III. PALEOENVIRONMENTAL HISTORY AND ARCHAEOLOGY IN THE RUSSELL LAKE AREA

THE PHYSICAL ENVIRONMENT

The Savannah River, extending from the Blue Ridge to the Atlantic Ocean, is one of the major drainages of the South Atlantic Slope, lying near the transitional area between the Atlantic and the Gulf coastal watersheds. The basin is approximately 320 kilometers in length and covers 10,600 square kilometers. The basin is comparatively narrow, draining a much smaller extent than the two major drainages that flank it, the Santee to the northwest and the Ocmulgee to the southwest. Formed in the Appalachian Mountains by the confluence of the Tugalo and Seneca Rivers, the river flows in a linear course from northwest to southeast to the Atlantic. Several fairly extensive tributary streams enter the river, including (from north to south) Rocky River, Broad River, and Little River in the piedmont, and Upper Three Runs, Lower Three Runs, and Brier Creek in the coastal plain.

The Richard B. Russell Multiple Resource Area is located in the central portion of the piedmont physiographic province, in Elbert and Hart Counties, Georgia and Abbeville and Anderson Counties, South Carolina. The maximum floodpool covers 26,650 acres, along an approximately 28 mile stretch of the river between the headwaters of Thurmond Lake and the dam forming Lake Hartwell. The Russell dam site is 275.1 river miles upstream from the mouth of the river, 29.9 miles below the Hartwell Dam, and 37.4 miles above the Thurmond Dam. The elevation of the maximum floodpool is 457 feet above mean sea level, with 546 miles of shoreline. Portions of several major tributaries inundated by the reservoir, proceeding from south to north, include Beaverdam Creek, Rocky River, Van Creek, Allen Creek, Coldwater Creek, Pickens Creek, Cedar Creek, Little Generostee Creek, and Big Generostee Creek.

In the area of the Russell Reservoir the channel was deeply incised. The floodplain was comparatively narrow and well defined, with islands, shoals, and small waterfalls common (Hall and Hoyt 1905). Major shoals in the reservoir area, proceeding from north to south, included:

> Turners Shoals, with a fall of 17 feet in two and a half miles, (2) Middleton Shoals, with a fall of 11 feet in one and one quarter miles, (3) Gregg Shoals with a fall of seven feet in one mile, (4) Cherokee Shoals with a fall of 19 feet in three miles, and (5) Trotters Shoals with a fall of 69 feet in six miles (Hemmings 1970:5-6).

Floodplains rarely extended more than 250 meters to either side of the channel, with fairly steep hills rising abruptly at the edge of the floodplain, to elevations of 100 feet or more above the floodplain. The piedmont is an eroded peneplain, and at

Trotter's Shoals the river formerly lay about 170 feet below the upland surface.

Floodplain soils were highly prized by early settlers in the upper Savannah River (McClendon 1910; Wood et al. 1986:8). Prior to the extensive farming and land clearing associated with historic settlement, floodplain soils were highly fertile and easily tilled "brownish or black sandy loam to loam" (McClendon 1910:24). Beginning in the early nineteenth century clearing of the upland accelerated tremendously, resulting in extensive sheet erosion, increased flooding, aggradation of stream beds, and extensive scouring or deposition in floodplain areas (Trimble 1969). Formerly fertile floodplain soils were either scoured away or buried under coarse sands on terrace crests and progressively finer sediments away from the crests; in slackwater environments thick clay deposits that impede fertility have built up (Campbell & Weed 1984:8-9).

PALEOVEGETATIONAL COMMUNITIES

The initial human occupation of the upper Savannah River area in all probability occurred between 15,000 and 11,500 years ago, during the Late Glacial era. During this interval sea level was much lower than at the present, up to 70 or more meters, and the Atlantic and Gulf shorelines were considerably seaward of their present location. As the continental ice sheets retreated in the north, water was returned to the oceans, and large sections of the continental shelf were inundated; by 9,000 B.P. sea level was within a few meters of its present stand. Widespread extinctions accompanied these environmental changes in North America, specifically the loss of 33 genera of large mammals, including the Equidae and Camelidae (horses and camels), and all the members of the order Proboscidea (elephants) (Martin 1984:361-363). Contemporary analyses indicate that these extinctions were complete by ca. 10,000 years ago (Mead and Meltzer 1984:447), shortly after widespread evidence for human settlement appears in the New World archaeological record. The relationship between these human and animal populations is a matter of considerable controversy (Martin and Klein 1984). While human predation of megafauna has been conclusively demonstrated at a number of locations, most notably in the southwest and on the Great Plains, to date only minimal evidence for megafaunal exploitation has been recovered from the eastern United States (Clausen et al. 1979; Webb et al. 1984).

Recent broad-scale paleoenvironmental analyses from the lower southeast indicate that a mixed oak-hickory hardwood forest was in place or rapidly emerging across the Southeast Atlantic Slope by ca. 10,000 B.P. (Larson 1982:208-222; Cable 1982:671-683; Sheehan et al. 1985; Delcourt and Delcourt 1983:269, 1985:19; Delcourt et al. 1983). In the Late Glacial era (15,000 to 10,000 years B.P.), northern hardwoods (hemlock, oak, hickory, beech, birch, elm) began to replace the pine and spruce of the boreal forest in the Georgia Piedmont, temperatures were becoming less equable (i.e., warmer in summer and colder in winter), and precipitation was increasing (Watts 1980; Holman 1982, 1985a, 1985b). Holman (1982:162) notes the coexistence in late Pleistocene (10,500-11,000 years B.P.)

deposits in northwest Georgia of tropical species such as the giant land tortoise and armadillo, and boreal species such as the spruce grouse. He argues that a more equable environment, with milder winters and cooler summers, must have existed in northern Georgia during the late Pleistocene (Holman 1982:162; 1985b:569). The vegetation mosaic of the late glacial period was replaced by a more evenly distributed and denser forest, with pine and oak gradually colonizing areas that were previously unforested.

South of 33 N latitude, roughly the latitude of Augusta, there is evidence to suggest that this hardwood canopy was in place considerably earlier, perhaps throughout much of the previous glacial cycle (Delcourt and Delcourt 1983, 1985). In the region just to the north of latitude 33 N, the full-glacial boreal pine-spruce forest and patchy, park-like vegetation apparently quickly gave way to more mesic, mixed hardwood and oak-hickory communities following the glacial maximum; this transition is thought to have been largely complete by the early Holocene (Watts 1971:687, 1980:195; Delcourt and Delcourt 1981:145-150; Davis 1983:172-173). Only during the mid-Holocene Hypsithermal Interval, from ca. 8,000 - 4,000 B.P., did southern pine communities begin to emerge in the sandy interriverine uplands; this was also the period when extensive riverine swamps began to emerge (Wright 1976; Howard et al. 1980; Delcourt and Delcourt 1981, 1983; Delcourt et al. 1983; Davis 1983; Knox 1983; Segovia 1985; Foss et al. 1985; Brooks et al. 1986).

The late Pleistocene to Early Holocene vegetational matrix on the Southeastern Atlantic Slope was thus rapidly changing, trending from a patchy boreal forest/parkland towards a homogeneous, mesic oak-hickory forest. In ecological terms, the vegetational matrix was changing from immature, or coarse-grained, to mature, or fine-grained in structure (c.f., Pianka 1978). The best available evidence suggests that this transition was complete over much of the region by shortly after 10,000 B.P., and almost certainly by 9,000 B.P. Although traditionally viewed as a time of major paleoenvironmental change, the early Holocene on the lower Southeastern Atlantic Slope (prior to the Hypsithermal Interval) appears to have been characterized by stable regional oak-hickory vegetational communities.

Later, post-Pleistocene paleoenvironmental conditions in the upper Savannah River area were examined as part of an integrated multidisciplinary research program. The importance of the paleoenvironmental research undertaken in the reservoir, particularly in relation to the discovery and interpretation of archaeological materials, will be examined in some detail. There is little doubt, for example, that site preservation and visibility can be directly linked to the nature and extent of post-occupational depositional and other environmental processes. Prehistoric occupations in the reservoir area are common on stable land surfaces, (e.g., Segovia 1985; Anderson and Schuldenrein 1985). These same "stable" land surfaces may, however, due to gradual depositional rates, have comparatively shallow, compressed or mixed archaeological deposits. The reservoir investigations indicate that it is sometimes in the less stable areas, where rapid changes in depositional regimes can occur, that the most favorable (i.e., sealed, stratified) archaeological deposits may occur. The linkages that were made between the archaeological and paleoenvironmental research programs were a major contribution of the Russell investigations.

ENVIRONMENTAL ARCHAEOLOGY OF THE RUSSELL RESERVOIR

Introduction

One of the primary objectives of the Richard B. Russell studies has been to furnish systemic or cultural context to the extensive but often disjunct reservoir archaeological record. The need for an overarching framework in which to place the Russell Reservoir archaeological investigations stems from the numerous research themes and interests addressed by individual scholars, compounded by the unique nature of the resources that were under investigation for over a decade. While individual research interests often resulted in the productive investigation of specific themes, a potential liability in this approach lay in the absence of prospective "big picture" reconstructions.

To a large degree, the ecological and paleoenvironmental investigators were shielded from embarking on overly parochial research avenues. This development was due to the careful planning by the IASD and Savannah District archaeological staffs in the sequence by which contracts were awarded for paleoenvironmental studies. Accordingly, the baseline geomorphology, pedology, and paleovegetation studies were initiated in advance of the site specific investigations (Gardner 1984; Segovia 1985; Foss et al. 1985; Sheehan et al. 1985). The initial and subsequent Scopes of Work for the paleoenvironmental components, for all study areas, clearly prioritized the need to address the overall issue of ecological change through time. This objective injected a diachronic, regional focus to the research from the outset. Consequently, the paleoecological component for the synthesis had inherent advantages that enabled it to provide integrative parameters for the reservoir research program.

While no single discipline was exclusively relied upon to furnish the environmental and paleoenvironmental data bases, an examination of the site reports shows that the earth sciences contributed most strongly to composite sequences and reconstructions. All the study areas that were investigated in any detail involved major inputs from the fields of geomorphology, pedology, and geoarchaeology. Paleovegetation studies were employed at selective sites and performance of floral and faunal analyses were necessarily restricted to sites where remains were adequately preserved. This overview is thus based primarily on landscape and climatic models of environmental succession. A major advantage of the geoarchaeological investigations was that they went beyond environmental reconstruction to the study of site formation processes. At key sites it was also possible to link changes in the archaeological record to specific environmental factors.

The bulk of the paleoecological studies were undertaken at those sites that also contained the richest archaeological records. One of the primary objectives was to trace the synchroneity in archaeological and environmental developments, initially within individual sites and subsequently between sites and over the extent of the reservoir. In this way it would be possible to describe systematic change through time for a major and dynamic component of the southeastern riverine network. Finally, it was hoped that a comprehensive appreciation of human ecological dynamics along the Savannah River would assist in understanding the larger scale changes occurring across the greater southeast.

The Contemporary and Historic Landscape

The overall attractiveness of the Middle Savannah River Valley is explicable in terms of the mix of physiographic, geologic, and biotic components of the contemporary landscape. The unique geography of the piedmont plateau must have played a role in drawing aboriginal people to the valley. The piedmont province extends north-south for approximately 80 miles, separating the Blue Ridge Mountain province to the north and west from the southeastern coastal plain. Technically the piedmont is the "non-mountainous portion of the older Appalachians" (Fenneman 1938) and its plateau surface formed as a result of degradation. The plateau generally slopes from the mountains eastward toward the coastal plain. Inner piedmont topography in Georgia and the Carolinas is relatively rugged and semi-mountainous. The relief is attributed to both the presence of abundant monadnocks near the mountain front and the relatively steep slopes at the headwaters of the major streams emptying east and southeastward into the coastal plain (Aniya 1970). The mountains of the inner piedmont are extensive and are clearly separated from each other and from the Blue Ridge chain by deeply incised valleys.

The eastern piedmont boundary is structurally delimited by a zone of igneous rocks underlying sedimentary rocks of the coastal plain. In most places, the juncture is a zone of steeper hills and downcutting channels that grades to the gentler slopes and more broadly spaced streams of the coastal plain. The zone broadly trends along a northeast-southwest axis and is referred to regionally and along the Atlantic Slope as the fall line. The project area is completely contained within the piedmont province, but dramatic gradient breaks are typical and have been invoked to explain turbulent channel behavior and major erosional surges (Paterson 1889; Kennedy 1964; Trimble 1974).

River Morphology and Evolution

Locally, the most extensive topographic features are broad divides separating major tributaries from the Savannah River. These consist of gently rolling ridges with rounded crests and uneven slopes that may often be abrupt and discontinuous. Perennial as well as intermittent streams have incised below ridge crests, but there are tracts of smooth and level land generally underlain by granite bedrock. In general, topography slopes from the northwest to the southeast. Elevations near the Savannah River range from approximately 400 ft.

to 350 ft. (120-110 m). Steeper slopes are characteristic of the terrain fronting the Savannah floodplain. In the lower portion of the Russell basin, higher elevations and steep slopes have given rise to pronounced headcutting and slope back wearing.

It is noteworthy that the confluences of the major basin tributaries with the Savannah are often associated with diagnostic alluvial landforms that supported prehistoric sites. Along the project area the most elevated alluvial landform has been identified as a terrace-levee, or T-1 surface, registering the principal depositional events in the central Savannah drainage over the past 15,000 years. Stream activity is the prime geomorphic process that has modified the piedmont landscape and relief in Quaternary times. The multiple drainages form a dendritic network and flow primarily in a southerly or easterly direction. Most of these streams are actively incising their channels at present. In most tributary valleys interfluves are sharp and narrow as they abut narrow floodplains along upstream reaches, but topographic gradation is typical below the fall line and near the mouth where alluvial fills thicken and widen.

Across most of the Russell project area the river ranges in width from 80 to 120 meters (Segovia 1985). Variable width and stream flow patterns reflect lithological and structural constraints, but frequent channel migration is characteristic. Sinuosity is not especially high, however, and an index of 1.13 has been calculated for the linear valley distance for the central site distributions (Anderson & Schuldenrein 1985:12); this is well below the meander stream threshold of 1.5 (Leopold et al. 1964). The evidence suggests that bedrock controls are most critical in maintaining channel regimen; regionally, Segovia (1985:6) proposes that "the bedrock valley is narrow enough that the meanders cannot increase their amplitude or sweep down the valley with total freedom."

Current interpretations of valley morphology indicate that the pre-Holocene valley history was characterized by a single sedimentary cycle. The initial period of deposition, of probable Sangamon age, is represented by a thin gravel accumulation capped by a six-meter thick sand aggradation (Carbone et al. 1982). This was succeeded by a late Wisconsin incision episode that scoured out the clastic fills but left exhumed terraces and isolated island remnants.

In this report terrace-levee features refer to the present elevated (T-1) surfaces rimming the contemporary Savannah River channel and these are 3-4 m above low water levels. In general, semi-continuous outcrops of the terrace-levee run the length of the valley axis of the study area with only minor changes in relief. As the homogeneous dispositions of raised alluvial T-1 surfaces would indicate, the channel gradient of the Savannah is relatively smooth and gentle, sloping at approximately 1 m/km. Below the Rocky River confluence, however, gradient changes to 3.75 m/km, a function of a base level knick point, related to either a Tertiary sea level stand or tectonic activity. Locally, channel steepening on the order of 3 m/km has been documented for a 300 m stretch between McCalla and Carter Islands, at sites 38AB288 and 9EB76, and this may explain the poorly drained settings at the former site (Segovia 1985:32).

After the late Wisconsin, the T-1 terrace-levee began to assume its present morphology; up to 4 meters of sediment built up the landforms that have been dated to the late Pleistocene/Holocene transition (Carbone et al. 1982): Geoarchaeological investigations at numerous project area sites have documented the variable nature and magnitude of subsequent alluviation episodes during the Holocene, but in general these episodes only augment landscape stability. A fining in sediment particle size upward in the sequence underscores the overall trend to geomorphic equilibrium. Over the course of the Holocene net accretion along most floodplain tracts was on the order of one to two centimeters per century; this has been demonstrated by independent researchers (Upchurch 1984; Anderson & Schuldenrein 1985; Segovia 1985:Plate 20).

Significant changes in the alluviation regime were generated in historic times due to the effects of dam regulation. Studies at Rucker's Bottom (9EB91) have shown, however, that since the Hartwell Dam began functioning in 1955 the general effect of dam activity has been to reduce the net sedimentation rates by up to one-half (Anderson & Schuldenrein 1985:Chapter 10). Examination of historic discharge records show that the well-bedded medium sandy alluvium that effectively sealed the late prehistoric Mississippian middens at reservoir sites such as Clyde Gulley, Rucker's Bottom, and Harper's Ferry is probably assignable to the last major inundations of 1908 and 1928. Average annual discharge rates are on the order of only 5,000-8,000 cfs along the central Savannah. Studies at sampling stations along the Broad River, a key tributary, show that daily discharges vary from September lows of 500 cfs to February-March highs of >8,000 cfs; particle size distributions of flood sediment are comparable with those analyzed in these historic alluvial fills at the Russell sites (see Kennedy 1964:Tables 5 and 6). Compared to the coastal plain reaches of the Savannah (Brooks et al. 1986), sediment yield along the piedmont stretch is on the order of 5 to 20 times higher, so that historic period sedimentation is expectedly widespread and abrupt block-like depositions of bedded medium sands are typical.

Probably the most conspicuous explanation for high sedimentation in the piedmont results from extensive erosive land use associated with European farming activities since the early eighteenth century (Trimble 1974). It has been estimated that an average depth of 7 inches has been stripped from native piedmont soil mantles by human-accelerated erosion, and these sediments have been differentially redeposited on the terrace-levees downstream.

Local Geology

The geological setting of the Savannah River is complex, due largely to the deep weathering of most of the rock types. The paucity of diagnostic outcrops of sedimentary and metamorphic rocks makes them difficult to study as well. Several major regional studies have been undertaken, including those of Georgia piedmont monadnocks (Aniya 1970), the pre-Recent surfaces (Dennis 1971), and the geology of Elbert County (1965). The most comprehensive geological study summarizes the structural and lithological history of South Carolina (Overstreet and Bell 1965), which has also served as a baseline study for mapping of the Georgia piedmont formations (DNR 1976). Figure 10 shows the distribution of the principal geologic belts and metamorphic facies in the reservoir area.

Across the piedmont, rocks are generally banded in northeast trending belts (Overstreet and Bell 1965), and the Russell study area incorporates portions of the Inner Piedmont, Charlotte, and Kings Mountain belts. The entire basement complex consists of metamorphic and igneous rock of Paleozoic and perhaps even of Pre-Cambrian age. Major periods of deformation occurred in early to late Paleozoic times, although limited deformation is ongoing, as evidenced by the sensitivity of the Charleston area to earthquake activity. Lithologic descriptions of the principal belts and facies follow.

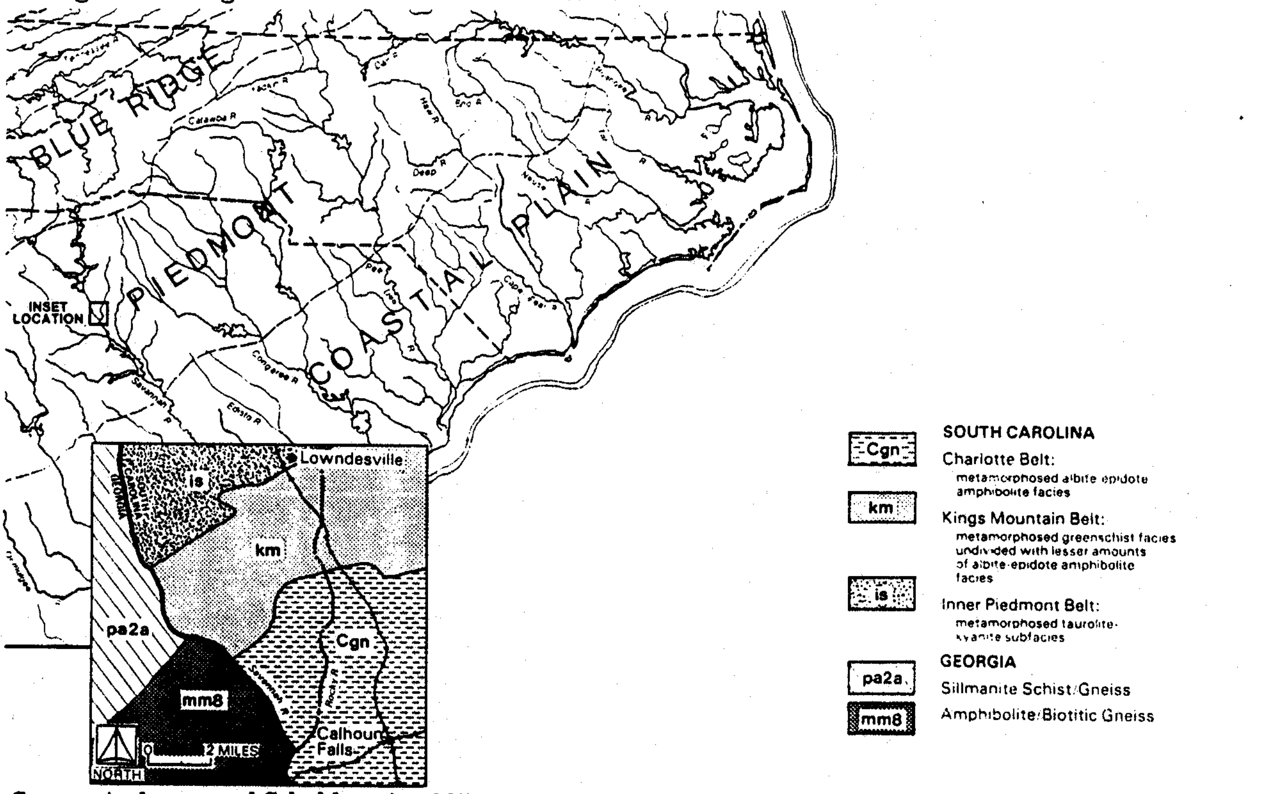
The Charlotte Belt consists principally of metamorphosed granitoid gneiss including gneiss, migmatite, and schist of the albite-epidote-amphibolite and amphibolite facies. These rocks are mostly granitoid in texture with strong compositional layering suggesting sedimentary origin, possibly from the Carolina Slate Belt which lies to the south under the coastal plain. The Kings Mountain Belt is well delineated and contains hornblende schist, sericite schist and small amounts of quartzite and marble. The metamorphosed hornblende schist unit contains hornblende schist, hornblende gneiss, actinolite gneiss, chlorite schist and marble. The Inner Piedmont Belt includes plutonic schists and gneisses that are intruded by igneous rocks of gabbroic to granitic character. The boundaries of this belt are not clearly defined and the high degree of metamorphism has made the interpretation of origin and geologic history difficult.

The deposition of the major rock formations and their subsequent metamorphism and igneous activity has been tied to the evolution of a continental margin that underwent subduction followed by uplift and isostatic stabilization (Segovia 1985). The widespread and patterned distribution of the metavolcanic and metasedimentary rocks is critical to the archaeological research as it affected lithic resource exploitation strategies. These concerns are most evident in the examination of changing lithic resource preferences at particular sites.

Soils

Soils of the Savannah River Valley have evolved in both upland and alluvial settings. At most sites alluvial profiles are the norm as they are associated with present or ancient floodplains. The processes of upland pedogenesis are critical, however, since colluviation and redeposition of slope and bluff deposits have affected the weathering patterns in terrace-levee milieus. In general, upland profiles formed in regolith weathered from parent materials of the three principal lithologic belts described above. Most dominant rock types are mica gneiss, hornblende gneiss, mica schist, massive and weakly foliated granite and gabbro, and diorite cut by dikes or minor intrusions. Foss et al. (1985) claim that soil profile characteristics including type and degree of horizon expression, profile thickness, color and amount of clay are influenced principally by the proportion of felsic and mafic minerals and the amount of quartz.

Geological Setting of the Richard B. Russell Reservoir.



Source: Anderson and Schuldenrein 1985:14

Correlation of Geologic, Pedologic and Archeo-Stratigraphic Units Across the Richard B. Russell Study Area.

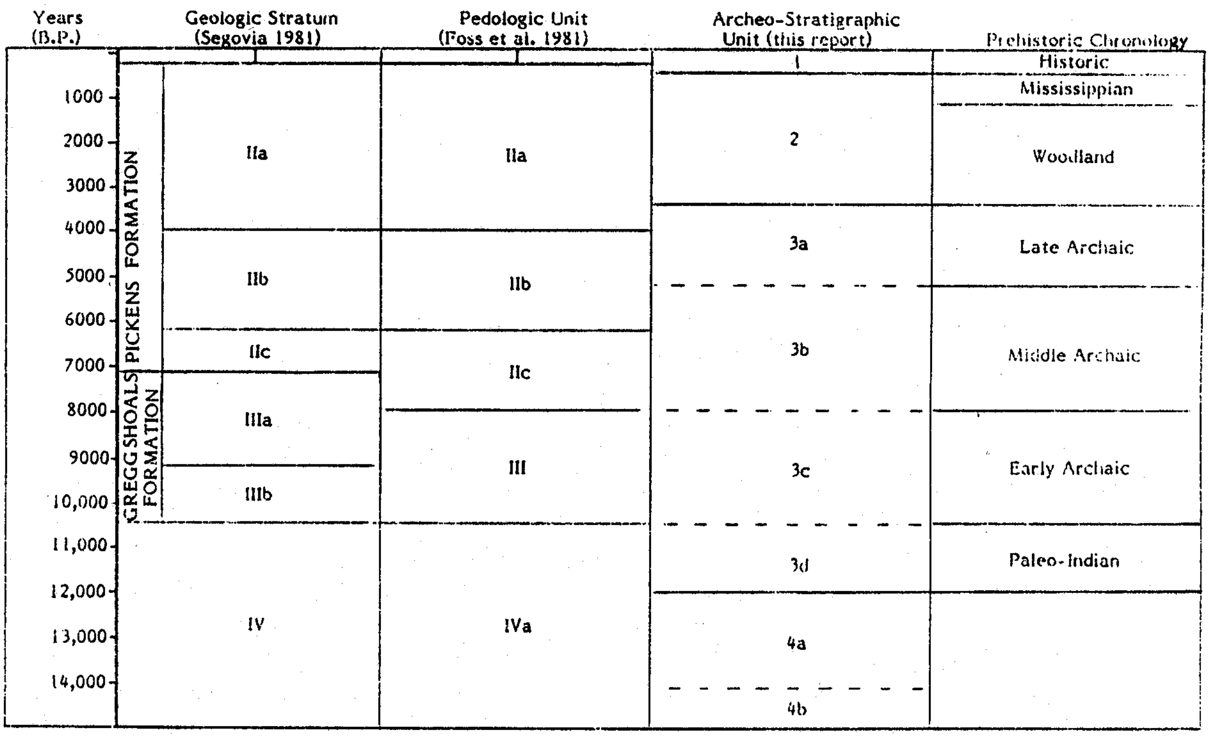


Figure 10. Geologic Formations and Stratigraphic Units, Richard B. Russell Reservoir Area.

In general, lowland soils are formed in floodplain fills variously reworked by stream or colluvial agency from initial upland settings. Profiles are variable, usually consisting of brown fine sandy loam underlain below 13-20 cm by yellow or brownish fine sandy loam which is often mottled due to periodic groundwater saturation. Thin lenses of sand, silt loam and clay loam occur at depths below 150 cm. These soils are deep, nearly level to gently sloping, well and poorly drained, and are subject to flooding at least once every 5 years. They occur on narrow to moderately broad terraces along the Savannah River and larger secondary drainages (Frost 1979, Herren 1980).

The upland soils have developed principally as a result of residual saprolitic weatherings of gneiss, mica schist, diorite, gabbro, granite and other basic or acidic igneous rocks. Subsoils are commonly reddish, yellowish or brownish clays, clay loams or gravelly clay loams. Surface textures are usually sandy loams with some areas of gravelly or sandy clay loams. The upland soils are deep to shallow, well drained, and are positioned on broad to narrow upland ridges, complex side slopes and the upper reaches of numerous small drainages. Slopes vary from very gently sloping to steep (about 40 percent) (Frost 1979, Herren 1980).

Most of the archaeological sites that saw extensive examination in the reservoir are terrace-levee settings associated with sandy substrate and Entisol profiles displaying minimal pedogenic alteration. Profile thicknesses typically range from only 30-60 cm in depth before encountering late prehistoric components (i.e., Woodland-Mississippian). Historic period sedimentation is not only minimal, but in most cases it can be linked to early twentieth century inundations since preserved foreset bedding structures, the signature of these flood deposits, are often sandwiched between two plowzones. At Rucker's Bottom, Clyde Gulley, and Harper's Ferry sites a sequential stratification of prehistoric components was observed terminating in the Mississippian midden. Overlying that stratum was a historic plowzone overlain by flood-related sand deposits. The midden/plowzone interface defines a geologic unconformity, indicating a 300-400 year erosional interval.

Land Use

The depositional gap and minimal preservation of relict landforms in the Russell reservoir area is consistent with Trimble's (1974) documentation of the southeastern piedmont as one of the most severely eroded agricultural areas in the United States. His research showed that the Elbert-Abbeville County areas experienced the most accelerated erosion due to cotton based land use in the late eighteenth and nineteenth centuries. Accordingly "...especially in Regions III and IV (Elbert and Abbeville counties), erosional debris filled streams and covered floodplains" (Trimble 1974:129). Presumably the redeposition occurred downstream of the area studied, probably below the fall line at Augusta where the floodplain widens. Comparison of 1979-1980 mean flood discharge data at a piedmont gauging station (at Calhoun Falls, South Carolina) with that at Augusta shows that at Augusta rates are up to 1.5 times higher (USDI 1980).

The disposition of the terrace-levee landforms in the reservoir area is also in accordance with an upstream-erosion downstream-deposition model, since they do not comprise an extensive concave-convex floodplain that is being actively flooded. Effectively there is no distinctive T-O surface along the central Savannah. It has either been differentially eroded by the regulatory effects of dam operation or it has been gradually worn away by the scouring and migratory regimen of a Savannah channel that has been in an erosional epicycle for the past few hundred years. Perhaps both explanations are responsible, but it would appear that the clearing-induced erosion since 1700 has had as much if not more impact on the transformation of the landscape systems than any previous cycle.

The impacts of prehistoric land use are, of course, difficult to assess, but Trimble (1974:22-32), citing European and colonial accounts, concludes that pre-contact erosion was minimal. This trend may be traced as far back as the early Holocene, based on studies at Gregg Shoals and Rucker's Bottom, where records of continuous prehistoric occupation were preserved (Upchurch 1984; Foss et al. 1985; Anderson and Schuldenrein 1985). Well stratified deposits for each major Archaic stage are interdigitated with diagnostic alluvial fills at these sites, demonstrating that stream aggradation was the dominant fluvial process for most of the Holocene, as each succeeding deposition sealed in a previous occupation horizon. These optimal preservation conditions characterizing the Archaic deposits at sites in the reservoir may be closely linked to regional climatic conditions. There is a tendency for streams in humid continental environments to aggrade, and hence bury and preserve cultural deposits during such major dry intervals as the Hypsithermal (8,000-5,000 B.P.), which spanned the Middle Archaic (see Schumm 1977). The field evidence clearly supports Trimble's (1974) hypothesis that no climatic fluctuations during the past 10,000 years were severe enough to cause massive removal of the vegetation cover and give rise to the magnitude of erosion that was initiated in early historic times. The fact that sustained deposition occurred along the ancient (i.e., early-middle Holocene) banks (= terrace-levees) of the Savannah may indicate not only that the post-Pleistocene channel was largely an aggrading stream, but also that during minor erosional epicycles the central Savannah constituted a minor sediment trap for redeposition of eroded upstream sediments. These epicycles may even have been associated with localized tectonic events that occurred in the study area (Segovia 1985:16).

Obviously, historic agricultural land use had extreme impacts on landscape stability in the piedmont. Documentation of the effects of this activity along the Savannah in particular is somewhat limited, but an incisive account has been offered by Paterson (1889) in a historic study of the destructive effects of Savannah River flooding. His account notes that most flood damage tended to occur immediately downstream from the project area, at the Broad River confluence. Since 1796 major floods, or those topping 6 ft. (ca. 2 meters) had occurred in 1840, 1852, 1876 and 1887. In an indictment of the land management practices of the day, which he claims were virtually nonexistent, Paterson (1889:13) traced the seemingly unpredictable floodlevels along various reaches of the Savannah to cumulative discharges produced by the parent Savannah and its principal arteries. To counter erosion, Paterson recommended systematic terracing along the most prominently affected channel reaches. In spite of his recommendations extensive terracing was not adopted as a major mitigative strategy, as federal planners opted for reservoir building. Paterson's (1889) account among select others (see Stokes 1951 for references) does provide insight into the persistent effects of Savannah stream activity during the era of optimal erosive land use regionally when cotton farming was in its heyday. Trimble (1974:130) notes that with the agricultural decline in the early twentieth century and the adoption of soil conservation practices, erosion has decreased markedly in the piedmont and landscapes have stabilized correspondingly.

Vegetation and Floral Communities

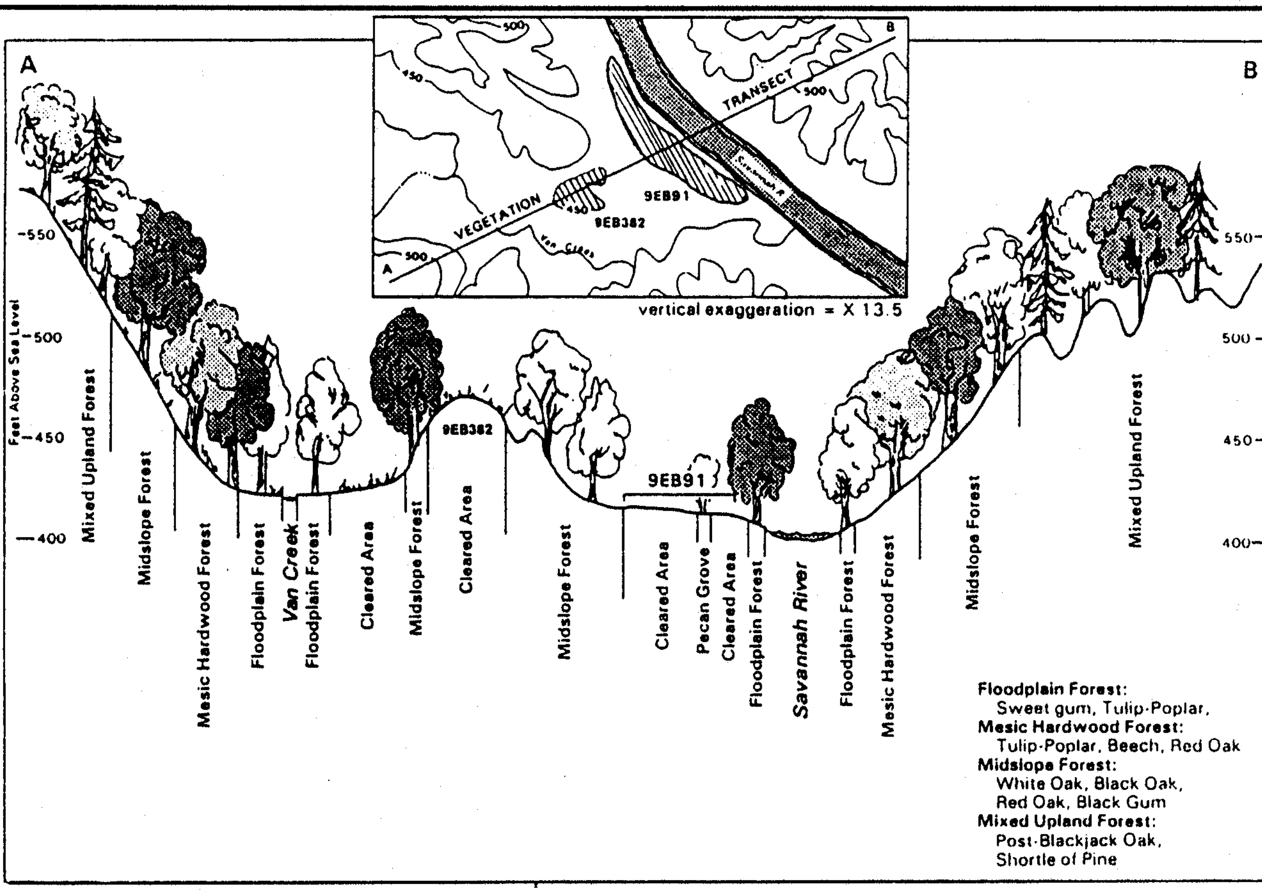
The following account attempts to link distributions of contemporary floral and faunal communities with those topographic and landscape gradients constituting the present regional ecosystem. The Savannah River study area lies at the front of a sensitive physiographic ecotone: the transitional province of the Oak-Pine Forest (OPF) and Southeastern Evergreen Forest (SEF) (Waggoner 1975). It has been emphasized that regional boundaries with respect to vegetation distributions

> ...are so indistinct that they can be but arbitrarily drawn... this is a transition belt where the ranges of trees of the central hardwood forest and of the evergreen forest of the southeast overlap (Braun 1950).

Consequently, vegetation distribution and dynamics are best understood on the local scale.

Most of the study area lies in the Oak-Pine Forest (Braun 1950). This region extends as a broad belt about 130 miles wide from southern New Jersey south to Georgia and then west to eastern Texas. On the east coast of the United States, Oak-Pine Forest extends across the coastal plain and piedmont north of the James River of Virginia and over the piedmont south of the James River.

Along the central Savannah Valley, principal upland arboreal species are post oak (*Quercus stellata*), white oak (*Quercus alba*), loblolly pine (*Pinus taeda*), short-leaf pine (*Pinus echinota*) and southern red oak (*Quercus falcata*). Bottomland and mesic arboreal species include sweet-gum (*Liquidamber styraciflua*), tulip-poplar (*Liriodendron tulipifera*), river birch (*Betula nigra*), willow oak (*Quercus phellos*), beech (*Fagus grandifolia*), red oak (*Quercus rubra*), southern silver maple (*Acer saccharum spp. floridanum*), and ash (*Fraxinus spp.*). Figure 11 illustrates the typical relationship between topographic and vegetational gradients in the vicinity of site 9EB91.



<u>Full Glacial</u> (22,000-18,000 years B.P.)

In the uplands this period was characterized by a very cool climate. Spruce and fir were not common in the vegetation but were present in the Piedmont, probably in special microhabitats. Pine was the dominant tree in the patchy forests. Oak was uncommon as were most deciduous trees. Herbs were much more important in the vegetation than in modern times. Their abundance and diversity, and the presence of several taxa with "boreal" affinities, give the impression of a parklike vegetation interrupted frequently by patches of trees and shrubs. The lowlands at this period are not represented at our pollen sites.

<u>Late Glacial</u> (18,000-12,000 years B.P.)

A decrease in the extent of pine dominance occurred, accompanied by a decline in the fir and spruce populations. Oak and hickory replaced these species to some extent, reflecting increased warmth. The continuation of high percentages of herbs and shrubs suggests that the increased warmth was not accompanied by increased precipitation. Towards the end of this period pine dominance was reestablished at the expense of oak and hickory. Shrubs became somewhat less important, but herbs remained a prominent feature of the generally open vegetation.

<u>Early Postglacial</u> (12,000-9,000 years B.P.)

In the Savannah River valley, pine, oak, and hemlock were the dominant trees. Spruce and fir were present locally. River birch, sycamore, and alder were important on the floodplains and streamsides. Chestnut was present, at least locally. In the uplands the forests gradually became denser with pine first, then oak colonizing the previously unforested areas. Hemlock was absent. Chestnut was present but not abundant.

<u>Mid-Postglacial</u> (9,000-4,000 years B.P.)

In the lowlands spruce, fir, pine, and hemlock rapidly decreased in importance, to be replaced by oak, gum, hickory, and other deciduous types. Toward 5,000 years B.P., birch replaced much of the oak, though probably just locally. In the uplands oak replaced pine forests to a large extent and was accompanied by gums, chestnut, and beech. Hickory became somewhat less important. Arboreal pollen values are maximal at this time, indicating very dense forest cover. Shrubs and herbs became minor components of the vegetation.

<u>Late Postglacial</u> (4,000 years B.P.-present)

In the Savannah River valley the vegetation from 1,320 years B.P. to an unknown later date is characterized by gradually declining populations of oak, ash, sycamore, and basswood, evidence of agricultural activity (maize, agricultural weeds), and, in the uppermost sample, an abrupt expansion of sweet gum and hickory populations. In the uplands this period is characterized by fluctuations in population sizes of pine, oak, and chestnut. Hickory and gums are generally unimportant here. Alder and ragweed become more important toward the end of this period, suggesting a thinning of the arboreal vegetation, possibly resulting from human disturbance (agriculture?). At no time is pine as important in the vegetation of this period as it is in other parts of the Southeast.

Sources: Anderson & Schuldenrein 1985: 24; Sheehan et al. 1985: 33-34

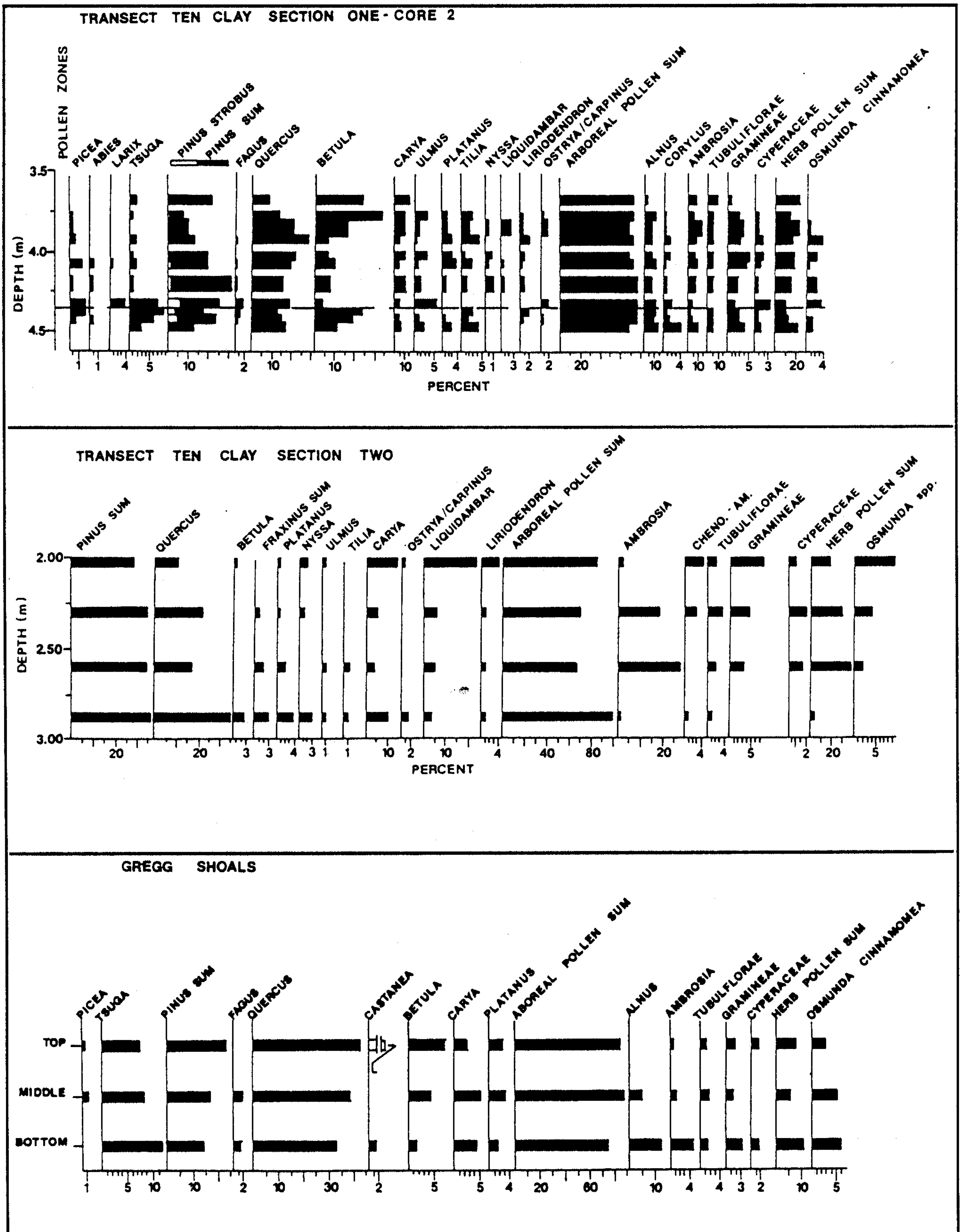
Figure 11. Present and Past Vegetational Communities, Richard B. Russell Reservoir Area.

GENERAL BACKGROUND: PALEOVEGETATION AND THE LATE QUATERNARY STRATIGRAPHY

To date several minor summaries have been compiled of the pollen successions in the vicinity of the Russell Reservoir area (Figure 12). Reconstructions have been based on coring at three major locales, Nodoroc, Gregg Shoals and Transect 10 (see Sheehan et al. 1985). Nodoroc is actually an upland bog located well west of the study area, so its use for local paleovegetational reconstruction is marginal. Gregg Shoals was a major prehistoric site (Tippitt & Marquardt 1984) but the interpretive potential of the pollen core suffers contextual limitations. Stratigraphic context in this column was only generally documented (i.e., Top, Middle, and Bottom zones). The core taken from Transect 10, from the floodplain in the south central part of the reservoir (see Figure 5) is perhaps the most reliable sampling location. It features two clay sections that document the local Early to Late Holocene vegetational succession. For the lowlands this pollen record is considered accurate for the period following 12,000 B.P., with the internal chronology supported by two radiocarbon determinations (Carbone et al. 1982:Table III).

An overview of what is known about the changing composition of paleovegetation communities since the late Pleistocene in the area is provided in Figure 11, derived from the work of Sheehan et al. (1985). Major transitions that occurred in the paleovegetational sequence involved the shifting boundaries of forest communities across the southeast (Watts 1980; Whitehead 1973; Delcourt 1979; Delcourt and Delcourt 1981, 1983, 1985) and especially near the physiographic transitions between ridge and valley, piedmont, and coastal plain provinces. The Savannah River Valley was most sensitive to changes in the nearby Blue Ridge Province and along the piedmont-coastal plain margin.

The early postglacial (12,000-9,000 B.P.) locally featured a Pine-Oak-Hemlock forest with river birch, sycamore and alder dominant along floodplains. Spruce and fir were present locally. River birch, sycamore, and alder were key components along the floodplains and stream sides, as was chestnut. In the uplands the forests became dense with pine and oak. The subsequent mid-postglacial (9000-4000 B.P.) era witnessed the influx of oak-gum-hickory complexes that stabilized deciduous forests. Birch replaced much of the oak on a local scale. In the uplands oak, chestnut, and beech stands replaced pine forests. Hickory gradually declined in significance. Arboreal pollen values were optimal at this time. After 4000 B.P. the pollen record becomes sparse, but by 1320 B.P. declining populations of oak, ash, sycamore and basswood suggested an expansion of the agricultural base on the floodplain locales. Alder and ragweed increase in significance, perhaps as a result of intensified soil erosion due to agricultural practices. In the uplands the borders of pine, oak, and chestnut forests were continually fluctuating and the dominance of pine forests diminished appreciably.



Source: Sheehan et al. 1985: 15, 17, 23

Figure 12. Pollen Diagrams, Richard B. Russell Reservoir Area.

The pollen record for the immediate reservoir area, although valuable, proved too general and incomplete to furnish a systematic and well-chronicled paleoclimatic background. The geomorphologic and pedologic records are somewhat more diagnostic and are discussed in detail in subsequent sections. For present purposes, it should be noted that the initial geomorphological and pedological investigations constructed a stratigraphy based on the floodplain soil and sedimentation record (Figure 13; Segovia 1985; Foss et al. 1985).

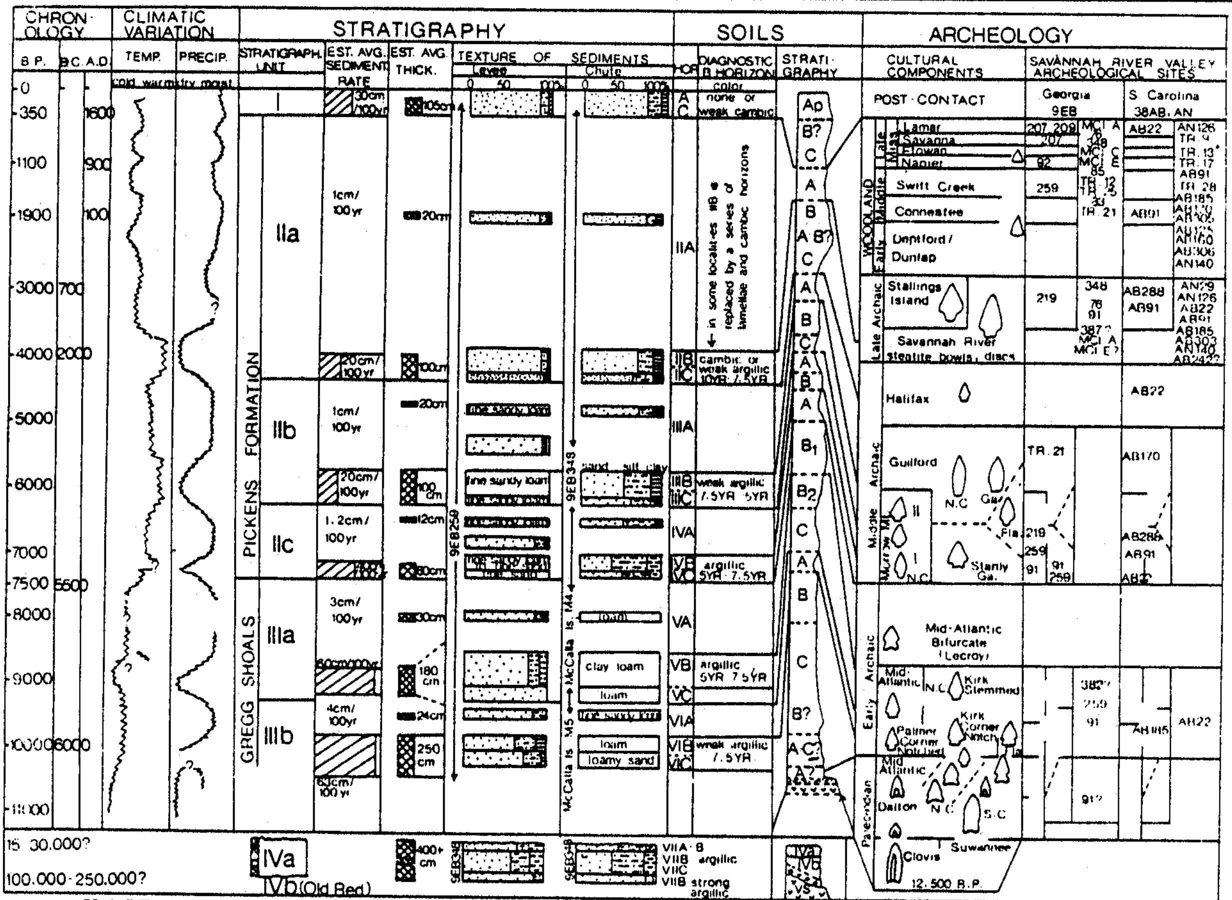
Alluvial events were assigned to four main episodes of floodplain deposition in the valley separated by intervals of down-cutting and soil development. The Late Pleistocene-Holocene transition was a threshold depositional interval registered by up to 4 meters of sedimentation capped (Unit IV) by a major paleosol (= Argillic B; Unit III). This was followed by a renewed depositional phase sealed again by a second paleosol (= Cambic B; Unit II) documenting renewed equilibrium. After A.D. 1700 rapid sedimentation is noted and is attributable to land clearance initiated in the colonial period and accelerated by nineteenth century agricultural practices (Unit I) (see Figures 10, 13).

In general, soils on the "recent levees" are not considered to have undergone major weathering, while ancient stream terrace and slope soils do contain more diagnostic red and clayey B-horizon characteristics (see Foss et al. 1985:Table 3). Subsequent research has modified these observations, demonstrating that many landforms initially classified as "recent" actually register developmental histories of over 15,000 years through pedologic units I to IV (see Anderson and Schuldenrein 1985). Recent alluvium does generally cap these landforms, however, and is the product of episodic flood inundations. Accordingly, most surface soils associated with alluvial fills are best characterized as belonging to the Entisol order.

The updated stratigraphy for the project area is illustrated in Figure 10. The four major episodes are represented by strata associated with two principal geologic formations. The present report attempts a finer grained differentiation of these stratigraphic relations by linking them to the cultural deposits discovered and integrated with the geological sequence at eight key sites, Gregg Shoals (Tippitt and Marquardt 1984; Upchurch 1984; Segovia 1985) and at the seven sites in the Rucker's Bottom and Abbeville Bullard site groups (Anderson & Schuldenrein 1985). Accordingly, an archaeostratigraphy has been established that correlates the paleoenvironmental, geomorphic, pedologic and archaeological signatures of the strata.

PALEOENVIRONMENTS AND GEOARCHAEOLOGY: AN EMPIRICAL RESEARCH DESIGN

Since most of the paleoenvironmental studies both reservoir wide and site specific highlighted deep site testing and floodplain geoarchaeology as a key investigative method, this served as a common focus for the overall paleoenvironmental



Unit I Recent Floodplain and Levee Soils (<250 years)

This association is the most extensive in the Savannah River area. This results from the extensive erosion resulting from agricultural activities and deforestation during the past 250 years and the attendant sedimentation on landscapes in the Valley. The soils in this association are also highly variable because they include soils developed on young, relatively unweathered alluvium as well as from sediment coming directly from the strongly weathered upland residuum. In some areas near the upland, the soils appear red and have a high clay content, but this has resulted from the source area being the residuum as contrasted to weathered in situ. Buried A horizons are generally found at the contact between the young material and the older soil. On recent levees, however, the soils area brownish in color and contain appreciable mica and organic matter. The high organic matter results from contribution of organics through sedimentation and the resulting vegetation that establishes itself on the sediment. These young soils will not have argillic B horizons, but incertain cases the B horizon will qualify as a cambic B.

Unit IIa, IIb, IIc Young Terrace or Levee Soils (250-8,000 B.P.)

Soils developed on alluvium deposited from 250 to 8,000 years ago are weakly developed and have minimal argillic (clayey) horizons. Although the stated interval is from 250 to 8,000 years, most of the soils observed on landscapes in this association are believed to be about 3,500 to 4,000 years in age. A major instability of the landscape between 3,500 to 4,000 years could have resulted from an extensive drought period. Few soils were described in the IIb or IIc subunits, be obvious breaks in sedimentation patterns and soil profiles were noted. Most of the soils in this association were described in terrace or levee positions and show numerous discontinuities and thin weathered zones. In fine sandy soils, lamellae devlopment may be appreciable in soils 3,500 years in age. The soils in this age association may also be a combination of profiles, with buried A and B horizons quite common within profiles.

Unit III Intermediate Terrace Soils (8,000-10,300 B.P.)

The soils developed on alluvium 8,000 to 10,300 years old are not particularly well preserved on landscapes in the Savannah River Valley. In most cases this soil underlies more recent sediment. In many other profiles, this particular component is present but probably only appears as a buried A or a remnant of a B horizon.

Unit IVa Old Terrace and Levee Soils (10,300-30,000)

This unit occurs mainly as extensive, partially dissected, terraces throughout the study area. In many areas the soils will have a post 10,300 B.P. mantle of fine sand resulting from overbank deposits or eolian processes. The well drained soils of this unit are reddish brown, fine loamy, and deeply weathered. In other regions of the main and tributary valleys, this unit is found underlying younger sediments. In soils with impeded drainage, the soils associated with this unit are grayish brown to gray, but they will still have strongly developed clayey, argillic horizons.

Unit IVb Ancient Terraces, Levees, or Colluvial Fan (100,000-250,000)

Soils developed on ancient terraces and/or colluvial slopes are red, clayey, and extremely well-developed soils. Although these soils are not extensive, they are quite contrasting to other soils in the Valley. In most cases these soils occur as dissected terraces or moderately sloping colluvial fans near the residual uplands.

Source: Foss et al. 1985: 93

Figure 13. Terrace Soils and Sedimentation History, Richard B. Russell Reservoir Area.

research synthesis. Much of the research focus also centered on the fact that occupations and stratigraphic columns were typically restricted to the period of human occupation, an interval spanning approximately the past 12,000 years. For synthetic purposes, then, a reconstruction of the late Pleistocene through Holocene alluvial sequence was the initial concern. From this base more comprehensive issues of concern to southeastern archaeologists could then be addressed:

1. What alluvial microenvironments comprised the habitation and subsistence areas of particular cultural groups?

2. How accurately may immediate site conditions as well as general resource environments (i.e., catchments) be reconstructed?

3. What was the pattern and scope of environmental change through time and how did it affect prehistoric lifeways and settlement?

Prior to addressing these questions, several methodological issues had to be resolved regarding the actual analysis and interpretation of the earth science data. On the most basic level this involved adopting uniform terminology for defining and classifying soils and sediments. Since it is often difficult to isolate soils from sediments in temperate piedmont settings, high resolution is mandated to document the paleoenvironmental correlates of sediment origins and subsequent weathering patterns. In the varied alluvial settings along the Savannah where relict landforms and complex features register facies changes and disjunct stratigraphies, it was necessary to sort out both depositional modes and diagnostic alterations as carefully as possible.

Certain basic trends and laws of fluvial sedimentation and pedogenesis provided fundamental guidelines. It was recognized that the Savannah floodplain featured a gently accreting concavo-convex floodplain and basin; weathering processes here are typically not continuous on the active alluvium, diagnostic soils do not often form, and azonal profiles are common. Foss et al. (1985) showed that regionally incipient soil formation was usually characterized by a series of "A" horizon transformations and the creation of a weak solum and a "texture" B-horizon. At a number of sites several generations of weak soil development were noted. The identifications of Ap, Ab, A2, and texture B horizons across most of the Russell sites suggested that gradational pedo-sedimentary changes were the rule at most floodplain and terrace settings (Gardner et al. 1983; Thompson and Gardner 1983; Foss et al. 1985) Generally similar profiles were recorded at most examined floodplain sites, but often intrasite soil/sedimentary histories remained unresolved due to both the varied topo-stratigraphic gradients at some sites and the limited testing programs conducted. This provided early indication that more regional reconstructions would be problematic, though a drainage-wide pedosedimentary mode has been formulated (Segovia 1985).

At all sites previous work was examined with great detail to isolate those locations where the sequence could or could not be readily incorporated into the synthesis.

For all sites the geological and archaeological notes and profiles were evaluated to determine:

1. depositional modes of sediment transport;
2. the shifting pedosedimentary balances in the profile;
3. introduction of anthropogenic residues in the sediment matrix.

In most cases strong differentiation of the floodplain, floodplain margin, and adjacent upland areas could be determined. Finer grained separation of deposits by sedimentary cycles and soil forming episodes was then possible.

To expand the geoarchaeological observations beyond the upper Savannah River Valley required linking floodplain sequences with the coastal and marine succession along the coastal plain. Recent research suggests that the Savannah River floodplain has undergone alluviation and built upward from an earlier incised channel that graded to Late Pleistocene low sea levels (see Brooks et al. 1986). Thus, PaleoIndian and Early Archaic floodplain sites associated with the Early Holocene (ca. 10,000-8000 B.P.) have been progressively covered by Middle and Late Holocene alluvium as post-Pleistocene sea levels rose and attained the near present stand (ca. 5000 B.P.). Alluviation kept pace with this changing base level until the present terraces were established in Late Archaic times. Downwarping of the Carolina coastal plain (Colquhoun 1969) doubtless accentuated alluviation along the Savannah River as well.

Since Late Archaic times and the establishment of the present floodplain system, the dominant processes affecting the landscape have involved both braided and meandering river patterns. In general, braided patterns are more prevalent along upstream and central reaches. Specific changes in valley and stream sinuosity may be verified on available topographic maps and aerial photographs. Indications are that Savannah River sinuosity has decreased to present configuration over the past 4000 years. Such changes can reflect variations in discharge, sediment load, decreasing gradient, or a combination of all of these variables.

With the added element of geoarchaeological site formation studies it is also possible to link the buried cultural and natural strata. In this way floodplain histories and more subtle land use patterns for later prehistory can be unravelled in the absence of deep or pronounced alluvial sequences.

EVOLUTION OF THE SAVANNAH RIVER FLOODPLAIN

The earliest period for which floodplain development interweaves with the archaeological record is the PaleoIndian era, from ca. 11,500 to 10,000 B.P. Evidence for early prehistoric occupation in the reservoir at this time is minimal and confined to limited artifact assemblages at isolated sites (see Chapter IV). For the succeeding Early Archaic period, from ca. 10,000 to 8,000 B.P. the situation is only marginally enhanced. Still, some locations do provide probable *in situ* context, thereby facilitating alluvial reconstructions for the critical late Pleistocene/Holocene interface. The prime sites furnishing evidence for early prehistoric occupation are Rucker's Bottom and Gregg Shoals. The latter site contains a deeply stratified sequence some 3.5 m thick, formed largely as a result of high sedimentation rates occurring at the confluence of an alluvial fan with the primary stream. It is not typical of primary depositional activity elsewhere along this part of the Savannah, where Holocene deposits are typically much thinner. The Rucker's Bottom site is more indicative of the valley sedimentation regime locally.

In the discussion below the depositional history of the Rucker's Bottom site is utilized as an index of the paleoenvironmental events that occurred since the time of earliest habitation. The emphasis is placed on the dynamics of climate and stream morphology. It is stressed that it was only in later prehistoric times (i.e., post-Woodland) that land use actually impacted the site settings appreciably. For these latter periods the study of site formation process becomes increasingly significant.

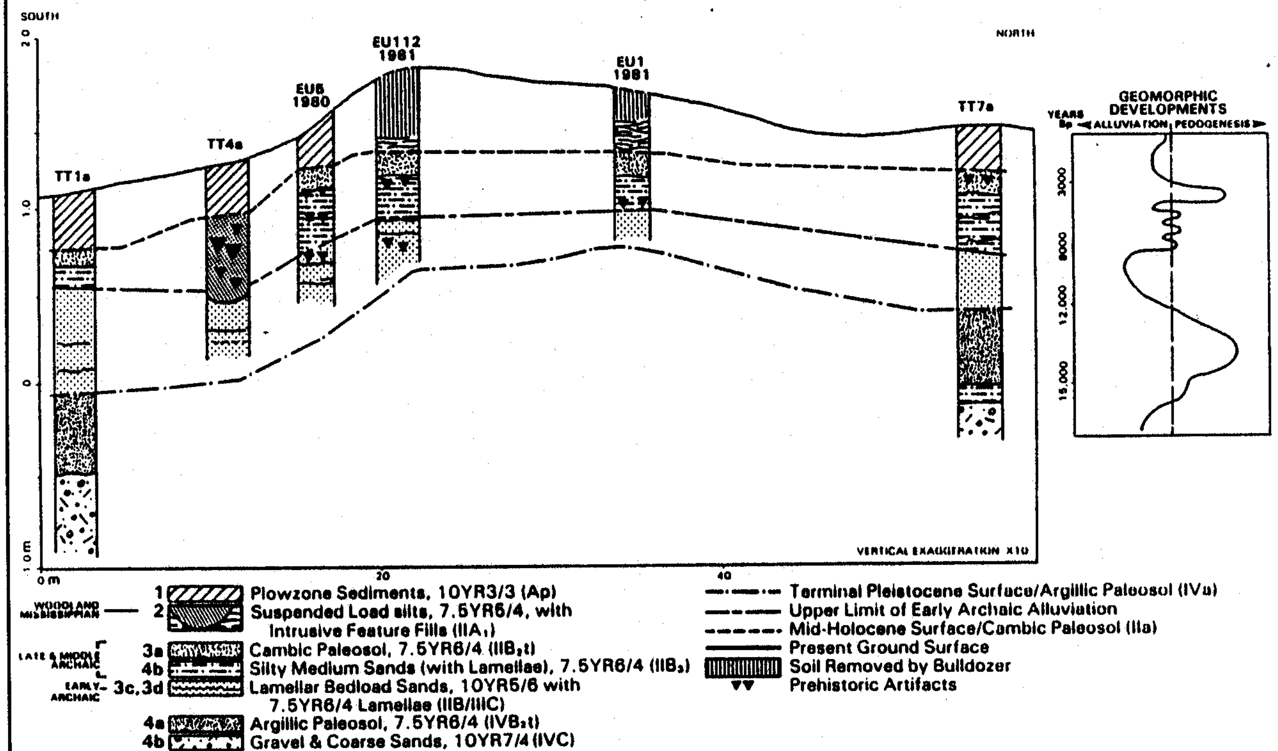
Terminal-Pleistocene through Holocene Events

Major sedimentation events and soil forming periods along the floodplain in this portion of the drainage are illustrated in Figure 14, a profile crosscutting the primary Archaic block excavations at 9EB91. The key feature is the succession of three major Archaic horizons spanning 7500 years. Since the total sediment accumulation from the base of the Early Archaic component, the lowest marker horizon, to the top of the sequence is only on the order of 1.3 m, it was necessary to monitor the compressed Archaic succession carefully in the field. Close attention was paid to subtle stratigraphic changes with depth.

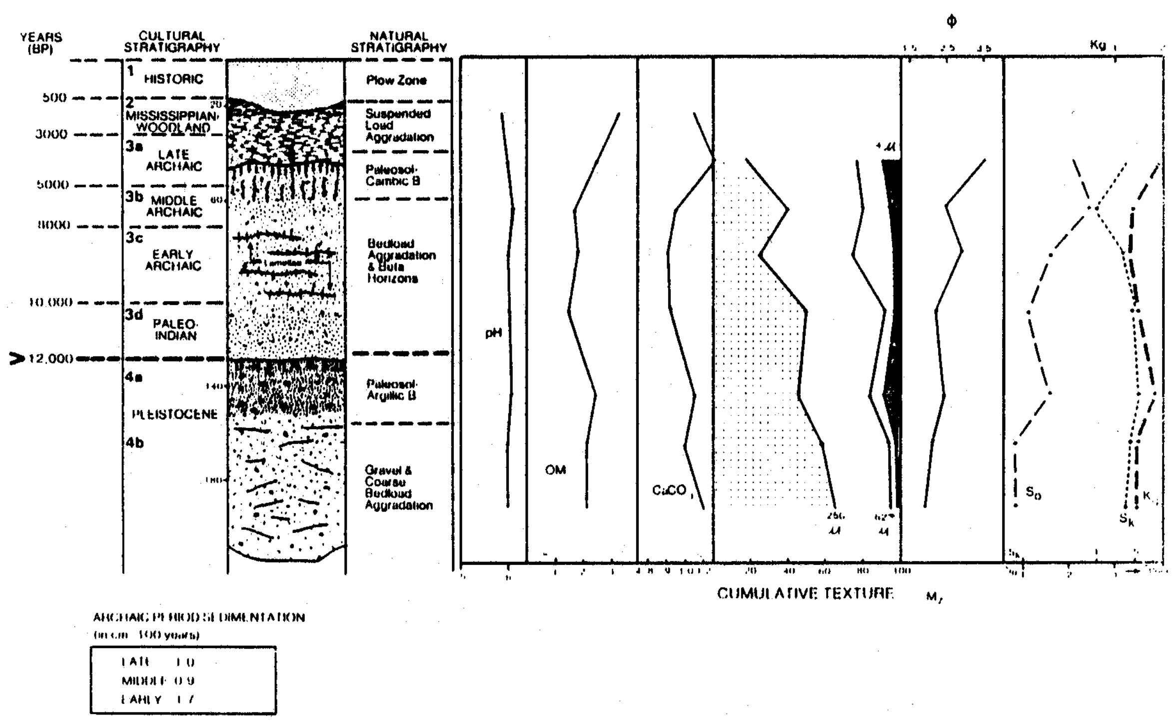
Contributing to this subtlety is the fact that the Savannah, as a braided stream over the duration of the Holocene, differentially eroded and deposited sediment on altimetrically equivalent surfaces, often obscuring the significance of surficial relief. To control for lateral and vertical stratigraphic variability the distribution and depths of the particular Archaic horizons were followed out over the Rucker's Bottom terrace, using an extensive series of backhoe and test units.

The relatively level ridgetop was a convenient index of contemporary land surface stability and allowed for correlation between the relief of subsurface Archaic levels. On the large-scale, the disposition of buried surfaces - most notably those defined by the terminal Pleistocene and mid-Holocene soils - does not diverge significantly from the contemporary ridge (see Figure 14). Subsurface probes did, however, suggest micro-topographic variations in the substrate. The Early Archaic occupations, for example, appeared at depths ranging from 80 to 130 cm in differing areas of the site. Upon closer inspection it was shown that these discrepancies were attributable to localized recession of floodwaters and the

Geoarchaeological Transect, Archaic Deposits, Rucker's Bottom, 9EB 91.



Composite Stratigraphy, Archaic Block, Rucker's Bottom, 9EB91.



Source: Anderson and Schuldenrein 1985: 396, 407

Figure 14. Late Pleistocene/Holocene Stratigraphy, Rucker's Bottom (9EB91), Richard B. Russell Reservoir Area.

minor displacement of artifacts along graded slopes of the terrace crest.

The most striking aspect of the earliest Holocene fills was their homogeneity, lateral extent, and consequently their long-term potential for stratigraphic correlation. They all occur in medium to coarse grained sands that were not visibly bedded, but were reasonably well-sorted and apparently tied to the same depositional regime and interval. Additionally, these sands occurred below a zone of laterally extensive mineralized bands known as lamellae, a feature prolific at Rucker's Bottom and at most of the other floodplain sites in the reservoir (Foss et al. 1985). The clear stratification in the site deposits indicated that if the mineralized bands were pedogenic (i.e., associated with stable land surfaces and hence soil forming episodes) they documented a post-Early Archaic interval of environmental equilibrium and stability.

The uniform presence of bedload sediments in the Early Archaic exposures at Rucker's Bottom and Gregg Shoals, in contrast, implied that vigorous channel activity was occurring at this time. The Early Archaic deposits at Rucker's Bottom were relatively coarse, and deposition was probably associated with a braided stream regimen when surfaces were quite unstable and dynamic, well-drained, and locally subject to intense sedimentation. They would appear to either predate period III or to coincide with its initiation.

Middle Archaic profiles were also exposed at many of the units at the site. Their broad ranging depths, from 50 to 155 cm, coincided with a widespread lateral distribution. Apparently the mid-Holocene stream flow was extremely sinuous and created an expansive floodplain. Taken together, the archaeological and sedimentological indications were for a more dispersed Middle Archaic settlement associated with a series of gently undulating floodplain rises and depressions. Sedimentologically, progressive diminution in mean grain size typified all exposures and argued for gentler and probably less competent stream flow. Variable entrenchment of the channel into underlying coarse Early Archaic deposits characterized a period of lateral planation after which meandering and accompanying suspended load deposition established a new channel morphology and sedimentation pattern trending to long-term overbanking.

The Middle Archaic horizons registered the most intensive distributions of the mineralized clay lamellae, generally occurring as abrupt beds varying in thickness from 2 and 3 cm to as much as 10 cm. Hypotheses in support of pedogenic origins for these strata - generically referred to as Beta horizons - were initially tied to a field model that merged several hydrographic and sedimentological variables. Central to the model was the systematic expansion of level floodplain surfaces promoted by progressive fining of the sediment matrix, the broader confines of a meandering floodplain, and diminished accretion rates up the sequence. Collectively the geoarchaeological ramifications of these site developmental changes translate into a broader, more diversified, and simultaneously more stable floodplain habitat with the passage of time. As it developed, this floodplain became increasingly attractive to more specialized prehistoric groups.

Across the terrace/levee, sedimentation rates slowed appreciably and began resembling contemporary trends by Late Archaic times. These strata overlie Middle Archaic units by 10-25 cm and Late Archaic artifacts were rarely found at depths of more than 30 to 60 cm below the surface. A systematic increase in the silt component and the redder hue of the sediment matrix suggested a more sustained pedogenetic interval than was noted for any previous prehistoric period. An extensive Cambic B-horizon caps the mid-Holocene alluvium at Rucker's Bottom and many other sites in the reservoir (Foss et al. 1985; Anderson and Schuldenrein 1985). In contrast to the Beta or lamellar horizons, the upper Late Archaic soil/sediment featured a graduated contact to the parent material. Truncated surfaces, marked in Middle Archaic lamellae by sharper contacts, were absent. Evidence for extended settlement of the floodplain environment occurred for the first time in the Late Archaic (see Chapter V), something that may be due in part to the progressive stabilization of the available floodplain occupation surface that took place at this time.

The sequence of alluviation, lamellar formation, and pedogenesis over the protracted period of Archaic period floodplain occupation is systematically represented in the exposures of the Archaic block units opened at Rucker's Bottom (Figure 14). In these units the range of stratified Early, Middle, and Late Archaic deposits illustrate a generally low index of net sedimentation associated with the particular depositional setting of the site. In an attempt to provide a crude and preliminary index of depositional dynamism, the sedimentation rates for each of the Archaic phases were measured. Net sedimentation was the sole quantitative parameter that could reflect general trends in the morphogenesis of the floodplain. Accordingly, thicknesses of sediment were determined from the base of the lowest clear Early Archaic stratum to the top of the Late Archaic stratum. Corresponding sediment thicknesses at two diagnostic (1980) sections were averaged out to provide mean values. Over the 7500 year interval, from 10,000 to 2500 B.P., net sedimentation was 75 cm, or an average of 1 cm/100 years. The results of segregating these data according to the separate Archaic components were as follows:

1. Early Archaic. 25.0 cm/1500 yrs. (=1.7 cm/100 yrs.)

2. Middle Archaic. 22.5 cm/2500 yrs. (=0.9 cm/100 yrs.)

3. Late Archaic. 10.0 cm/2000 yrs. (=1.0 cm/100 yrs.)

It should be stressed that these results are solely site-specific and are very general indexes since they measure exclusively net sedimentation rates (i.e., irrespective of differential erosion and degradation rates in the past, etc.); they also lack precise radiometric controls. It is striking, however, that a general decrease in sedimentation is observed up the sequence, to Middle and Late Archaic times, that broadly mirrors the synchronous trend to finer sedimentation and stability through time. Parallel trends have been documented geoarchaeologically for other multicomponent Archaic floodplain sites in similar (i.e., Humid subtropical, Koppen:Caf) environments, most notably at the Koster locality in the lower Illinois Valley (Butzer 1976).

A corollary to these results is obviously that sedimentation rates at sites in the Savannah River floodplain were slow over much of the Holocene. As a result, the probability of the preservation of largely *in situ* archaeological materials was correspondingly high throughout the reservoir. This was demonstrated repeatedly in the floodplain and island testing programs (Gardner et al. 1983; Thompson and Gardner 1983).

Evidence from site sedimentological analyses confirm field observations and are illustrated in Figure 14. This is a composite profile of the archaeo-stratigraphy of the Archaic excavation block units at Rucker's Bottom, pointing out sequential variation in chemical and sedimentological properties. As the natural stratigraphy column shows, each cultural stratum featured a unique geoarchaeological signature, but over the 2 m profile, fully 1.3 m of bedload (below 3b) document the earliest and most active sedimentary phases, from 14,000 to 8000 B.P. This is the signal indicator that overall channel behavior was predetermined by late Pleistocene and Early Holocene build-ups and that general stream and flow cycles did not diverge significantly from those initiated earlier in the Pleistocene, despite changes in channel geometry.

In general terms the presence of four principal depositional units (1-4) offset by two paleosols (3a and 4a) was confirmed. Progressive fining characterized the discrete depositions up the sequence. Unit 3 was the most pervasive and thickest accumulation spanning PaleoIndian to Late Archaic times. Minor soil forming episodes are distinguished by the thin and crenulated red-brown lamellae ranging from 2 to 10 cm in thickness. Evidence of their origin points to pedogenetic transformations on discrete alluvial units (Dijkerman et al. 1967; Schuldenrein 1981; Larsen 1982). Mineralogical enrichment proceeded on well-sorted medium to fine-grained sands. The lamellae are the sole indicators of even limited soil formation over the 7000 period of the early to mid-Holocene. Otherwise the entire central portion of the sequence records gentle and episodic floodplain accretion. Clearly, over this duration sedimentation dominates over pedogenesis. Figure 14 shows the time-stratigraphic and pedo-sedimentary correlations within this column, dating the optimal period of soil formation to around 15,000 to 12,000 B.P. That interval dates the age of the lower paleosol, Unit 4a, and is equivalent to regional soil Unit IVa (Table 10-5; Foss et al. 1985:Table 3). The 9EB91 sequence is a more detailed version of the reservoir wide model outlined in Figure 10.

At Rucker's Bottom the relations between pedomorphic, sedimentary, and archaeological units are most apparent (Figure 14). As noted earlier, the distributions of the Archaic assemblages were relatively diffuse. This is a function of the mildly acidic composition of the substrate, which exemplifies a poorly maintained anthropogenic context for occupational horizons. Leaching of the prehistoric A-horizons and their susceptibility to stripping would have degraded features and eliminated their sedimentary integrity and consistence. The localized displacement of artifacts by winnowing and recession of periodic floodwaters only enhanced this trend. At Rucker's Bottom the time factor appears to have been most diagnostic for the relative degree of archaeological preservation, with the later Woodland-Mississippian features maintaining relatively intact occupational matrices and the pre-Late Archaic components exhibiting more disjunct spatial and stratigraphic articulation. Consequently, a distinctive pre-Late Archaic anthrosol cannot be distinguished on sedimentological grounds.

Both sedimentological and pedological properties are highlighted by the graphs in Figure 14. The pH values show that acid-base balances remained fairly consistent and mildly acidic for the duration, but the organic matter curve displays significant variation with time. Obviously, values are high for upper (i.e., Late Archaic and subsequent) occupations housing preserved features; the fine-grained sandy matrix supported a forest cover and thin leaf litter horizon that resulted in rapid leaching at the level of the Cambic B-horizon. Subsequent declines in lower Archaic levels attest to the poorly developed soil covers that were apparently subject to more inundation and sediment reworking. Organic values only rise in the Argillic B-horizon, marking the terminal Pleistocene erosional surface, which was a long-term and therefore stable marker horizon. Pollen studies locally and regionally offer suggestions that this time frame (15,000-12,000 B.P.) was one of expansion for floodplain vegetation communities, a trend accommodated by richer preservation of organic matter (Sheehan et al. 1985; Watts 1980, 1983). Calcium carbonate values also peak at this level and show that leaching and mineral translocation occurred, probably below the rooting zone in a forested situation. High carbonate values are normally associated with former A-horizons because of chemical reactions resulting from optimal concentrations of CO_2 at levels of root and micro-organism respiration (Birkeland 1974:115); they diminish down the profile. On the terrace/levee the CaCO3 signature bulges at the A/B transitions underscore this trend.

Perhaps the most telling index of change in the depositional regimen is the granulometric data illustrating the transition from bedload to suspended load aggradation up the column. Principal shifts occur in the relative proportions of the fine and medium sand grade (at 250 phi). By the end of Late Archaic times finer grade sands and silts begin to dominate the sediment load and mark a turning point towards progressive floodplain stabilization, a point underscored also by the scaled reduction in sedimentation rates over the course of the Archaic (Figure 14). Mean particle sizes decrease to the top of the prehistoric column. The only bulges in the clay fraction occur in the paleosols where illuviation was the dominant process. Finally, the sorting data show that sediment uniformity was the rule until overbanking and differential settling altered the depositional pattern around 8000 B.P.; sorting is best in the bedload aggradation units and worst in pedogenic units and overbank strata.

A final consideration involves the paleoclimatic implications of the alluviation phases, which peak during the intervals 10,000-8000 B.P., 5000-4000 B.P., and 1500 B.P. Fluvial geomorphologists are divided as to whether high level sedimentation attests to intensification or retardation of runoff and attendant precipitation. Most recent research suggests that in humid temperate regions cooler and wetter climates may result in reduced sediment yields (due to greater upland ground cover and decreased runoff and erosion), the consequent erosion and incision of primary channels carrying the increased precipitation, or minimally channel enlargement (see Schumm 1977:Table 5-2). Conversely, in situations with increased sediment yield, such as those implicated by the two alluviation peaks, slightly drier and warmer conditions than those favoring soil formation would have prevailed. Along these lines, it is striking that major alluviation cycles bracket what is considered the warmest and driest phase of the Holocene, the Hypsithermal (8000-5000 B.P.). If that phase reliably dates a warm-dry peak, then the pattern of climatic changes recorded by the floodplain stratigraphy at the Rucker's Bottom terrace-levee may best be viewed as a continuum with optimal warm-moist conditions prevalent in pedogenesis phases and alluviation bridging a transition to cooler and drier environments.

Late Holocene Events: Anthropogenic Sediments As Documented at Rucker's Bottom

While climatic changes, specifically moisture and runoff regimes, were largely responsible for modifying landscape systems during most of the prehistoric period, it was human activity that affected the stability of landforms and surfaces in later times. During the Mississippian, intensive occupations stripped soil covers and produced middens and extensive feature networks that drastically altered the natural habitat. Some of the key sites with major Mississippian components include the Beaverdam Creek Mound (Rudolph & Hally 1985), Clyde Gulley (Tippitt and Marquardt 1984), and Rucker's Bottom (Anderson & Schuldenrein 1985). At the latter site the nature and intensity of site utilization was measured using a variety of geochemical techniques.

By Mississippian times the terrace levee at Rucker's Bottom was a stable landform, only periodically exposed to inundations. The location of the terrace and its broad extent made it naturally attractive to the agriculturally-based Mississippian populations. The occupation was both intensive and extensive, as evidenced by the number and variety of features discovered over the course of investigation. To gain insights into feature function and significance two experimental methods were applied to the study of feature fills: quantitative trace element analysis and phosphate fractionation.

Trace element tests were conducted on soil elements that were known to be affected by various forms of human activity. Such chemical determinations have been used across broad ranges of archaeological settings and have been helpful in identifying such occupational parameters as duration of human activity, types of activities performed, and patterns of site degradation (Cook and Heizer 1965; Sokoloff and Carter 1952; Hassan 1978). Several exploratory investigations have focused on the nature of anthropomorphic sediments in late prehistoric North American village sites (Parsons et al. 1962; Griffith 1980), and their results were initially considered in the present research due to the analogous site contexts. In general, these and other geochemical studies have shown that phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg), and sodium (Na) may all be diagnostic of particular human activities.

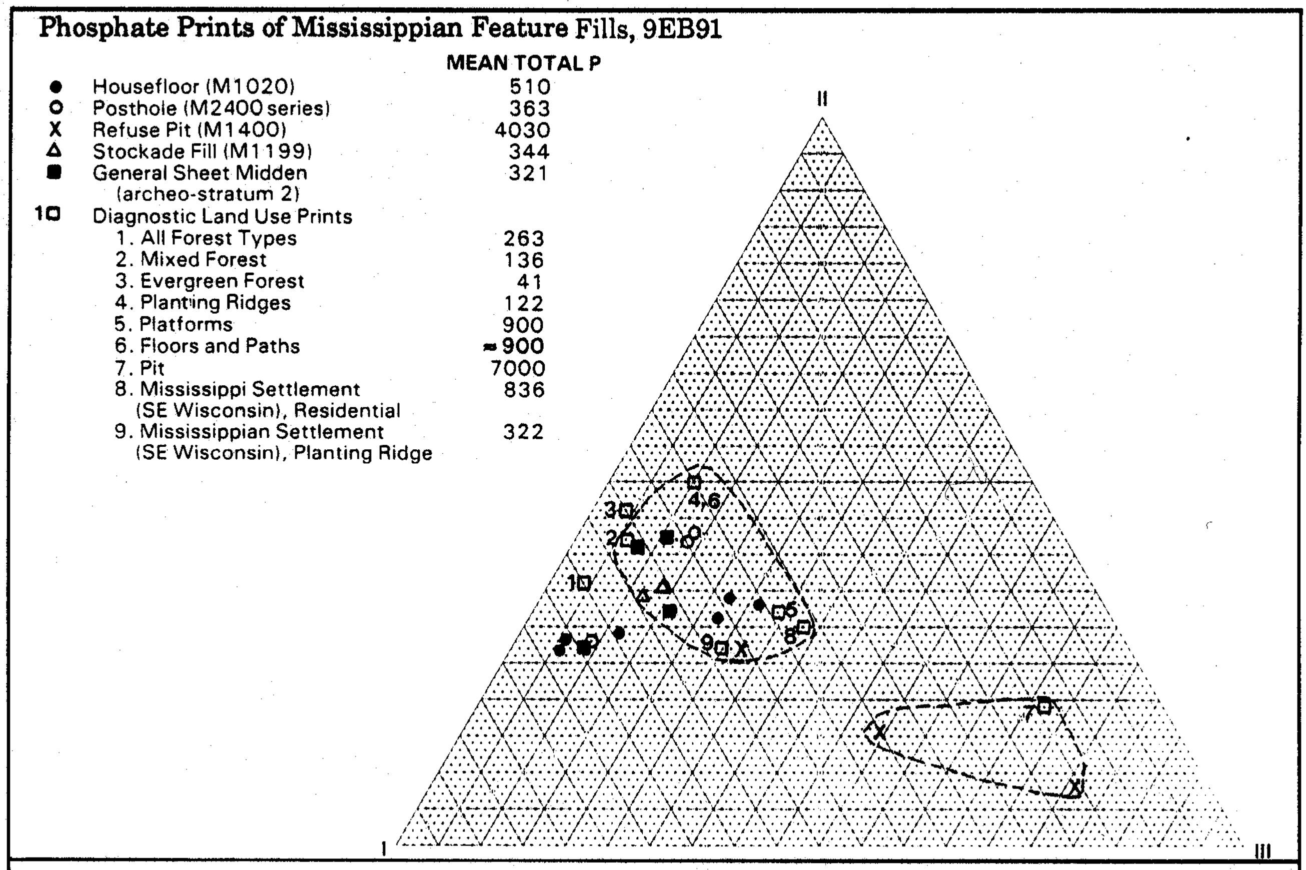
Phosphorous is perhaps the most widely known indicator of human activity (Cook and Heizer 1965; Eidt 1973, 1977; Sjoberg 1976). Potassium may be worked into the soil by degraded animal and bird remains (Griffith 1980), as well as by burning of the soil (Tarrant 1956), and by extensive wood-ash deposits associated with hearths and fire-pits (Butzer 1982). Calcium is dominant in human feces, in all animal tissues (Cook and Heizer 1965), and in a variety of organic human refuse items (Heidenreich et al. 1971). Most significantly, potassium is an optimal indicator of ancient buried A-horizons and vegetation covers and hence of former habitation surfaces (Parsons et al. 1962; Birkeland 1974). Magnesium is also a major component of wood-ash and is contained in animal, fish, and bird bones; it would be an excellent indicator of high intensity activity areas (i.e., intrusive features), but interpretations must be indexed against the strong presence of the ion in subhumid settings such as those along the Savannah. Finally, sodium may be considered a negative indicator since its abundance is actually detrimental to the preservation of organic components in oxidizing environments (Butzer 1982). Thus, low presence of sodium in conjunction with other positive habitation indices would serve to verify the nature of the occupational record.

In light of these considerations, the Mississippian occupation units at Rucker's Bottom were sampled for potentially diagnostic anthrosol properties, in part to confirm the archaeological observations, and in part to assess the significance of particular elements for measuring activity patterns. Five sets of Mississippian feature types were sampled: sheet midden fills, occupation floor/fill levels, post holes, trash midden, and palisade-ditch fill. The Mississippian sample series was compared to a set of naturally stratified but archaeological sterile Holocene samples from the same terrace environment. It was therefore possible to compare both populations for trace elements and determine if any or all of the elements furnished evidence for significant alteration by human agency.

To assess the differences between the two populations the Z statistic was employed as a probability measure. The statistic is a means for determining if the chemical differences in the occupation sediments and the natural sediments are significant (i.e., due to human activity) and not a consequence of relatively small difference due to chance. Griffith (1980) utilized an analogous strategy in comparing on and off-site soils at a Huron village site.

Pooled variances were utilized in the determination of the degrees of freedom for the calculations (Snedecor and Cochran 1973). Results of the statistical analysis are presented in Figure 15, showing the differences between the Mississippian and naturally stratified sediments. Both P and K appear to be most diagnostic of anthropogenic inputs. The strong presence of P was expected given the very high levels of activity documented at all site locations, and the very clear utility of P as an anthrosol indicator under most circumstances.

Of more striking concern are the high K values since in an ostensibly similar site context, the Benson village site in central Ontario, Griffith (1980) found only P and



DETERMINATIONS OF ANTHROSOL GEO-CHEMICAL PROPERTIES

	x (in ppm)	Z*
I. Phosphorous (P)		
Mississippian	135.0	3.21
Natural	62.4	

The natural soils are statistically different at the 99% level from the Mississippian soils based on P content

	x (in ppm)	Z*
II. Potassium (K)		
Mississippian	116.0	3.38
Natural	72.5	

The natural soils are statistically different at the 99% level from the Mississippian soils based on K content

	x (in ppm)	Z*
III. Calcium (Ca)		
Mississippian	585.5	0.19
Natural	567.7	

The natural and Mississippian sediments are derived from the same population based on Ca content

	x (in ppm)	Z*
IV. Magnesium (Mg)		
Mississippian	19.5	-1.47
Natural	39.7	

The natural and Mississippian sediments are derived from the same population based on Mg content

	x (in ppm)	Z*
V. Sodium (Na)		
Mississippian	4.56	0.52
Natural	4.65	

The natural and Mississippian sediments are derived from the same population based on Na content

*** In all cases the following obtain:**
Mississippian (n_1) = 18
Natural ($n_2$0 = 13
d.f. = 29

Source: Anderson and Schuldenrein 1985: 580, 586

Figure 15. Feature and Anthrosol Geochemistry, Richard B. Russell Reservoir Area.

Mg to be useful for delimiting signs of the occupation. Moreover, previous clay mineral analyses at 9EB91 indicated an extremely strong illite, and therefore mobile K presence in the natural sediments, due to the subhumid weathering conditions that have prevailed since late Pleistocene times. In fact, natural K contents are about 20 times higher at Rucker's Bottom than at Benson and occupational K levels are 30 times higher. The inference is that even though the more-continental natural environment at Benson was generally less conducive to K-profile weathering, it is apparently cultural activity that accounts for an even larger than expected discrepancy between sites. K values are high for all sets of features in the Mississippian sample series. If K content is a function of such diverse activities as soil clearing, wood burning, and disaggregation of animal tissue, the evidence suggests that in all probability the entire range of these activities were occurring at 9EB91. Sheet midden, trash midden, and occupation floor fills would easily accommodate all activities noted.

The relatively low values of Mg may be of some concern, since these are also optimal activity indicators, but when viewed, again in relation to the Benson site, mean values of 19.5 ppm versus 23.4 ppm at Benson are not that divergent; since Mg is not, however, a discriminating element, it should be noted that Mg is naturally abundant in the parent sediment matrix at 9EB91.

As noted, it is the P component that has been the most widely researched indicator of anthrosol genesis. Phosphate fractionation is now a reasonably reliable method for distinguishing particular modes of activity and settlement at sites (Eidt 1973, 1977; Sjoberg 1976). In general, the cultural or human impact on the land surface will have an identifiable effect and differing activities will register singular phosphate "prints." These prints can be analyzed by a fractionation method consisting of separation of inorganic settlement phosphate into three separate components, or fractions, by means of nonoverlapping extractions. Calculations of the relative loadings of phosphate levels on each fraction provide an index of land use type (Figure 15).

The abundance of total phosphorous (P) in a particular feature is a measure of land use intensity. Total P determinations are routinely performed at archaeological sites with high levels of success (Arrhenius 1931; Cook and Heizer 1965; Hassan 1978; Goffer et al. 1983). Eidt (1977) has suggested that total P value ranges may be diagnostic of activity intensity as follows:

P range (in ppm)	Activities
10-300	hack farming and ranching
300-2000	dwelling, gardening, manufacturing, garbage dumping
>2000	burials, refuse pits, slaughter areas, urban living

At Rucker's Bottom 18 phosphate samples were taken from provenances of the following feature types (note feature numbers in parentheses):

a. House floors (M1020)
b. Post Holes (M2400 series)
c. Refuse pits (M1400; taken from debris-laden entrance fill)
d. Stockade ditch fill (M1199)
e. General sheet midden (unit 2)

Samples were submitted for phosphate fractionation and produced the results shown in Figure 15. This is a representation of the relative loadings on each fraction on a percentage basis. All 18 samples and total P values are plotted as well as nine additional reference land use "prints." The reference "prints" are mean determinations of discrete feature types accumulated by Eidt (personal communication) from a variety of different locales. Attention is drawn particularly to types 8 and 9 that document Mississippian occupations. The reference prints provide a comparative framework for assessing the significance of the Rucker's Bottom features.

Examination of the clustering pattern of the site feature samples reveals distinctive sorting, delimited graphically by two distributions. The major clustering is keyed to a heavy loading for Fraction I with proportionately lesser weight on Fractions II and III. The cluster encompasses what may be considered a generalized matrix of Mississippian land use patterns. Accordingly, the limits of the distribution are defined by both the residential and planting ridge prints as well as by floors and paths (prints 4, 6) and, interestingly, by a mixed forest (print 2) possibly representative of the pre-clearance vegetation. Taken together, these activities would be expected to incorporate extensive features as opposed to focused or activity specific variants such as, for example, the sheet midden. In fact, three of four sheet midden feature samples fall within the distribution.

A series of alternating sterile (and overburden) and house floor (Feature M1020) strata offers perhaps the most singular distribution. The floor fills cluster tightly in a band loaded at 30 to 35 percent on Fraction II, shown by Eidt (1977:Figure 3) to be an index of dating due to its extraction by time transgressive iron and aluminum oxide deposition. This fraction may be indicative of a rapid succession of house floor building episodes. As Figure 15 shows, a measure of the diagnostic potential of the "extensive occupation" signature lies in the fact that the overburden strata above the Feature M1020 floor fills all fall considerably outside the perimeter of the distribution. Both post hole (M2400 series) and stockade fills (M1199) are also tightly focused on Fraction II, at 43 and 35 percent respectively. If this fraction could be calibrated to an absolute date it could furnish an optimal chrono-stratigraphic marker. In summary, it appears that what may be considered an extensive Mississippian occupation signature consists of phosphate distributions that load from 35 to 55 percent on Fraction I and 25 to 55 percent on Fraction II. While these are very crude indices, it is stressed that only 15 samples from four feature types were analyzed.

An indication of the utility of the method for activity identification is furnished by the second print cluster in Figure 15, dramatically offset from the first with a high loading on Fraction III and proportionately minimal loading on Fraction II. Mean total P is 4000 ppm, so that the print is indicative of a very specific type of land use, concentrated trash disposal. The contents of the two samples (M1400) that sort out with Eidt's pit print (7) were sufficiently degraded so that initial visual inspection in the field did not in and of itself reveal the full significance of the feature, although subsequent wide-area stripping revealed it to be a ditch line. In a feedback sense, then, systematic feature sampling can potentially result in post-hoc identifications of site activity loci. This type of observation is extremely critical for resolving land use problems in humid temperate environments such as the southeast, where soil acids degrade fills at high rates.

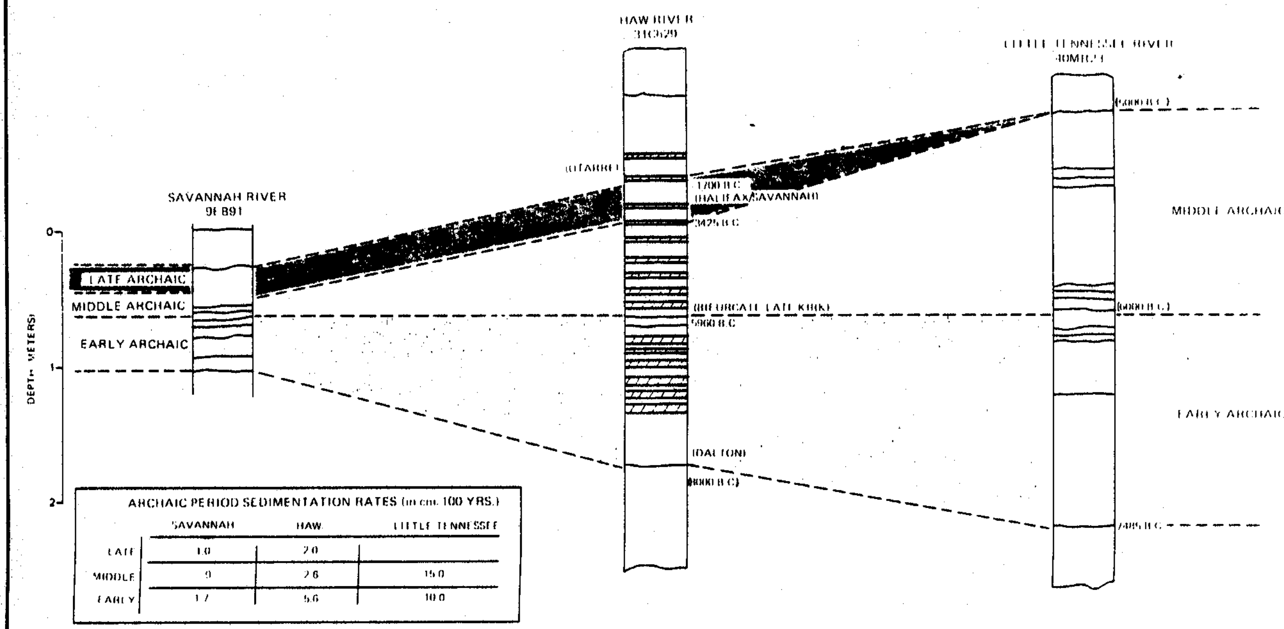
With the refinement of geochemical techniques it will be possible to address such questions as the ancient management of land and reclamation of the site microenvironment. Recent research, for example, suggests that flood management was a major problem in later prehistoric periods and that the building of control embankments was actively pursued in pre-Columbian Peru (Knapp 1982; Orfloff and Mosely 1983). The Mississippian groups may have utilized analogous management practices (i.e., floodwater diversion) to maintain the kind of environmental balance required by a mixed agricultural hunting-gathering economy. As Smith (1978) argues, in most instances the lush aquatic biomes favored by the Mississippians were in close proximity to the raised floodplain surfaces on which their villages were built. Periodic changes in the hydrologic budget could conceivably have flooded out and destroyed the agricultural tracts and households, especially at sites like Rucker's Bottom where surface relief is extremely graded. Flood control is not a problem that has been addressed by archaeologists working on Mississippian period research, but it has major implications for understanding the nature of land use by agricultural societies.

HUMAN ECOLOGY IN THE UPPER SAVANNAH RIVER

Prior to expanding the paleoenvironmental and geoarchaeological models from the upper Savannah River drainage to other regions in the southeast, it is necessary to summarize the primary human ecological correlations observed in the Richard B. Russell project area. As stressed earlier these apply largely to systematic prehistoric occupation and utilization of the floodplain environments. For each major prehistoric period there is a distinctive alluvial environment. Figure 16 outlines the relationship between prehistoric components and geoarchaeological contexts on a period by period basis.

In broad terms the later Woodland and Mississippian landscapes were the most analogous to those of the present. Independent lines of evidence suggest that the stable floodplain surfaces of the present had essentially assumed their present dispositions between 2000 and 3000 B.P. While medium to low energy alluvial regimes persisted, they generally had strongest impacts on low-lying landforms

Archaic Period Profiles-Three Southeastern Floodplain Sites.



Source: Anderson and Schuldenrein 1985: 696, 705

SUMMARY OF PREHISTORIC COMPONENTS AND GEOARCHEOLOGICAL CONTEXTS

Prehistoric Components	Geoarcheological Contexts (and Archeo-strata)
Mississippian, Early Woodland, Late Archaic, Middle Archaic (38AB22)	Mississippian midden in buried context on outer levee (2); Early Woodland in terminal floodplain deposits (1,2) on inner levee; Late Archaic associated with inner levee Cambic paleosol (3a). Middle Archaic articulates with lamellar units (3b).
Middle/Late Woodland (9EB75)	Cultural materials housed in inter-digited buried A-horizon and weak sheet midden on terrace-levee (2).
Mississippian, Middle/Late Woodland, Early Woodland, Late Archaic, Middle Archaic, Early Archaic (9EB382)	Surficial manifestations on exhumed late Pleistocene terrace.
Mississippian, Middle/Late Woodland, Late Archaic (9EB76)	Mississippian in disturbed (i.e., plowzone) context (1); Woodland and Archaic associated with terrace-levee Cambic paleosol and swale-edge (2,3a).
Mississippian, Middle/Late Woodland, Early Woodland, Late Archaic, Middle Archaic (38AB288)	Mississippian and Woodland materials in disturbed or recently sealed alluvial contexts (1,2); stratified Late Archaic assemblages preserved in both classic slackwater and ponding deposits and in underlying Cambic paleosol developed on low energy flood silts (3a); Middle Archaic associated with Argillic paleosol in slough and lower elevations and with silty bank sediments at outer levee (3b).
Mississippian, Middle/Late Woodland, Early Woodland, Late Archaic (38AB91)	Mississippian and Woodland in maxtrix of stabilized floodplain surface sediments (1,2); Late Archaic housed in Cambic paleosol (3a).
Mississippian, Middle/Late Woodland, Early Woodland, Late Archaic, Middle Archaic, Early Archaic, Paleo-Indian(?) (9EB91)	Mississippian articulates with both extensive sheet midden and activity specific features assignable to discrete occupational phases (1,2) across terrace-levee and into swale edge; Woodland deposits are spatially localized on terrace-levee (2); Late Archaic features extensive distributions on Cambic B profile documenting stabilized floodplain surface (3a); Middle and Early Archaic distributions rest on surfaces that evidence dynamic geomorphic balances, alternately registering episodes of soil formation (lamellae) and channel activity (both vertical and lateral aggradation) (3b,3c); Paleo-Indian(?) manifestation is associated with early Holocene gravel flow.

Figure 16. Local and Regional Geoarchaeological Contexts.

(i.e., swales, ox-bows, meander-scrolls) that tended to infill and flood either seasonally or in response to more sustained intervals of high runoff. Mississippian settlements were most visibly geared to utilize the differentiated floodplain micro-environments, as demonstrated by the extent of midden deposits that trail off the well drained terrace-levees and into downslope flanks (i.e., at 9EB91 and 38AB22).

Scott (1985) has made a case for seasonally dictated site utilization over the course of Mississippian times, citing the paucity of small animal bone among other lines of evidence as an indicator of winter settlement in the later Mississippian; broader species representation argues for more permanent habitation during the earlier Mississippian. Alternatively, however, this patterning in the faunal remains may reflect greater specialization, or focalization of procurement over time, a trend noted in a number of intensive agricultural populations (Speth and Scott 1985). Similar seasonal trends are not verifiable for the Woodland period, due to the meager data base, but in general it appears that the last 2000 years of prehistory register more specialized site utilization, and the strong anthropogenic components of the sediment matrices in varied site settings document these impacts. Since landform configurations had essentially assumed their current dispositions, the later prehistoric geological deposits were not indicative of major paleoenvironmental changes. The only exception to this trend is the past century's alluvium (in archaeo-stratum 1) that blankets historic and late prehistoric surfaces. That deposition is attributable, in part, to dam-regulated inundations and the bedload deposits are most analogous to the early Holocene aggradation unit (archaeo-stratum 3d).

It is the late Archaic Cambic paleosol that is the most pervasive natural sedimentary unit (archaeo-stratum 3a). The utility of this archaeo-stratum assumes major significance, since it can be used to date alluvial successions even in the absence of diagnostic archaeological assemblages or stratigraphies. The paleosol effectively furnishes a broad chrono-stratigraphic benchmark across the study area.

Below the paleosol, both the prehistoric and geologic stratigraphies display disjunct distributions. Intact Middle Archaic deposits have been noted at numerous sites while Early Archaic matrices are not nearly as abundant. In no case did the cultural materials appreciably alter the natural matrix of the alluvial fills or associated weathering profiles. Correlations across sites corroborate the model for an upward fining sequence established at 9EB91, intermittently disrupted by minor intervals of soil formation over an approximate 6000 year span (10,000-4000 B.P.). As discussed earlier, the primary evidence for soil formation derives from the present interpretations on the origins and sequential modifications of the graded beds into the lamellae.

In general, previous research (see Segovia 1985:Plate 20) has stressed the interval between 7500 and 4000 B.P. as marking the optimum expression of the Altithermal in the central Savannah valley. Three discrete peaks, at 7000, 6000 and 4000 B.P., are offset warm-dry maxima and also coincide with prime conditions for soil formation as well as for alluviation. The present research modifies these general trends somewhat and suggests that the only major period of soil formation occurred between 4000 and 3000 B.P., when the Altithermal had effectively come to an end. This Late Archaic Cambic paleosol would therefore have developed under relatively moist conditions, circumstances normally associated with the evolution of soil profiles in mid-latitude environments (Birkeland 1974; Bunting 1967). Weak pulses governing the shifting pedo-sedimentary balances during the interval 8000-5000 B.P. are accordingly manifest in the closely spaced lamellae as discussed earlier.

Previous reconstructions of the prehistoric floodplain at 9EB91 have suggested independently that by Altithermal times slowing alluviation regimes promoted by medium energy streamflows and a migrating stream exposed broader floodplain surfaces and allowed for more extensive vegetation mats, soil formation and the proliferation of the lamellae. Research by Knox (1983) across the Eastern Woodlands indicates alluviation rates had slowed in most areas east of the Mississippi River by 8000 B.P. and that in fact moderately moist conditions may have persisted in the southeast; on a finer-scale, then, the lamellar pulses may help calibrate these developments.

REGIONAL CORRELATIONS

It is clear that the primary value of archaeo-stratigraphies in the critical early to mid Holocene time range lies in sorting out processes and rates of sedimentation and soil formation and in placing general Early, Middle and Late Archaic sequences in the context of a changing floodplain. Towards this end it is feasible and appropriate to synthesize the relatively refined geoarchaeological sequences documented in the Russell Reservoir and to compare them with analogous integrated prehistoric and alluvial successions from across the southeastern United States. In this manner, it could conceivably be possible to discern regional synchroneity in the geoarchaeological record.

Three floodplain Archaic site complexes are considered: the Russell Reservoir sites along the upper Savannah River, the Ice House Bottom site along the Little Tennessee River (Chapman 1976, 1977), and the Haw River sites in the North Carolina Piedmont (Claggett and Cable 1982)(Figures 16 and 17). At all three site complexes, broadly analogous natural settings and the use of similar field methods and conceptual approaches provide a base for comparison.

Immediately striking are the following geographic observations:

1) The sites are situated at locales where depositional basins are the norm and gradients are slight. These pockets are generally downstream, except along the Savannah, but here the gradient is uniformly gentle.

2) Steep fall is characteristic only of the Little Tennessee and is accompanied by the intense upstream erosion typical of ridge and valley streams. Work by floodplain geomorphologists has shown that, with increased slope and sediment load, there is a trend to high sinuosity and meandering (Schumm 1977). This is the behavior of the Little Tennessee River as it reaches base level and the confluence with the Tennessee. Dramatic morphologic changes can occur abruptly when critical erosional and/or depositional thresholds are exceeded. This is an especially crucial consideration in explaining abrupt, block-like Archaic sediment accumulations versus the more progressive, gradual and diminished accumulations of the less dynamic piedmont streams.

3) On a finer scale, turning points along the gradient implicate variability in sedimentation modes that are critical. While micro-depositional pockets explain a high degree of this variability, studies have shown that patterned distributions of these pockets are functions of overall river hydrography (Leopold et al. 1964; Schumm 1977).

As stressed above, regional scale comparisons necessitate appreciation of a multiplicity of variables including landform configurations, channel geometry, runoff patterns, stream dynamics, and vegetation cover. Relationships among these variables are often problematic. Empirically, the geoarchaeologist has limited research resources that are determined by the soil-sediment matrix and the context it is found in. The two major parameters that may be most comfortably examined in this regard are:

1) Sedimentation Rates. These are gauged by time-depth controls using archaeological assemblages as stratigraphic indicators;

2) Soil Forming Processes. These are disclosed by the presence of relict features, in this case the Beta horizons or lamellae that occur at all the prehistoric sites under consideration.

Both parameters were examined in detail and were utilized to compare the pedo-sedimentary profiles of the three locales under consideration.

At both piedmont site complexes (Haw River and in the Russell Reservoir), the earliest major diagnostic cultural horizons are Early Archaic and occur in medium to coarse-grained sands, apparently tied to a relatively uniform depositional regime. These sands are coarsest below the zone of lamellae formation. The presence of bedload sediments at Early Archaic exposures implies vigorous channel activity at this time. Middle Archaic depths of occurrence, especially at 9EB91, are the most variable of those encountered and are associated with a series of surfaces. Progressive diminution in mean grain size is typical and argues for gentler and probably less competent streamflow. Evidence derived from recognition of paleotopographic gradients implicates variable entrenchment of the channel into underlying coarse Early Archaic deposits and characterizes a period of lateral planation across the floodplain. After this time, meandering and accompanying suspended load deposition resulted in differentiated floodplains that were relatively broad and featured a drastic reduction in the sedimentation rate.

It is the Middle Archaic horizons that mark the appearance of the mineralized clay lamellae, generally occurring as abrupt beds varying in thickness from 2 and 3 cm to as much as 10 cm. The broader, more diversified, Middle Archaic surfaces define a more stable floodplain habitat that became increasingly more attractive to more specialized prehistoric groups. By Late Archaic times sedimentation rates and patterns slowed appreciably and began resembling contemporary trends.

Because of its location in more accentuated terrain and the emergence of a more dynamic fluvial system, the depositional context of the Ice House Bottom site is in marked contrast with those characterizing the piedmont sites. Ice House Bottom is the most deeply stratified site, featuring over 3 m of deposition over 2500 years. Earliest occupation began around 9500 B.P. and the floodplain sedimentation continued through the Middle Archaic. The site is located on the first terrace of the south bank of the Little Tennessee River along a stretch of the river that displays extreme sinuosity; this is an island type situation. Sedimentation at Ice House Bottom is characterized by episodic block-like depositions with cultural and natural strata displaying more abrupt textural and structural features than the Haw River or Russell Reservoir sites, as well as clearer stratification.

Despite the dramatic differences between site settings produced initially by the constraints imposed upon the fluvial system by physiographic zonation, they all register analogous vertical successions. These are illustrated by synchronous breaks in the sedimentation and pedogenic regimes as depicted in Figure 16. Moreover, critical breaks are tied to distinctive transitions in the prehistoric succession. The synchroneity in the geoarchaeological record is initially discernible in the recurrent geological cycles registered across all three profiles. As shown, all the representative sites from each setting feature geologically sealed Archaic sequences characterized by progressive fining of sediments up the sequence. Active deposition is cyclically disrupted by lamellar horizons which appear to be pedogenetic in origin. For want of a better term we can categorize these floodplain sequences as displaying alternating intervals of pedo-sedimentary equilibrium and disruption. At given stages active net deposition ceases, and stabilization ensues and is marked by a variable degree of soil development. This may be succeeded by an erosional phase, after which deposition resumes. While the magnitude and intensity of the component phases of the cycle vary, general trends are parallel through time.

In site-specific terms, the Savannah River Rucker's Bottom site features the most compressed depositional record with obviously slow net sedimentation rates and, while the occupations are tied to the lamellae, the compactness of the profile often blurs the relationship. Lamellae are clustered at the Early/Middle Archaic stratigraphic boundary (Schuldenrein 1988, n.d.). At Haw River there is a much deeper accumulation and a more complex sequence of lamellae. The most closely spaced and thin lamellae are situated at the Early/Middle Archaic interface, highlighting some of the most crowded occupations. These abundant lamellae are indicators of relatively low sedimentation rates. The data show a major drop off in Haw River alluviation intensity prior to Morrow Mountain/Middle Archaic times (Larsen 1982). At both piedmont locations relatively low sedimentation rates are registered for the Archaic, but significantly the Early Archaic with its bedload sediment features twice the deposition of the Middle and Late Archaic periods. This may be an indicator of a desiccation trend documented for the early Holocene across the eastern Woodlands and would substantiate contemporary hypotheses linking such trends to higher alluviation rates (Schumm 1977; Knox 1983).

At Ice House Bottom the sedimentation rate data illustrate a significantly different picture. Net aggradation is much more rapid than at piedmont sites and intensifies with time. This may be attributed to a stream regime that is more episodic with a high degree of periodicity. Major accumulations against terrace edges as well as erosional unconformities (Chapman 1977) provide strong evidence for a more abrupt depositional pattern than that characteristic of the Haw and Savannah Rivers, which, as indicated earlier, featured semi-continuous overbanking intermittently disrupted. Nevertheless, the key point is that the lamellae are clustered in the middle of the sequence where they are described as "distinct but closely spaced vertically" and are so clearly linked with unique occupations. The indication is that site occupation occurred more frequently at this time. As at the other two locales this time frame brackets the Early/Middle Archaic interface. The lamellae disrupt an otherwise rapid rate of deposition.

Summarily, then, this exploratory study has documented three major regional trends bearing on Archaic period geoarchaeology:

1) Sedimentation modes, patterns, and rates along piedmont streams are, expectedly, different in intensity and magnitude from those of the ridge and valley province due to variable stream dynamics. Piedmont streams flowing along gentler gradients are distinguished by overbank sedimentation regimes over the course of the Archaic. Over time these streams lay down progressively finer sediments; Early Archaic deposition was much greater than that of subsequent periods and was associated with relatively coarse bedload deposits. The ridge and valley province supports high energy river systems whose dynamics are governed by intense upstream erosion, episodic downstream sedimentation, and abrupt sedimentation regimes reflecting sharply defined geomorphic thresholds.

2) There is a cyclical pattern for Archaic period floodplain development that may cross-cut physiographic boundaries in the southeast. Major streams feature progressive sedimentation followed by intervals of stabilization, after which soil development ensues and is succeeded by erosion. Patterned sequences of floodplain buildup and lamellae formation seem to be recurrent.

3) In this connection there is a clustering of lamellae at the Early/Middle Archaic stratigraphic boundary, suggesting that this period witnessed minimal deposition and floodplain stabilization on a regional scale. There is a correlation of the shifting pedo-sedimentary balance with the prehistoric record which establishes principal trends in floodplain morphology as they pertain to the archaeological record. The major break in the 6000 year record features a dominance of pedogenetic process at the Early/Middle Archaic boundary, during which stable and broad floodplains were promoted and contain stacked successions.

Consistent with regional observations, the model supports the hypothesis that the Altithermal was heralded by increasing sedimentation rates as erosional conditions were accelerated and the climate assumed a warming-drying aspect (i.e., by the close of Early Archaic times). New patterns of geomorphic equilibrium set in over the interval 8000-5000 B.P. as floodplains stabilized and shorter term pedogenic-sedimentation cycles dominated. The correlation between lamellae and artifact density at this juncture then assumes added significance, insofar as it suggests that drier climatic conditions may have encouraged prehistoric groups to cluster at floodplain locales.

In conclusion, it is argued that future investigations of subsistence-settlement systems across the southeast would benefit by the consideration of paleoenvironmental and geoarchaeological research. The research program undertaken during the Russell Reservoir investigations has attempted to provide an environmental context for viewing the cultural sequence and changing record of adaptation and settlement. The linkage of archaeological and paleo-environmental data is imperative if Quaternary scientists and archaeologists hope to expand the scale of prehistoric research.