.8	0.0	2.4
	E	80	0.2	21.0	55.4	15.2	0.8	94.4	5.3	0.3	0.8
	E w/bl	140	0.0	7.2	71.2	19.6	1.0	99.0	0.3	0.7	2.9
ST #7	A2	20	0.0	8.6	77.2	12.0	0.4	98.2	1.8	0.0	1.4
	E	100	0.0	6.4	75.4	16.8	0.8	99.4	0.5	0.1	2.8
	Eb	180	0.0	5.4	71.0	22.0	0.4	98.8	1.1	0.1	4.1
	E w/bl	230	0.0	5.0	69.4	23.8	1.0	99.2	0.7	0.1	5
ST #8	A1	20	0.0	8.2	78.2	11.4	0.2	98.0	1.4	0.6	1.4
	AE	80	0.0	6.4	75.6	16.0	0.8	98.8	0.6	0.6	2.6
	E	150	0.0	5.4	71.4	20.6	1.2	98.6	0.2	1.2	4
	W w/bl	280	0.0	5.0	70.6	21.8	1.6	99.0	0.8	0.2	4.7
ST #10	A1	20	0.0	8.6	77.6	10.8	0.8	97.8	1.9	0.3	1.3
	AE	80	0.0	5.8	77.0	15.0	0.8	98.6	1.4	0.0	2.7
	EBw	140	0.0	6.8	77.2	13.4	0.8	98.2	1.4	0.4	2.1
	Bw2	200	0.0	4.6	70.8	22.2	1.0	98.6	1.2	0.2	5
	Bh	380	0.0	6.6	76.0	14.6	0.8	98.0	1.9	0.1	2.3
	E'	400	0.0	4.0	63.6	28.2	2.8	98.6	1.2	0.2	7.8
985N/ 1004E	A1	5									
	A2	25	0.0	8.0	77.8	13.0	0.1	99.0	0.0	1.0	1.6
	AE (E)	50	0.0	9.5	79.5	9.6	0.0	98.7	0.0	1.3	1
	Ab1	75									
	Ab2	100	0.0	9.9	71.1	15.7	0.8	97.8	0.1	2.1	1.6
	AbE	115									
	Eb1	140	0.0	9.8	74.3	15.4	0.2	99.7	0.0	0.3	1.6
	Eb2	185									
	Bwb	210									
	BwBhsb	250	0.0	9.7	73.6	15.6	0.1	99.1	0.0	0.9	1.6

* Sand-size class designations: VC = very coarse, C = coarse, M = medium, F = fine, VF = very fine.

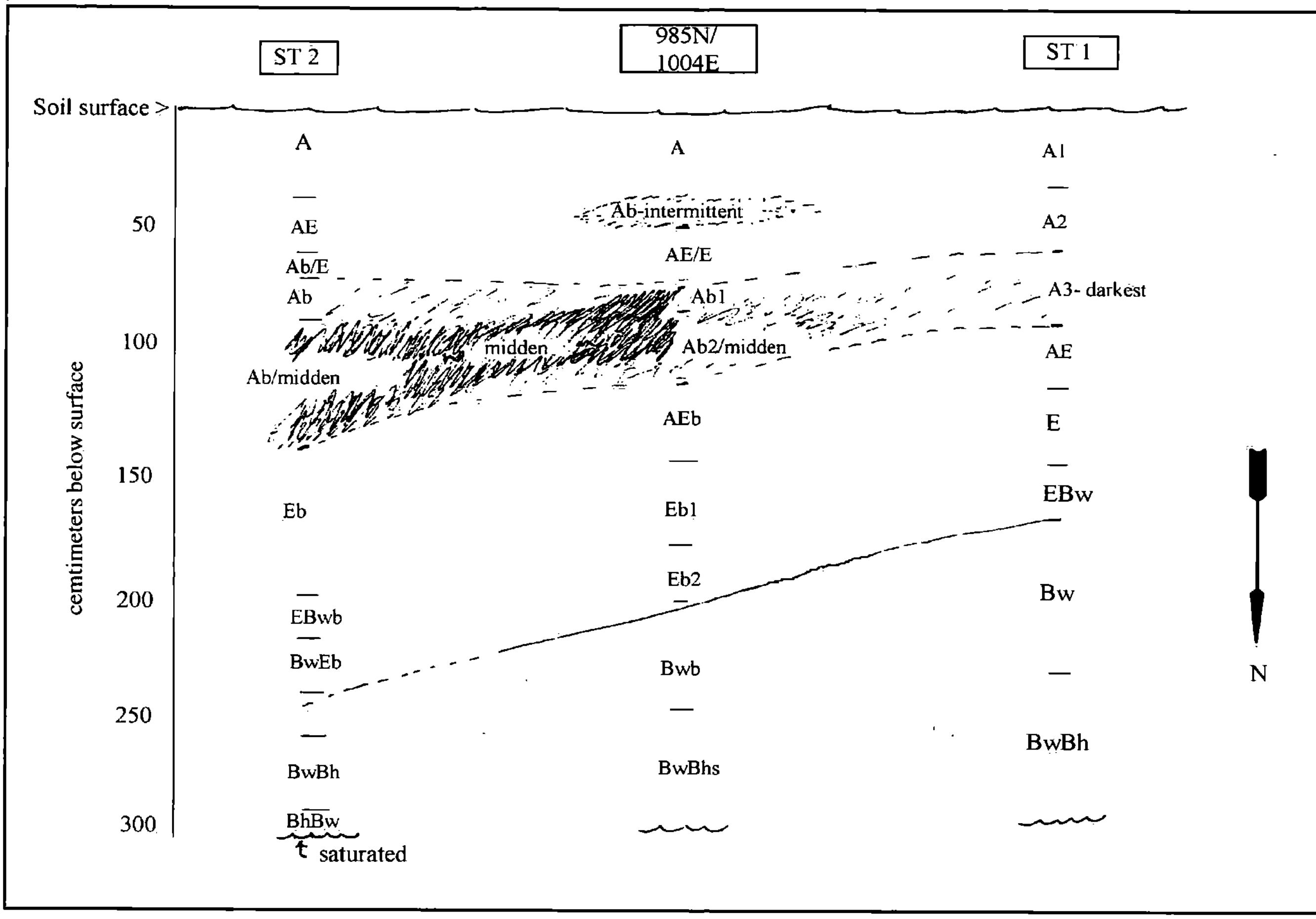

Figure 4. Cross-sectional profile of south end of site.

Aluminum content was highest in horizons with the most OC (A horizons and buried A/midden horizons) and in the "colored" Bw and BwBh or Bh horizons. It was lowest in the E horizon across the site, and lowest throughout the soil column at ST #7 and #8.

Iron content was highest in the most well-developed soil profile, ST #10, and in the Ab/midden horizon of unit 985N. Within the other tests it was generally lower in E horizon samples and higher within B horizons.

DISCUSSION

Localized Landscape Variations: A Subsurface View

Local variations in soil characteristics suggest a former landscape quite different from that which constitutes the Blueberry site today. Midden thickness (Fig. 4) increases to the east, downslope toward the edge of the wet prairie. The dark A3 horizon of ST #1, to the west of unit 985N/1004E, may be the up-slope edge of the midden itself, but is certainly contiguous with the former soil surface. It is at the same depth as the true midden layers in the other two tests and shows a similar pattern of accumulation of organic C, Ca, and Mg, though absolute contents of those constituents are not as high as in well-defined midden levels. One can envision the Belle Glade Period inhabitants living on the flank of the ridge, using the resources of the seep spring, upland sandhills and ponds, wet prairie marginal woodlands, and the huge open marsh itself. The debris from their habitation site and activities spread downhill to accumulate in a wedge-shaped deposit on the sloping foot of the ridge. Although the south end of the site is now essentially flat, the topography of the subsurface soil horizons underlying that area indicates that the land sloped more abruptly toward the prairie when the midden was forming. Because the formation of Bh horizons in the southeastern United States is dictated by the position of the water table (Garman et al. 1981), and the water table under a gently rolling landscape generally parallels the ground surface (Birkeland 1984), it can be inferred that the subsurface horizons here formed in mounded

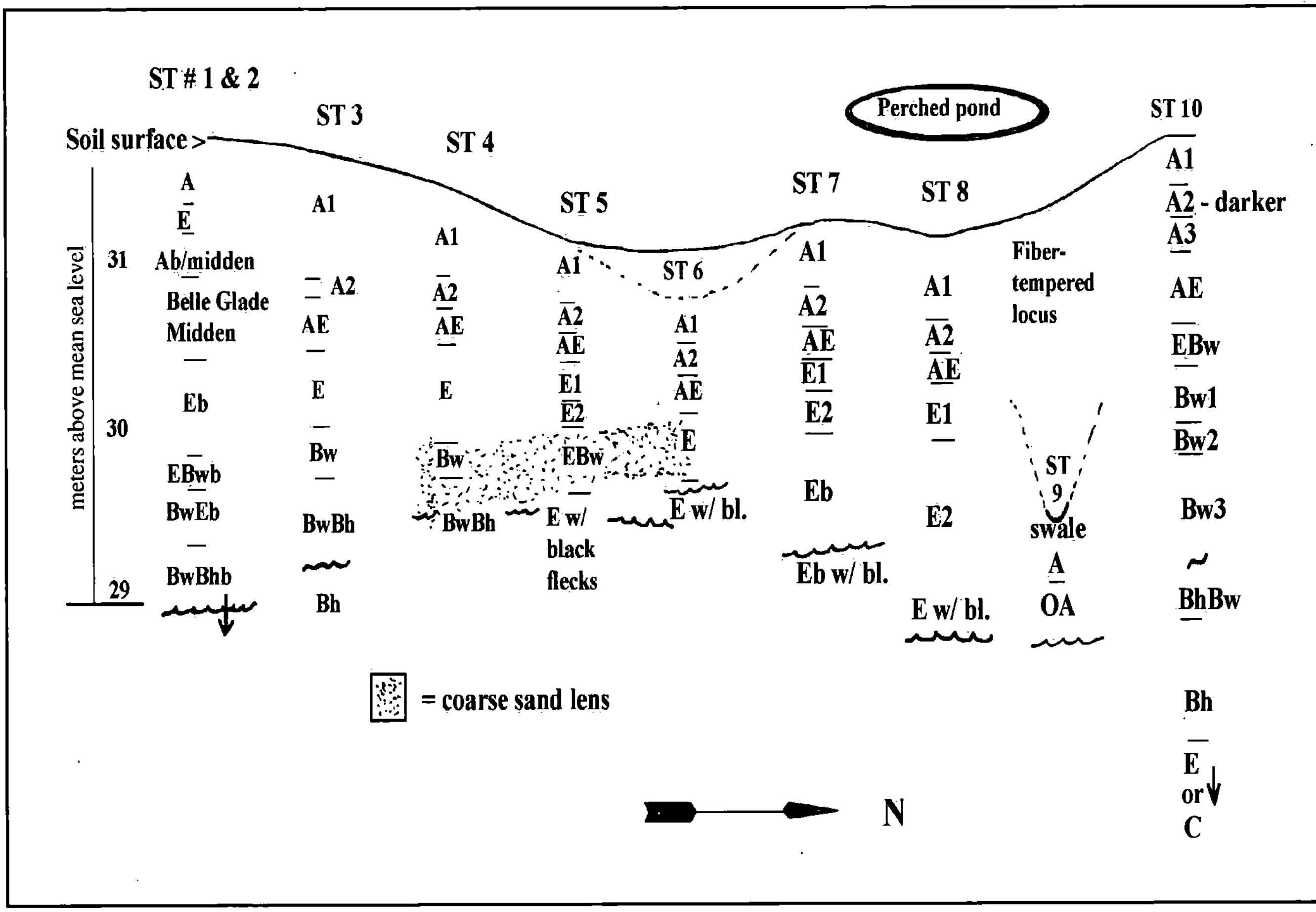

Figure 5. Cross-sectional profile of long axis of site.

sediments and not in flat, horizontally bedded ones. The midden itself was deposited on this sloping landform.

Other variations in the "subsurface landscape" begin to address the relationship between the buried Belle Glade midden and the northern end of the site with its older, fiber-tempered sherds. The profile of the long axis of the site indicates that, although the north and south ends of the site are now connected by a slightly concave stretch of ground, in the past they may have been less directly connected and were certainly separated by more relief.

At the north end of the site, a deep sequence of gray-to-brown soil horizons can be seen. The gray A and AE horizons change with depth, first to the brown Bw horizon and then to the very dark grayish-brown Bh horizon. The Bw horizon is tinted by iron oxides, very small amounts of which can color the stripped "white" sand grains brown or red. These colors can develop only in well drained soils. The humic-stained Bh horizon is composed of sand grains coated with a combination of aluminum oxides and organic carbon, both transported by a fluctuating water table. As with the Bw horizon, the Bh horizon must have formed under at least partially aerobic conditions. In addition, the Bh horizon at ST #10 is underlain by a second E horizon 4 m below the surface, indicating a second round of horizon differentiation under the influence of a lower water table. This profile presents evidence of a soil that has undergone extensive pedogenesis on a very stable land area under well-drained conditions.

At the south end of the site the soil also shows signs of long-term development under conditions favorable to the formation of a Bh horizon. However, between the north and south ends of the site, some interesting subsurface transitions have occurred. No B horizon of any kind was found in the central area. The deepest E horizon in this central area consisted of stripped quartz grains with black organic carbon flecks suspended in the soil water. The zone of saturation itself was closer to the surface than at either end of the site, and terminated in the "E with black flecks" horizon at each test. The lack of a B horizon means that conditions were never sufficiently drained for the oxidizing or accumulative part of the horizon-formation process to occur. These lower levels probably were always saturated and more related to the prairie edge than the sand ridge. In addition, one of the most abrupt particle-size distribution changes occurred here. Coarse and very coarse sand content virtually tripled in a deep, centrally located lens-shaped area.

The coarse sand lens in the subsurface horizons, the slightly lower elevation of the ground surface in the center of the site, and the perched pond to the west of this area on the flank of the higher ridge suggest that the central area may have once been an area of drainage from the pond or a seep similar to the one now flowing just south of the site. This drainageway, or depression, would have been downhill from the higher, stable area around ST #10, including the locus that produced the fiber-tempered sherds. Across the way to the south, at the level of the Belle Glade midden, was another slightly elevated, stable area that would someday be populated by the Belle Glade inhabitants. In essence, what the subsurface soil horizons and local landscape features reveal is a picture of relationships no longer in existence: two relatively stable and well-drained end points separated by a lower swale or drainage and used at different times by different peoples—and all being slowly buried by sand.

FIRE AND CLIMATE CHANGE

The two intermittent A horizons found in unit 985N are traces of a thin surface accumulation of OC separated by varying thicknesses of charcoal-containing light gray sand. These partial horizons, coupled with the pale, poorly developed A1 horizon underlain by a darker, more enriched buried A, indicate a generalized and episodic burial of parts of the site by sand moving down from the higher ridge areas. Particle-size analysis indicates that most of the sand moved colluvially, or at least that sand of the same size-classes moved locally. Although there is slightly more silt in some surface horizons—indicating some aeolian input—the medium-sand fraction does not change. Consequently, there was no substantial importation, by wind, gravity, or human endeavor, of soil or sediments of a very different character from those that already existed on the site.

The particle-size data, coupled with the faint build-up of OC in the intermittent A horizons, the homogeneous distribution of fine charcoal in the A and AE horizons in unit 985N, and the absence of charcoal in the midden-buried horizons can be used to address the origin and nature of the charcoal-laden sand covering the Belle Glade midden. A reasonable scenario is this: 1) the landscape occupied during Belle Glade times (a period believed to be cooler and drier than today, see below), was subjected to fire and denuded of vegetation, 2) sand eroded down the ridge flank and was briefly stabilized by colonizing vegetation that began forming a thin A horizon, then, 3) area-wide fires swept the landscape again and the cycle was repeated.

Whether the fires producing the evenly distributed charcoal in the upper horizons of the Blueberry site soil were human- or lightning-induced is not within the scope of this study. However, studies of sea-level changes and their effects on climate in the Pleistocene and Holocene epochs are pertinent. Researchers have found evidence of low-amplitude sea-level oscillations worldwide, in beach-ridge sets (Tanner 1992), tropical ice packs (Thompson et al. 1988), zooarchaeological faunal samples (Walker et al. 1995), stable isotope ratios (Hodell et al. 1991), and wave-cut beach rock (Fairbridge 1961, 1974). As the more conservative view of a smooth sea-level rise gives way to multiple lines of evidence for a punctuated, episodic series of rises and falls, the timing of these episodes becomes more refined (Walker et al. 1995). Certain dates proposed by individual researchers for particular transgressive or regressive events in localized geographic areas begin to overlap with dates from other areas. One range of dates that correlates with a recent lowstand, the "Little Ice Age," is A.D. 1430 to 1850 [This range is according to Gribbin (1978); other authors broaden or contract the range according to regional data, e.g., Eddy (1977), sets the range at A.D. 1250 to 1920.] The calibrated radiocarbon date obtained from charcoal in the buried Belle Glade midden at the Blueberry site—A.D. 1410 to 1455 (Beta-83917)—falls within the Little Ice Age. Conditions in Florida during sea-level lowstands were generally cooler and drier. As sea level fell, fresh-water lake levels also fell, along with inland river discharge rates, rainfall volume from convective weather systems, and the subsurface water table (Widmer 1988). Plant communities adapted to more xeric conditions, becoming more vulnerable to the effects of fire and other disturbance. These conditions prevailed during the Belle Glade Period of habitation of the Blueberry site, circa A.D. 1430. On-site evidence of area-wide fires, in the form of intermittent soil surface horizons and well-mixed charcoal in the upper horizons, corroborates this interpretation of climatic conditions at that time.

Table 2. Chemical analyses, Blueberry Site (8HG678).

Unit/		Depth		Organic	Element content (mg/kg)									
Test	Horizon	(cm)	pH	carbon*	Ca	Mg	K	P	Mn	Zn	Cu	Na	Al	Fe
ST #1	A1	20	6.0	0.3	118.0	7.2	9.2	1.2	2.22	0.72	0.04	1.4	12.9	6.64
	A3	70	4.3	0.6	275.0	5.7	3.1	4.4	0.79	1.53	0.00	2.4	30.6	6.39
	E	150	4.6	0.1	27.1	0.9	0.0	0.9	0.26	0.30	0.00	0.7	7.2	6.46
	BwBh	290	4.0	0.6	113.0	19.9	6.9	18.7	0.89	1.87	0.00	1.2	158.0	6.76
ST #2	A	20	7.3	1.0	1370.0	102.0	200.0	141.0	24.90	5.79	0.00	8.6	23.7	1.46
	El	60	6.8	0.3	196.0	12.8	3.0	4.2	0.93	0.85	0.00	0.7	5.4	0.80
	AB1	80	6.7	0.3	223.0	13.7	4.6	8.1	1.10	0.95	0.00	0.3	5.8	0.92
	Mid/Eb	140	5.8	0.3	405.0	11.6	1.0	108.0	4.86	3.35	0.00	3.7	24.2	5.32
	Eb	160	5.7	0.2	81.6	3.0	0.2	15.2	1.61	1.04	0.00	0.8	5.6	3.29
	BhBw	300	4.3	0.6	60.3	13.0	6.9	77.8	1.04	0.69	0.00	1.7	447.0	5.62
ST #3	A1	20	6.3	0.7	2190.0	57.1	15.1	581.0	6.90	11.00	0.01	12.8	48.3	2.43
	A2	80	6.1	0.3	337.0	16.9	1.7	14.2	0.44	0.65	0.02	0.7	9.6	1.75
	E	150	5.7	0.2	71.8	3.6	0.0	6.6	0.52	0.54	0.00	0.3	5.0	2.57
	Bh	260	4.5	0.3	87.0	7.2	2.6	22.1	0.52	0.64	0.00	1.3	85.4	2.98
ST #4	A1	25	6.5	1.0	2720.0	82.9	19.6	687.0	3.96	10.90	0.00	12.9	54.5	3.24
	AE	75	6.4	0.3	237.0	6.7	0.1	28.9	0.78	1.04	0.00	0.7	5.5	1.30
	E	115	6.2	0.2	72.4	3.0	1.5	6.3	0.48	0.84	0.00	1.0	2.1	1.14
	EBw	155	5.8	0.2	54.8	2.1	0.0	16.1	0.20	0.47	0.00	0.3	23.1	4.62
	BwBh	205	4.8	0.3	168.0	10.9	2.9	26.5	1.21	1.27	0.00	1.4	71.1	2.47
ST #5	A1	20	5.9	0.9	1190.0	75.1	7.6	28.3	2.16	8.32	0.01	1.8	29.5	1.77
	El	80	5.5	0.2	50.6	3.3	1.3	0.4	0.10	0.39	0.02	0.6	2.3	2.95
	EBw	130	5.4	0.2	28.6	2.1	1.5	0.5	0.20	0.40	0.04	1.0	3.3	3.97
	E	210	4.6	0.1	47.7	5.2	3.4	0.7	0.39	1.35	0.01	1.4	5.4	1.75
ST #6	A1	20	5.7	0.2	738.0	48.1	8.4	13.8	9.10	8.40	0.03	1.3	21.0	1.54
	E	80	5.7	0.2	36.7	2.8	1.2	1.0	0.25	0.36	0.00	0.3	1.3	1.34
	E w/bl	140	5.7	0.1	92.7	8.1	2.9	0.8	1.65	2.22	0.01	1.2	3.2	3.65
ST #7	A2	20	4.6	0.5	171.0	26.9	2.8	0.2	0.51	0.84	0.00	0.8	17.1	3.95
	E	100	4.9	0.2	38.2	2.8	3.0	0.1	0.76	0.63	0.00	0.7	1.7	1.86
	Eb	180	4.6	0.2	18.2	3.9	0.8	0.0	0.48	0.54	0.00	2.4	2.0	2.50
	E w/bl	230	4.7	0.2	24.7	5.7	2.0	0.0	0.62	3.43	0.00	2.2	1.9	2.19
ST #8	A1	20	5.9	0.5	617.0	32.0	12.7	1.3	5.52	3.12	0.00	2.6	13.0	1.50
	AE	80	4.9	0.2	53.9	6.0	9.9	0.3	0.44	0.28	0.03	1.7	5.4	3.26
	E	150	5.2	0.1	20.1	1.8	0.3	0.0	0.14	0.22	0.00	0.6	1.5	1.77
	W w/bl	280	4.9	0.2	10.9	3.6	2.8	0.0	0.32	0.37	0.00	1.4	1.4	1.78
ST #10	A1	20	5.0	0.7	296.0	22.5	11.7	2.3	5.34	0.74	0.00	1.9	18.0	3.99
	AE	80	4.6	0.2	30.2	4.8	2.4	0.2	0.19	0.21	0.00	0.8	13.5	5.78
	EBw	140	4.6	0.2	19.6	2.5	0.7	2.5	0.83	0.36	0.00	1.9	16.4	11.70
	Bw2	200	4.4	0.3	18.8	2.4	0.4	47.8	0.37	0.40	0.00	8.2	114.0	54.40
	Bh	380	4.5	0.5	41.1	9.6	3.2	39.1	1.74	1.18	0.00	3.2	268.0	8.88
	E'	400	4.6	0.2	21.8	5.8	3.2	11.2	0.62	1.76	0.00	2.9	61.4	5.99

*Organic carbon is recorded as weight%.

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