Cretaceous-Tertiary Stratigraphy of the Upper Edge of the Coastal Plain between North Augusta and Lexington, South Carolina

by

Paul G. Nystrom, Jr., Ralph H. Willoughby and Lucille E. Kite

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South Carolina Geological Survey

Front Cover: Crossbeds in Cretaceous sediments at Stop 1 of the 1986 CGS field trip.

Quarter (lower left) for scale.

Copies of this guidebook are available from:

South Carolina Geological Survey

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FOREWORD

The noble science of Geology loses glory from the extreme imperfection of the record. The crust of the earth with its imbedded remains must not be looked at as a well-filled museum, but as a poor collection made at hazard and at rare intervals. The accumulation of each great fossiliferous formation will be recognized as having depended on an unusual occurrence of favourable circumstances, and the blank intervals between the successive stages as having been of vast duration.

Charles Darwin, 1872 (sixth edition), The origin of species by means of natural selection or the preservation of favoured races in the struggle for life, Chapter 15, Recapitulation and conclusions.

I believe that I was considered by all my masters and by my father as a very ordinary boy, rather below the common standard in intellect. To my deep mortification my father once said to me, "You care for nothing but shooting, dogs, and rat-catching, and you will be a disgrace to yourself and all you family."

Charles Darwin, quoted in Francis Darwin, 1902, Charles Darwin: His life told in an autobiographical chapter, and in a selected series of his published letters: John Murray, publisher, London, Chapter 2, Autobiography, p. 9.

DEDICATION

Drilling of nearly 400 auger holes in the area of Plate 1 has allowed us to make our geologic mapping a reality. Gary L. Taylor (left in photo), Geologic Technician, has skillfully operated the drill rig for most of those holes. We dedicate this guidebook in appreciation to Gary Taylor and other state employees who have helped during our drilling: Danny Alexander, Greg Bowers, Walter Green, Paul Hawkins, Jeff Peay, Andy Timmerman, Kevin Wilson and Sam Zollicoffer.

CAROLINA GEOLOGICAL SOCIETY
Guidebook for 1986 Annual Meeting
Pages 1-5

CRETACEOUS – TERTIARY STRATIGRAPHY OF THE UPPER EDGE OF THE COASTAL PLAIN BETWEEN NORTH AUGUSTA AND LEXINGTON SOUTH CAROLINA

Paul G. Nystrom, Jr., Ralph H. Willoughby and Lucille E. Kite
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INTRODUCTION

This guidebook presents a description of the stratigraphy in the upper edge of the Coastal Plain in western South Carolina. The sediments included range in age from Cretaceous to Quaternary. The "Geologic Map of the Upper Edge of the Coastal Plain between North Augusta and Lexington, South Carolina" (Plate 1) is included in the guidebook. The work is based on geologic mapping by the three of us from 1981 to the present.

Previous geologic maps, other than compilations and other than our own work, of this part of the South Carolina Coastal Plain, are by Hammond (1883), Cooke (1936), Land (1940), H. Smith (1949), Siple (1967), de Araujo (1975), Metzgar (1977), Bramlette (1980) and G. Smith (1979a 1980) and Campbell (1982). Other stratigraphic work in this area of South Carolina has been by Sloan (1904, 1907, 1908), Cooke and MacNeil (1952), Colquhoun and Johnson (1968), Colquhoun and others (1969, 1982, 1983), Oldham (1979), Bishop (1982), Campbell (1982) and Colquhoun and Steele (1986). Our own published or open-file work is listed in the references; the division of mapping responsibilities among ourselves is shown on Plate 1.

PIEDMONT ROCKS

Rocks seen in the Piedmont part of the map area (Plate 1) include granite, metagranite, gneisses, and metavolcanic and metasedimentary slates. A discussion of these rocks is beyond the scope of this guidebook and field trip.

CRETACEOUS SEDIMENTS

Previous work

The Cretaceous strata of the upper edge of the Coastal Plain of western South Carolina have been referred to as the "Hamburg beds" and "Middendorf beds" of Lower Cretaceous age (Sloan, 1904, 1908), the Middendorf Formation (Cooke, 1926), and the Tuscaloosa Formation (Cenomanian, Late Cretaceous) (Cooke, 1936; Lang, 1940; Siple, 1967; Prowell and O'Conner, 1978). Berry (1914) described assemblages of Upper Cretaceous leaf fossils from two localities in Aiken County that he assigned to the Middendorf member of the Black Creek formation. Berry's account (1914, p. 6-7, p. 10-11) notes that prior to 1906 Earle Sloan sent a collection of fossil leaves from the Langley locality to Professor L. C. Glenn at Johns Hopkins University, and in 1910 Sloan sent a collection of fossil leaves from the Miles Mill locality to Berry at the U.S. National Museum. Berry cited 17 plant species from the Langley locality and 7 plant species from Miles Mill.

Sloan (1904) provided rater precise directions to the Miles Mill locality, his exposure no. C. 200: "the Middendorf clays attain their Mill, high up on the side of a valley formed of crystalline rocks. This deposit afforded many fossil leaves;" (sloan, 1904, p. 77). And "2.6 miles west from Miles' Mill (railway station); connected by road; 0.5 miles distant from Horse Creek. Thickness of bed: 4 feet; overburden: 5 feet with rapid increase. Clay properties: fine grained, pink color (many fossil leaves present)" (Sloan, 1904, p. 126). Miles Mill is shown on the map by Bowles (1871) and is at approximately the site of Sunny Brook as shown near the center of the Trenton, South Carolina 7.5 minute quadrangle map (U.S. Geological Survey, 1973, photorevised 1982). Therefore Sloan's directions place this locality in the upper valley of Horse Creek as shown on the Trenton quadrangle map. Piedmont saprolite and Cretaceous clays and sandy clays crop out on the road crossing at Pearsons Pond on that stream valley, as well as on both sides of the valley at Sunny Brook. These localities are very close to the northwestern pinchout of the Cretaceous sediments.

Directions to the Langley locality provided by Sloan (1904, p. 77, 127) and by Berry (1914, p. 10) differ slightly. Our mapping is consistent with directions by either Sloan or Berry. This area is in southern Graniteville quadrangle and lies outside the area of Plate1.

Smith and White (1979) and Smith (1979b) recognized that most of the kaolin-bearing strata in Aiken County are (Paleocene to) middle Eocene in age and mapped them as the Huber Formation, and they tentatively and locally mapped, as the Upper Cretaceous Middendorf formation, the lower of the two kaolin-bearing sequences in the Graniteville – Hollow Creek area. Smith (1980) did not map Cretaceous strata in Lexington County. Buie and Schrader (1982) and Nystrom and Willoughby (1982c) concluded that neither Tuscaloosa Formation nor Middendorf Formation can be properly applied to the Cretaceous sediments exposed in western South Carolina, and preferred unnamed, Cretaceous sequence. Buie and Schrader (1982, p. 2-3) and Nystrom and Willoughby (1982c, p. 86) referred to pollen dates to assign a Late Coastal Plain in the area between the Savannah and Congaree rivers by ourselves (see Plate 1) has continued in this same manner. The Cretaceous sediments, as seen in surface exposures and in near-surface auger holes, extend along strike with similar lithologic characteristics from western Aiken County through Lexington County. We have not been able to differentiate the Cretaceous sediments into more than on map unit, and we infer that the sediments represent a single deposition sequence.

Lithology

Within the report area along the upper edge of the Coastal Plain, the Cretaceous sediments consist of fine- to very coarse-grained, mostly coarse-to very coarse-grained, poorly sorted, angular to subangular, kaolinitic, micaceous quartz sand with minor amounts of sandy kaolin. Granules and pebbles are fairly abundant, most commonly consisting of smoky quartz. Fine-grained, well-sorted sands occur locally. Fine-to coarse- grained, dark heavy minerals are commonly scattered through the sediments or concentrated along bedding planes. Kaolin balls of various sizes are abundant, as are discontinuous clay laminae. Fresh exposures are white to cream colored, with local purple colorations due to Fe-concentrations.

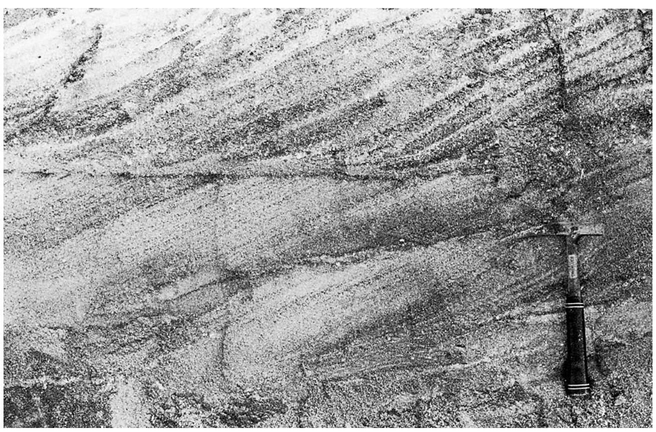

Figure 1. Cross-bedded, poorly sorted, micaceous, clayey sand in Cretaceous sediments in northeastern 1/4 of Monetta quadrangle at 81 degrees 50’ 05”, 33 degrees 33’ 18” W.

Exposures of the kaolinitic sands and gravels typically exhibit well-developed trough cross-beds (see cover), tabular cross-beds (Figure 1), and channel-fill structures. Bedding is very irregular and shows little or no lateral continuity. Upward fining of sands within cross-bed sets is common.

Lenses of kaolin typically occur in the upper portion or at the top of the Cretaceous sediments. These Cretaceous (“soft clay”, Figures 2 and 3) kaolin deposits are typically distinguishable for overlying Tertiary (“hard clay”, Figure 4) kaolin beds (Buie and Schrader, 1982) and have smooth, conchoidal fracture, a bright white, cream or locally purple color and adhere easily to the hands. Most of those kaolin deposits of thickness, continuity and quality to be of commercial grade found within the map area of Plate 1 that have

Figure 2. Conchoidal fracture in kaolin bed at the top of the Cretaceous in J. M. Huber Corporation’s Corder kaolin mine in northwestern ¼ of Foxtown quadrangle.

been mined have been used in manufacture of structural clay products such as brick. Cretaceous kaolin is being mined from J.M. Huber Corporation’s Edisto and Corder pits and Cyprus Industrial Minerals Company’s Gentry pit, all in western Foxtown quadrangle, for industrial uses. For more information on the stratigraphy of the Aiken County kaolin mining district see Nystrom and Willoughby (1982 b).

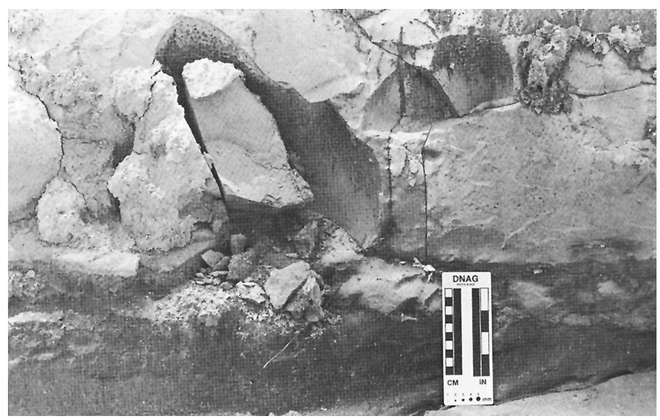

Figure 3. Conchoidal fracturing in Cretaceous kaolin, dirt road north of Mason Branch in western Aiken NW quadrangle.

Localized silicification of the kaolinitic sands and clays has resulted in ledges of sandstone which are discontinuously exposed in several areas, the best of which is along the valley walls of Congaree Creek in central Lexington County, as discussed by Kite (in review). Several meters of cross-bedded to massive, kaolinitic sand are exposed in numerous outcroppings of high ledges and large boulders. One of these exposures is thought to be that referred to by Tuomey (1848, p. 145) as “Rock House” (see Stop 11). Other exposures of silicified sandstone can be found southeast of Leesville along the valleys of Marlowe Creek, Hellhole Creek and Lightwood Knot Creek. Tuomey (1948, p. 144, 145) and

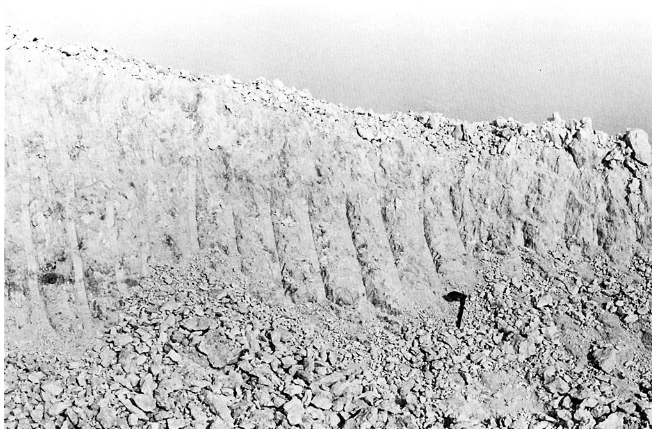

Figure 4. Thick bed of kaolin with distinctive, hackly fracture at the top of the Huber Formation in W. R. Grace Company's Scott-Garrett kaolin mine in northwestern ¼ of Foxtown quadrangle.

Sloan (1904, p. 87; 1908, p. 342) referred to these exposures, but included the silicified sandstones in the Eocene rather than the Cretaceous.

The base of the Cretaceous sediments is marked by angular to rounded cobbles, pebbles and coarse-grained sand which rest upon saprolite of the underlying Piedmont. This contact exhibits considerable relief over short distances, and drops steeply to the southeast. The contact between the Cretaceous sediments and the overlaying Tertiary sediments dips southeastward at 2.3 meters per kilometer along Shaw Creek in Aiken County and 5.5 meters per kilometer in the Gilbert quadrangle in western Lexington County. The contact is easily recognized in the field within the report area, the very clayey, very micaceous, very coarse-grained sand or sandy clay of the Cretaceous typically overlain by finer-grained, less clayey sand of the Huber Formation (Figure 5). Locally post-Cretaceous weathering has produced pisolitic kaolin at the top of the unit, and clasts of pisolitic clay are commonly incorporated into the basal portion of the Huber Formation.

Figure 5. Exposure of white, clayey Cretaceous sand overlain by loose sand of the Huber Formation in northeastern corner of Foxtown quadrangle.

Distribution

The Cretaceous sediments are exposed over quite a large are of Lexington County, extending inland beyond the Tertiary units to the fall line. However, from just east of Leesville in western Lexington County and continuing westward through Saluda, Edgefield and northern Aiken counties, the Cretaceous sediments pinch out updip between the crystalline rocks of the Piedmont and the overlying middle Eocene sediments (Nystrom, 1986a; Willoughby, 1986a, b).

Age and Correlation

Analysis of pollen from a locality along I-20 in southern Aiken NW quadrangle (made by Ray Christopher, provided by David Prowell and cited by Nystrom and Willoughby, 1982c, p. 86) has yielded a Late Cretaceous (late Campanian) age determination. Correlation of the pollen-bearing locality, and by extrapolation most of the Cretaceous sequence in western South Carolina, with Unit UK of Prowell and others (1985) and with the Black Creek Formation of eastern South Carolina is likely.

HUBER FORMATION

Previous work

The Huber Formation was named by Buie (1978) "for all of the post-Cretaceous pre-Jackson strata in the kaolin mining districts of Georgia, northeast of the Ocmulgee River", he designated a type locality or type area, and he provided a measured section from a specific kaolin mine. In that area the entire stratigraphic section between the Piedmont crystalline rocks and the base of the Jacksonian sediments (Barnwell Group) was for years called Tuscaloosa and classified as Late Cretaceous. Eargle (1955) did, however, suggest the possibility that the kaolin deposits of central Georgia might be of pre-Jacksonian Tertiary age. In 1964 Buie found molds of Tertiary mollusks below a kaolin bed near Huber, Georgia. This was the first concrete evidence that part of the kaolinitic sequence in Georgia and South Carolina was of Tertiary age (Buie and Fountain, 1968). Subsequently a number of workers have identified Cretaceous, Paleocene or Eocene ages by analyzing pollen in carbonaceous material associated with kaolin in Georgia (Scrudato, 1969; Scrudato and Bond, 1972; Cousminer, 1973; Cousminer and Terris, 1973; Tschudy and Patterson, 1975; Buie and Schrader, 1982; Horstmann and others, 1983).

Abbott and Zupan (1975) reported Eocene diatoms from an outcrop of kaolin near Couchton in Oakwood Quadrangles in Aiken County, South Carolina. Subsequent mapping in the area shows this exposure is near the top of the Huber Formation (Kite, 1983a). Hutchenson (1978) identified as middle Eocene fossil leaves collected from near the base of a commercial kaolin bed mined by Cyprus Industrial Minerals Company. Mapping by Willoughby (1984) demonstrates this kaolin bed is at the top of the Huber Formation.

Fossil leaves were collected from gray-brown kaolin at the top of the Huber Formation at Dixie Clay Company's McNamee #2 pit near Bath (see measured section for Stop 5 in Nystrom and others, 1982). A pollen-bearing sample of this kaolin was identified as from the lower part of the middle Eocene (Norm Fredrickson, written communication to Dave Prowell, 1982).

Buie (1978) was aware that his definition of the Huber Formation included beds of both Paleocene and middle Eocene age and he referred to identification of both ages by Tschudy and Patterson (1975). As used by us in the map area (Plate 1), the Huber Formation designates a single depositional sequence of lower middle Eocene age. Paleocene strata that occur at the surface and in the subsurface southeast and east of the map area are lithologically and biostratigraphically different from the Huber, as we use the term, and are not included as part of the unit. We recognize that formal restriction of the term "Huber Formation" to either the middle Eocene depositional sequence or to a Paleocene depositional sequence may be desirable, but if so the work should be done in the type area and at the type section in Georgia and is beyond the scope of this guidebook.

Lithology

The massive beds of pure kaolin mined from the Huber Formation occur at the top of the unit in South Carolina (Figure 6). These commercial beds occur only here and there, however, and the upper part of the Huber (approximately 20-40% of the section) in outcrop is typically cross-bedded, orange sand with white kaolin balls (Figure 7). The sand is generally cohesive, fairly well-packed, with moderate to minor amounts of interstitial clay. Usually it is poorly sorted, medium- to very coarse- grained sand with some granules. The sand grains are subangular. Pebbly sand occurs in places. Burrows occur in some exposures. In drill holes the top of the Huber is commonly drab-brown, cohesive, clayey-grit with interstices partially to completely clay-filled. Subangular coarse grains, very coarse grains, granules, and scattered subrounded to rounded pebbles comprise the grit. In places there is no grit and the top of the unit is white, pale yellow or orange, loose, clean, powdery, poorly sorted, subangular, fine- to very coarse-grained quartz sand with some quartz granules.

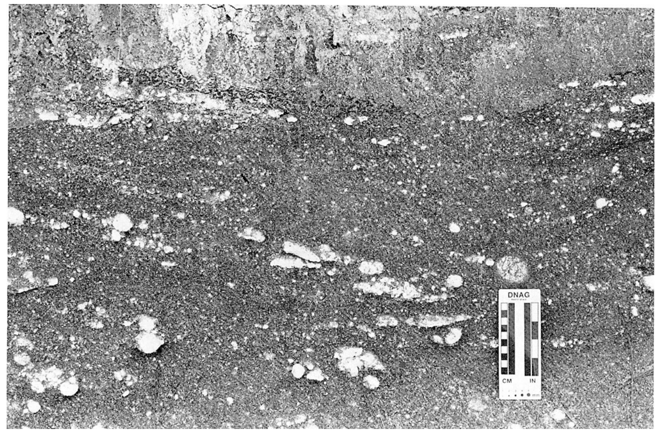

Figure 7. Typical upper Huber cross-bedded orange sand with white kaolin balls in southeastern Ridge Spring quadrangle.

The lower part of the Huber (approximately 60-80% of the section) is characteristically clean, loose sand with no interstitial clay. Well-sorted, fine-grained "sugar sand" with thin clay interlayers is common, but the texture varies and includes very poorly sorted, medium- to very coarse-grained

Figure 6. Bench of massive, pure kaolin at the top of the Huber Formation in W.R. Grace's Scott-Garrett mine, southwestern corner of Foxtown quadrangle.

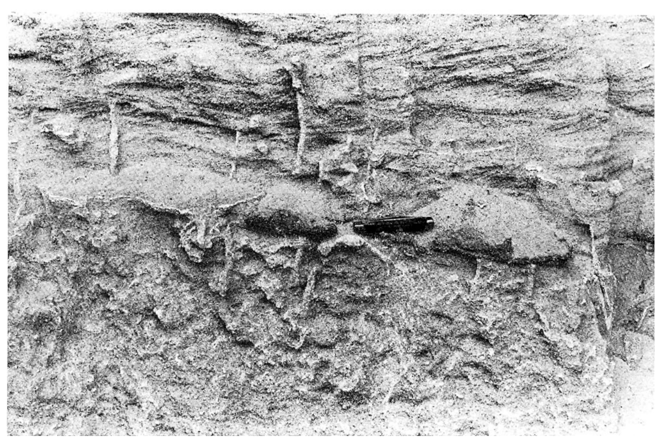

Figure 8. Burrows in cross-bedded sand in the lower part of the Huber Formation. J.M. Huber Corporation's Corder kaolin mine in the northwestern ¼ of Foxtown quadrangle.

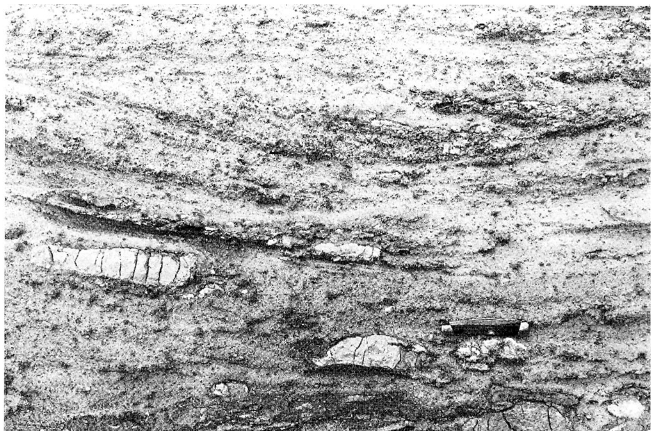

Figure 9. Cross-bedded sand with large clay clasts in the lower part of the Huber Formation. Same locality as Figure 8.

sand with abundant granules and scattered pebbles. The sand grains are generally subangular, but vary from angular to subrounded. Heavy minerals are more abundant than in the Cretaceous, Barnwell Group, or upland unit sediments. The heavy minerals range from very fine- to fine-grained in the "sugar sands" to fine- to coarse-grained in the coarser sands. Burrows are locally abundant (Figure 8). Bedding varies from thin- to thick sets (more than 1.5 m or 5 feet) of sweeping cross-beds. Locally flat clay rip-up clasts occur in the cross-beds (Figure 9).

In drill holes the basal one meter or so of the Huber Formation is commonly dark brown or magenta, loose, clean, poorly sorted grit comprised rounded pebbles. Fine-to very coarse-grained heavy minerals are abundant. Locally large pisolitic kaolin boulders occur at the base. The lower part of the Huber is distinctively different from the cream-colored, moderately stiff, clayey grit or clay that characterizes the Cretaceous sediments below.

Distribution

The Huber Formation varies in thickness from a feather edge at the Coastal Plain margin to 40 m or 130 feet in places along the southeast edge of the map area. Throughout most of the map area the Huber is bounded below by Cretaceous sediments and above by Jacksonian sediments of the Barnwell Group. To the southeast and east of the map area the Huber overlies Danian age or Sabinian age strata of the Black Mingo Group (Van Nieuwenhuise and Colquhoun, 1982). From Leesville southwest to beyond Sweetwater (near North Augusta) the Huber extends to the very edge of the Coastal Plain, overlapping the Cretaceous and lying directly on Piedmont crystalline rocks. From Edgefield to Batesburg there are only two units at the edge of the Coastal Plain, the Huber Formation and the upland unit. The Huber overlaps the Cretaceous by more than five miles between Edgefield and Ward, and near Ward it extends about five miles updip beyond the pinchout of Barnwell Group sediments.

BARNWELL GROUP

Introduction

The current concept of the Barnwell Group and of the formations in the Barnwell Group is based on work done in Georgia. For a review of those developments, see Huddlestun and Hetrick (1978, 1979, 1986), Huddlestun (1982) and Nystrom and Willoughby (1982b). Prowell and others (1985) presented lithostratigraphic and biostratigraphic information pertaining to the Barnwell Group in Georgia and South Carolina. Prior to the work of Siple (1967), Smith and White (1979) and Kite and Nystrom (1983), the wide areal extent of the "Hawthorn Formation" or upland unit was not recognized in western South Carolina, and the upland unit was included with the Barnwell Formation on earlier geologic maps. Colquhoun and Steele (1985) also included the upland unit in the Barnwell.

Previous Work

Sloan (1907a, p. 17; 1907b, p. 90; 1908, p. 454, 460-461) named his "Barnwell Phase" to include stratified fine-grained sands, glauconites and ferruginous sandstones that overlie his Warley Hill formation and Santee limestone (middle Eocene). Sloan (1908, p. 461) considered the Barnwell to be "incident to the latter part of the middle Eocene." Sloan did not designate a type section or type locality for his concept of the Barnwell. Subsequently, Cooke (1936) used the Barnwell formation in western and central South Carolina to include updip Eocene sands that overlie the McBean formation (middle Eocene), and he considered the Barnwell to be late Eocene in age. Lang (1940) and Siple (1967) also mapped the Barnwell formation in updip, western South Carolina. Cooke and MacNeil (1952, p. 26-27) discussed the Barnwell Formation and considered it to be of Jacksonian, late Eocene age. Colquhoun and Johnson (1968) recognized the Barnwell Formation in western South Carolina and (p. 116) cited its occurrence at the edge of the Coastal Plain at elevations as high as 200 m above present sea level. Colquhoun and others (1969) also recognized and discussed the Barnwell Formation in western South Carolina.

De Araujo (1975) mapped and described the Barnwell Formation in Aiken NW quadrangle, although his map outline for the Barnwell differs from current mapping. LaMoreaux (1946a,b) first recognized the "upper sand member of the Barnwell formation" that Huddlestun and Hetrick (1978) formally named the Tobacco Road Sand. Huddlestun and Hetrick (1979) recognized the inconsistencies and inadequacies of previous concepts of the Barnwell, and they established the Barnwell Group to include the Clinchfield

Formation (Pickering, 1970), Dry Branch Formation and Tobacco Road Sand. Smith and White (1979) and Smith (1980) mapped undifferentiated Barnwell Group in Aiken and Lexington counties, and Smith (1979b) described lithologies of the Dry Branch Formation and Tobacco Road Sand of the Barnwell Group in Graniteville and Hollow Creek quadrangles in Aiken County. The authors of the South Carolina field descriptions in the 1982 Carolina Geological Society field trip guidebook (Nystrom and Willoughby, 1982b) recognized the Dry Branch Formation and Tobacco Road Sand but did not formally apply the term "Barnwell Group". Colquhoun and others (1983, Cross-sections D and E and Map #18) recognized the Dry Branch and Tobacco Road formations or undifferentiated Barnwell Formation over parts of Aiken, Lexington and Orangeburg counties.

The Clinchfield Sand of central Georgia has not been recognized in South Carolina. Herrick (1972) cited a list of (upper Eocene) foraminifera collected from the "Cooper Marl" at Baldock, Allendale County, South Carolina and he correlated the beds at Baldock with the Clinchfield Sand in Georgia. Steele (1985a, 1985b) has mapped the Baldock with the Clinchfield Sand in the Dry Branch Formation, and Steele, Zullo and Willoughby (in press) recognize the calcareous Griffins Landing Member (Huddlestun and Hetrick, 1979) of the Dry Branch Formation at a locality on Lower Three Runs in Allendale County. Zullo and Kite (1985) recognized the Griffins Landing Member in cuttings from 2 auger holes in eastern Aiken County. In our surface geologic mapping in South Carolina we have recognized only the Dry Branch Formation, Tobacco Road and, in extreme updip areas near the northwestern pinchout of the group, undifferentiated Barnwell Group.

Age

Sediments of the Barnwell Group lie unconformably on the Huber Formation of early middle Eocene age and are overlain by the upland unit. Huddlestun and Hetrick (1979) considered the Barnwell Group to be Jacksonian, late Eocene, in age. We concur with the upper Eocene age for the Dry Branch Formation and Tobacco Road Sand proposed by Huddlestun and Hetrick (1978, 1979, 1986) and as discussed by Prowell and others (1985). Published opinions in support and to the contrary are discussed below.

Prowell and others (1985) recognized several geologic units in the Coastal Plain of central Georgia to western South Carolina, an their information for Jacksonian strata warrants further discussion here. They did not describe the nature of the boundaries between their geologic units, but they provided discussions of the biostratigraphy of calcareous nannofossils and dinoflagellates from those units. Their unit E6 is the lithostratigraphic and biostratigraphic equivalent of the Clinchfield Sand of the Barnwell Group, and they consider it to be early late Eocene (Jacksonian) age (zones NP19/20), and yields dinoflagellate assemblages of units E6 and E7. Their unit 01 lacks diagnostic fossils. "Its position atop beds of late Eocene age (unit E8) suggests that it is probably Oligocene, but it may be younger."…… "In eastern Georgia and western South Carolina, the biostratigraphic and lithostratigraphic equivalent of unit 01 could be the Tobacco Road Sand Member is considered late Eocene (Jacksonian) by Huddlestun and Hetrick (1979), Nystrom and Willoughby (1982) and Prowell and O'Connor (1978) present evidence that it could be Oligocene" (Prowell and others, 1985 p. 2).

The age information presented by Prowell and others (1985) for their unit E8 agrees with the late Eocene (Jacksonian) age for the Dry Branch Formation and Tobacco Road Sand proposed by Huddlestun and Hetrick (1978, 1979, 1986) and accepted by us. The suggested Oligocene age for the Tobacco Road Sand of the Barnwell Group has not been demonstrated. The relationship between the Tobacco Road Sand of outcrop areas in Georgia and South Carolina and geologic unit 01 of Prowell and others (1985) is not certain. The evidence proposed (Nystrom and Willoughby, 1982c; Prowell and O'Connor, 1978) to support an Oligocene age for the Tobacco Road Sand is discussed here and is not supported.

Zullo and others (1982, in Nystrom and Willoughby, 1982b) recognized a late Oligocene to early Miocene barnacle species at 3 localities in the Dry Branch Formation or Tobacco Road Sand in Aiken County. Zullo (1984) formally described the barnacle species as *Lophobalanus baumi,* based on specimens from the lower Miocene Belgrade Formation in North Carolina, and he also illustrated specimens of *Lophobalanus baumi* from the Dry Branch Formation in Aiken County, South Carolina. Willoughby and others (1984) proposed that the rocks and sediments in South Carolina that yield *Lophobalanus baumi* are, instead of the Dry Branch Formation or Tobacco Road Sand, a younger depositional sequence of late Oligocene or early Miocene age. Thus the documented occurrences of *Lophobalanus baumi* in Aiken County, South Carolina should no longer be cited as providing evidence for the age of any part of the Barnwell Group.

In discussing the age of the upper sand member (= Tobacco Road Sand as used by us) of the Barnwell Formation, Prowell and O'Connor (1978, p. 683) cited a written communication from R.W. Purdy, 1977, and stated: "Fossils collected in the downdip area of this unit….indicate that it is Oligocene to lower Miocene." The exact stratigraphic source of the shark teeth collected has not been demonstrated conclusively. The cited Oligocene to early Miocene age suggests that the fossils under discussion may be derived from the upper Oligocene to lower Miocene depositional sequence that Willoughby and others (1984) recognized in Aiken County, South Carolina rather than from the Tobacco Road Sand.

Green, silty clay at Bradley Mill Branch in southern

Aiken NW quadrangle has yielded a dinoflagellate assemblage that Lucy Edwards identified as early Oligocene or possibly latest Eocene (Willoughby and others, 1984). Comparison of the age determination based on calcareous nannofossils with that based on dinoflagellates from unit E6 of Prowell and others (1985) suggests that the younger end of the age limit provided for the clay body at Bradley Mill Branch should be evaluated critically. The clay body at Bradley Mill Branch certainly is part of the Barnwell (Jacksonian) depositional sequence and it is lithologically most like parts of the Dry Branch Formation. The relatively young age proposed for the clay body's dinoflagellate assemblage suggests its correlation with the Tobacco Road Sand. Alternatively, if the clay body at Bradley Mill Branch is a part of the Dry Branch Formation, it may demonstrate a lower lithostratigraphic (and biostratigraphic) range for dinoflagellate species that occur there.

Environment of Deposition

The marginal marine, coastal environment that Huddlestun and Hetrick (1979, p. 1) proposed for the Barnwell Group seems reasonable in view of the following features that we recognize in the Dry Branch Formation and Tobacco Road Sand in South Carolina.

The abundance of quartz sand.

Scattered to common occurrence of the trace fossil *Ophiomorpha nodosa.*

Rare to only scattered occurrences of marine body fossils in updip areas.

Occurrence of montmorillonitic clay in Dry Branch Formation.

The general absence of calcareous sands updip and the transition to, or addition of, calcareous sediment (Griffins Landing Member) downdip.

Concave-up outlines of montmorillonitic clay beds of the Dry Branch seen in some kaolin mines suggest an origin as fillings in tidal channels. Huddlestun and Hetrick (1978, p. 71-75) presented evidence both for a marine, nearshore origin and for a coastal environment of variable, marine conditions for the Tobacco Road Sand.

Distribution

The Barnwell Group occurs throughout the area of Plate 1 except in dissected areas and except for the extreme updip area between Ropers Crossroads quadrangle and the vicinity of Leesville in Lexington County. Along the updip, inland edge of the Coastal Plain between those two area, the upland unit has overlapped the Barnwell Group and lies directly on the middle Eocene Huber Formation. Outcrops of the Dry Branch Formation and Tobacco Road Sand become less common and the two formations become thinner toward the northwestern pinchout of the Group. In some auger holes drilled near the Barnwell Group pinchout, the two formations are thin or difficult to recognize, but in other auger holes drilled near the pinchout (for example, south-central Johnston quadrangle) the two formations are readily separable from each other and from the overlying formations.

Dry Branch Formation.

Previous work. Huddlestun and Hetrick (1979) named the Dry Branch Formation to include calcareous, fossiliferous sand (Griffins Landing Member), intermixed sand and montomorilonitic clay (Twiggs Clay of Shearer, 1917 or Twiggs Member) and bedded sand and lesser clay (Irwinton Sand of LaMoreaux, 1946a, 1946b or Irwinton Member), as well as undifferentiated Dry Branch Formation. In our geologic mapping in parts of Aiken, Edgefield, Lexington, Orangeburg and Calhoun counties we have recognized only undifferentiated Dry Branch Formation.

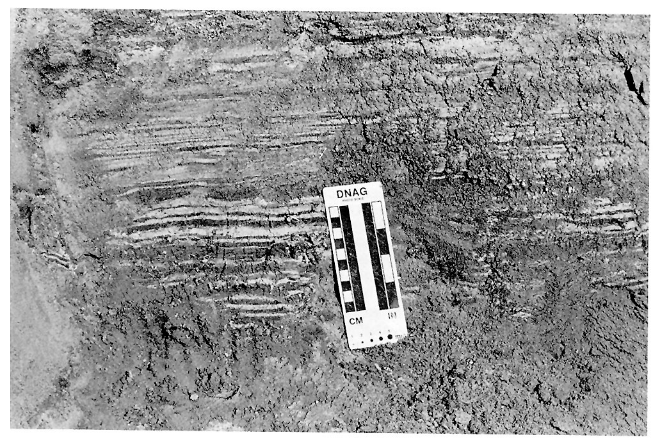

Figure 10. Horizontal bedding in fine-grained quartz sand with minor laminae of montmorillonitic clay of the Dry Branch Formation in a borrow pit by S.C.G.S. drill hole 19-3 in northeastern Trenton quadrangle.

Lithology. The three main lithologies we have recognized in the Dry Branch Formation in South Carolina are described below.

1. Well-sorted, loose, incohesive, very fine- to fine-grained quartz sand with little or no interstitial clay. Typically occurs above the base of the Dry Branch. Wispy clay laminae are common to absent (Figure 10).
2. Poorly sorted to moderately well-sorted, medium-to very coarse-grained quartz sand and quartz granules with moderate interstitial clay and scattered to abundant quartz pebbles. Wispy, interrupted clay laminae may be scattered to abundant. This aspect of the Dry Branch Formation may include scattered to abundant *Ophiomorpha nodosa* trace fossils (burrows), or the burrowing may have disturbed the sediment so intensely that original bedding is difficult to recognize (Stop 2).
3. Stacked laminae and thick beds of plastic, cohesive,

sticky, waxy, montmorillonitic clay are a distinctive feature at many exposures of the Dry Branch Formation, particularly at more downdip localities. The clay beds and laminae are olive green in fresh exposures (rare) and weather to light green, yellow, tan, brown, purple and cream. Bedded clay typically occurs in the lower part of the Dry Branch Formation and may form beds up to 1.5 or 2 m thick; occurrences we have seen extend a few tens of meters laterally (within a kaolin pit or borrow pit) but cannot be recognized or traced beyond that scale. The montmorillonitic clay in the Dry Branch Formation in South Carolina is similar to the montmorillonite clay body in central Georgia that is named the Twiggs Clay or Twiggs Member of the Dry Branch Formation, but the clay occurrences in updip, western South Carolina are intermittent and discontinuous and probably were never physically continuous with the Twiggs of central Georgia.

Rounded or discoidal quartz pebbles are locally abundant in the basal Dry Branch Formation. The lower, coarser sands commonly include more interstitial clay and more clay laminae and thin beds than the finer-grained typically clay-poor sands that usually occur higher. Wispy, irregular, discontinuous clay laminae are common at most exposures of the Dry Branch and help to distinguish it from the Tobacco Road.

Probably most clay beds in the Dry Branch that are more than 1 m thick occur in the lower one-third or one-half of the formation, but this is not universally so. For example, the clay bed, 1 to 2 m thick, exposed in the wall of the reclaimed borrow pit (now serving as a mobile home park) by auger hole 2-161 in southern North Augusta quadrangle is in the upper one-third of the Dry Branch.

Thickness. The Dry Branch Formation is more than 16 m (52 ft) thick at auger hole 2-161, in southern North Augusta quadrangle near the southwestern margin of Plate 1, and thins rapidly updip to the northwest toward the pinchout of the Barnwell Group.

Fossils and Age. Fossils are known but are not common in the Dry Branch Formation in western South Carolina. Recent work by Nystrom in northeastern Hollow Creek and northwestern New Ellenton quadrangles shows several localities that are demonstrably in the Dry Branch Formation and that include silica-cemented rocks with silica-replaced fossils noted by Nystrom are in the same immediate area and elevation as a locality for the barnacle-bearing rocks first noted by Zullo and others (1982). The newly discovered occurrences need not violate the conclusions reached by Willoughby and others (1984) in assigning the 3 documented "barnacle rock" localities of Zullo and others (1982) to a younger depositional sequence rather than to the Dry Branch Formation or Tobacco Road Sand. The recognition of silica-cemented rock, with included silica-replaced fossils, demonstrably in the Dry Branch Formation or Tobacco Road Sand. The recognition of silica-cemented rock, with included silica-replaced fossils, demonstrably in the other silicified rock at positions of initially uncertain stratigraphic placement should be viewed as a result of diagenetic phenomena rather than as an indicator of stratigraphic position. Thus the localities in Aiken County for fossiliferous, silica-cemented rock noted by Willoughby and others (1984), other than the 3 documented localities for *Lophobalanus baumi* Zullo, 1984, should be considered as Dry Branch Formation or possibly Tobacco Road Sand unless they are proved younger. These localities include occurrences in southwestern and west-central Aiken quadrangle and at the common corner of Graniteville, Trenton, Aiken NW and quadrangles.

Harris and Fullagar (1982) reported a Rb-Sr isochron age of 20 $\pm$ 0.2 million years (near or just above the Oligocene/Miocene boundary) for glauconite grains from the Twiggs Clay or Twiggs Clay Member of the Dry Branch Formation at the Medusa Portland Cement Company pit in Houston County, Georgia. Huddlestun and Hetrick (1986) provide evidence, based on planktonic foraminifera, for the strictly Eocene age of the Twiggs a short thickness below the sample dated by Harris and Fullagar. Apparently the late Oligocene or early Miocene isochron age reported by Harris and Fullagar (1982) permits the reassignment of the upper, glauconitic bed at the Medusa pit to a younger depositional sequence but does not affect the age assignment of the remaining Twiggs.

Published or in-press descriptions of fossils from the Dry Branch Formation in South Carolina were noted in the discussion of the Barnwell Group. The late Eocene age of the Dry Branch Formation is well documented in central and eastern Georgia (Huddlestun and Hetrick, 1979, 1986; Prowell and others, 1985).

Tobacco Road Sand

Previous work. LaMoreaux (1940a,b) first recognized the "upper member of the Barnwell formation" that Huddlestun and Hetrick (1978) formally named the Tobacco Road Sand. The formation consists primarily of medium-to very coarse-grained quartz sand with minor to moderate interstitial clay. The base of the Tobacco Road commonly consists of coarse- to very coarse-grained quartz sand and quartz granules with rounded, flat to discoidal quartz pebbles; the coarseness of the quartz grains in the base of the Tobacco Road contrasts with the much finer-grained quartz sand, locally with montmorillonitic clay, that commonly forms the top of the Dry Branch Formation and on which the unit lies.

Lithology. The Tobacco Road Sand consists primarily of medium- to very coarse-grained quartz sand and quartz granules with a moderate amount of interstitial clay. The basal Tobacco Road, like the basal Dry Branch, consists of coarse- to very coarse-grained quartz sand and quartz granules with locally abundant rounded or discoidal quartz pebbles (Figure 11). The contact between the Dry Branch

Figure 11. Pebble bed at the base of the Tobacco Road Sand overlying the Dry Branch Formation at a locality in northeastern Foxtown quadrangle, 33 degrees 41' 20" N, 81 degrees 30' 48" W.

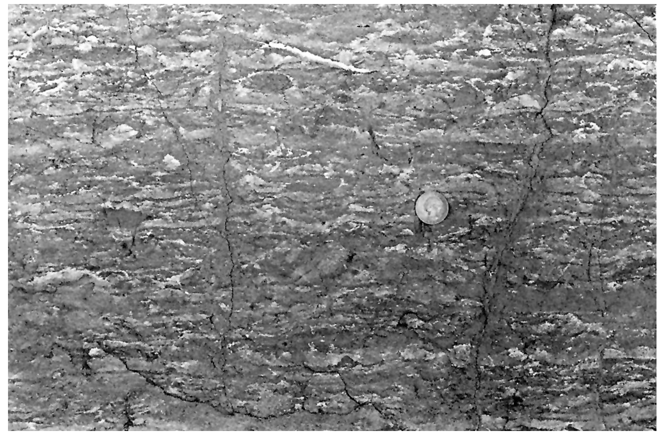

Figure 13. Typical disrupted beds and *Ophiomorpha nodosa* burrows in clayey, fine-grained quartz sand of the upper Tobacco Road Sand in the southeastern ¼ of Foxtown quadrangle at 33 degrees 38' 28" N, 81 degrees 32' 01" W.

Formation and the Tobacco Road Sand usually is easy to distinguish where the two formations are well exposed (Figure 12). The upper part of the Tobacco Road commonly consists of silty, fine- to medium-grained quartz sand with minor to moderate interstitial clay and shows moderately well-defined horizontal bedding, gentle cross-bedding and common to abundant clay-lined horizontal bedding, gentle cross-bedding and common to abundant clay-lined *Ophiomorpha nodosa* burrows (Figure 13). Clay beds and clay cobbles are rare but do occur in the Tobacco Road (Figure 12).

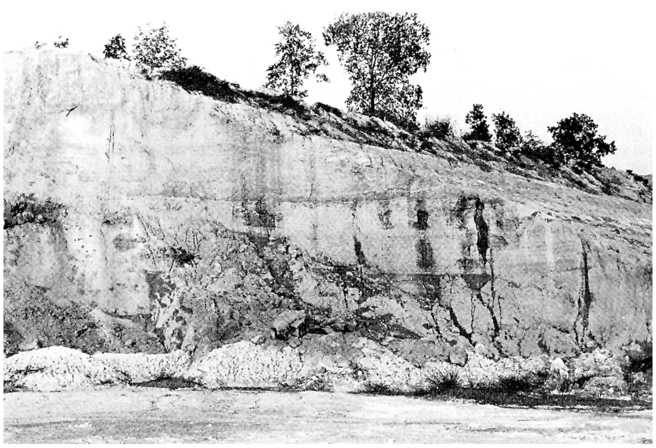

Figure 12. Sharp contact between the Tobacco Road Sand (note white kaolin clasts at base) and the Dry Branch Formation. Huber kaolin at base of photo. W.R. Grace Company's Scott-Garrett kaolin mine in southwestern corner of Foxtown quadrangle.

Thickness. Scouring at the base of the upland unit has reduced the thickness of the Tobacco Road Sand locally and has completely removed the Tobacco Road at two known localities. The upland unit, whit quartz cobbles in a sand-and-clay matrix, lies directly on the Dry Branch Formation in southern Aiken NW quadrangle at auger hole 2-129, 1.5 km due west of the center of Interchange 22 on Interstate 20. Auger hole 2-129 confirms the upland unit – Dry Branch contact seen in residuum in a road ditch slightly east of the drill site. The upland unit also lies directly on the Dry Branch Formation at J.M. Huber Corporation's Chicora kaolin mine (Stop 10, p. 169-171 in Nystrom and others, 1982) in northern Hollow Creek quadrangle, south of the area of Plate 1.

Fossils. Huddlestun and Hetrick (1978) cited the echinoids *Periarchus pileussinensis* and *P. quinquefarius,* the oyster *Crassostrea gigantissima,* and poorly preserved molluscs, foraminifera and ostracodes from localities in the Tobacco Road in Georgia, and Steele, Zullo and Willoughby (in press) cite the barnacle *Kathpalmeria georgiana* from the Tobacco Road near Irwing, Georgia. Further discussion of fossils relating to the Tobacco Road Sand is provided under the heading of the Barnwell Group.

Other than a single arthropod claw (Bishop, 1986), no body fossils have been described from the Tobacco Road Sand in South Carolina. Shark teeth and ray dental plates occur in Barnwell Group sediments at the southeastern corner of Trenton quadrangle inside the area of Plate 1 and outside that map area at several localities in the Seivern 15-minute quadrangle. Fossils formerly attributed possibly to the Tobacco Road Sand are discussed under the heading of the Barnwell Group.

UPPER OLIGOCENE (?) TO LOWER MIOCENE, MARINE CHANNEL DEPOSITS

Zullo and others (1982) recognized a previously undescribed barnacle species collected from barnacle-bearing buhrstones (silica-cemented quartz sandstone with silica-replaced fossils, mostly barnacle plates) at a locality in Graniteville quadrangle and a locality in Aiken NW quadrangle, and in loose quartz sand at a locality in Hollow Creek quadrangle. Another locality yielded specifically unidentifiable barnacles. The first two of those localities occur in the area of Plate 1 although those pinpoint occurrences are not noted on the map. Zullo (1984, p. 1319, figures 3f-7) formally named the species *Lophobalanus baumi* based on specimens from the lower Miocene Belgrade Formation in North Carolina, and he also illustrated specimens from Aiken County, South Carolina that he attributed to the Dry Branch Formation. Willoughby and others (1984) proposed that the *Lophobalanus baumi* specimens from Aiken County are derived, not from the Dry Branch Formation or Tobacco Road Sand, but from a younger depositional sequence of late Oligocene or early Miocene age. The sediments were deposited in tidal channels or in incised, but later drowned, fluvial channels.

If the sediments and rocks that bear *Lophobalanus baumi* are of a depositional sequence younger than and separate from the Barnwell Group, then those sediments must also be either younger than, older than, or the same age as the upland unit. Nystrom (1986b) preferred the latter possibility in suggesting that the barnacle rocks described by Willoughby and others (1984) may be a part of a marine aspect of the upland unit that occurs more commonly in more downdip areas.

UPLAND UNIT

Introduction

The upland unit is a distinctive assemblage of heterogeneous lithologies that caps the interfluves throughout the map area (Plate 1) and prior to the incisement of the land surface extended continuously across the South Carolina – Georgia Upper Coastal Plain from the Congaree River southwestward to beyond the Ocmulgee River (South Carolina Geological Survey mapping by ourselves; Huddlestun, in press). Rapidly deposited fluvial sediments derived from the crystalline terrane to the northwest are a major component, but cross-bedded, burrowed sands suggest part of the unit is marine. This extensive, unique formation reflects a major Piedmont – Blue Ridge uplift event, probably during the Micoene, that was unparalleled in the Tertiary history of the Southwest (Nystrom, 1986a).

Lithology

The upland unit typically consists of poorly sorted, clayey grit that is pebbly, angular to subangular, and medium- to very coarse-grained with abundant granules. Scattered quartz gravels are a common component throughout the unit, not necessarily confined to the basal contact. The abundant clay occurs as interstitial material and ubiquitous, rounded clasts of varying sizes which help to define

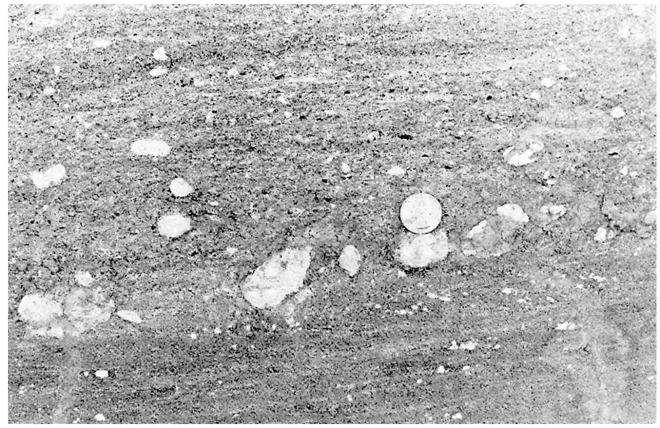

Figure 14 (opposite page, top). Close-up view of upland unit clayey grit with clay balls and small clay flecks, southeastern ¼ Foxtown quadrangle.

bedding; tiny white clay flecks or sand-sized grains give the unit a distinctive speckled appearance (Figures 14 and 15). There are also local occurrences of thick, laterally discontinuous lenses of massive clay. Fresh exposures are commonly a reddish-orange color and are indurated, relatively tough and resistant to erosion.

Bedding is characterized by lateral discontinuity and varies from crudely horizontal to steeply-dipping, sweeping cross-beds; scour and fill features and channel structures are common. Deposits of clayey sand with abundant, bedded cobbles (upland fluvial channel deposits of Nystrom and Willoughby, 1982c) confined mainly to western Aiken and southern Edgefield counties (see Stops 2 and 3).

Figure 15. Typical roadcut exposure of upland unit clayey grit with clay balls and cross-beds, southeastern ¼ Foxtown quadrangle.

The contact between the upland unit and the underlying Tertiary units is typically well defined (Figure 17), can show considerable relief, and is commonly marked by pebbles and clay clasts in the base of the upland. Where the cobble-bearing portions of the upland unit are present, the contact

Figure 16. The upland unit showing typical speckled appearance due to white clay clasts ranging in size from sand to small pebbles, and showing abundant, large (up to 5 cm) quartz pebbles and a white clay cobble (12.5 cm). In the west ditch of a dirt road at 33 degrees 45' 37" N, 81 degrees 45' 48" W, near drill hole 19-13 in southeastern Johnston 7.5-minute quadrangle.

between the upland and the underlying Eocene sediments is sharpest, most striking, and shows the greatest relief. Where the Barnwell Group is present the upland unit typically rests upon the finer-grained, bioturbated sands of the Tobacco Road Sand; locally, channels within the upland have scoured away the Tobacco Road and the upland unit lies upon the Dry Branch Formation. Updip the upland unit overlaps the Barnwell sediments and rests upon the Huber Formation to the fall line. Locally the upland unit is found to lie directly upon Piedmont saprolite (see Plate 1).

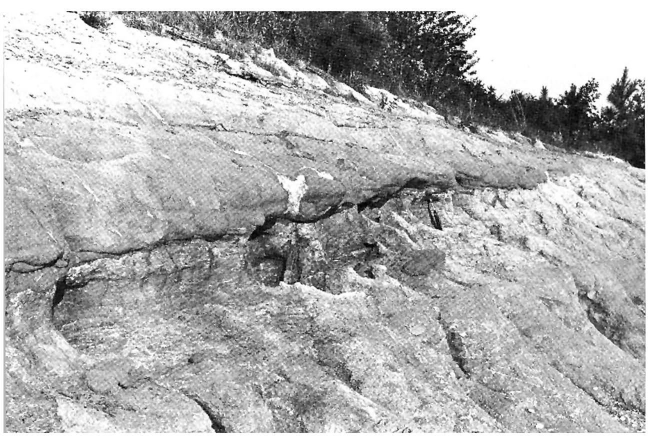

Figure 17. Upland unit – Tobacco Road Sand contact at W.R. Grace Company's Scott-Garrett kaolin mine, southwestern ¼ of Foxtown quadrangle.

Distribution

In South Carolina the upland unit was first mapped by Siple (1967; he used the term Hawthorn Formation) over an area of approximately 670 square kilometers (260 square miles) on the Savannah River Plant and a short distance beyond its boundaries. Cooke and MacNeil (1952) described but did not map a "sandy clay and gravelly sand", an updip facies of the marine, downdip Hawthorn Formation. They recognized that it was extensive in the South Carolina Upper Coastal Plain and was continuous with the previously mapped updip Hawthorn of Georgia (MacNeil, 1947). Kite and Nystrom (1983) extended the upland unit from Siple's (1967) area northward across Aiken County into southern Lexington County and eastward into Orangeburg County. Subsequent detailed and reconnaissance mapping by ourselves has shown the upland unit caps the major interfluves from the northwest edge of the Coastal Plain downdip to the Orangeburg Scarp between the Savannah and Congaree rivers (Nystrom, 1986a). At least one local outlier occurs on a ridge crest northeast of the Congaree River (see Colquhoun, 1965, p. 41).

In Georgia the upland unit or Altamaha Formation of Huddlestun (1985; and in press) caps the ridge between the Savannah River and Brier Creek downdip to the Orangeburg Scarp and extends southwest from the ridge to beyond the Ocmulgee-Altamaha River. It covers parts of more than 30 counties and "is the most widespread outcropping lithostratigraphic unit in Georgia" (Huddlestun, in press). In Georgia the unit does not extend updip to the Piedmont as it does in South Carolina (Plate 1).

In our map area the upland unit extends essentially to the edge of the Coastal Plain from about 8 km (5 miles) north of North Augusta to east of Leesville, a distance along the margin of more than 67 km (42 miles). Only a thin sequence of Huber Formation sediments separates the upland unit from the Piedmont at the edge. Between Johnston and Ward the upland unit occurs 8.5 km (5.3 miles) beyond the updip limit of the Barnwell Group and 8.8 km (5.5 miles) beyond the limit of the Cretaceous. The upland unit lies on the Piedmont in outliers in Edgefield and Ridge Spring quadrangles and at localities at or near the edge of the main body of the Coastal Plain in Ridge Spring, Monetta and Batesburg quadrangles (Plate 1).

Previous work, Age and Correlation

Evidence bearing on the age of the upland unit in South Carolina is of an indirect nature. McGee (1891) and Sloan (1904) described Lafayette sediments in the Aiken area that are part of the upland unit. McGee believed the unit was Miocene to Pliocene in age. Sloan assigned the Lafayette to the Pleistocene. Lang (1940) recognized the cobble deposits that are part of the upland, was uncertain whether they were part of the Barnwell Formation (Tobacco Road Sand), and suggested they may have been deposited during on e of the Pleistocene erosional cycles. A regional surface unit shown as covering a large part of the southeastern Coastal Plain including the map area (Plate 1) was described by Doering (1960) as the Citronelle Formation and believed to be of early Pleistocene age.

The upland unit was not recognized as a separate map unit by some workers and portions of it were subsequently included with the Cretaceous sediments, Huber and McBean formations, and with the Barnwell (Cooke, 1936; Smith and White, 1979; Smith, 1980). Nystrom and Willoughby (1982) did recognize the upland fluvial channel deposits in western Aiken County, and Kite and Nystrom (1983) included these gravel deposits in their description of an upland unit consisting predominantly of very coarse-grained, very clayey sand with a previously unrecognized widespread distribution across the Upper Coastal Plain of South Carolina.

Siple (1967) tentatively assigned his Hawthorn Formation a Miocene age. This was consistent with Cooke and MacNeil (1952) who mentioned a railroad cut near Dunbarton on the Savannah River Plant as showing excellent exposures of the Hawthorn. A small assemblage of foraminifera recovered from Hawthorn depths in a test on the southeast bank of Tinker Creek and identified by H.M. Herrick was listed on page 61 of Siple (1967). The assemblage was thought to have late Miocene affinities and it was suggested the foraminifera may have slumped down from pre-existing Duplin sediments above. Colquhoun and Steele (1985) discussed the Citronelle (our upland unit) as part of the Barnwell Group. They interpreted the unit as having been a progradational upper delta plain sequence that immediately followed deposition of the Tobacco Road Sand. We have found no fossils, other than trace fossils, in the upland unit in South Carolina.

A Miocene age assignment was tentatively made by Prowell and others (1985) for their MI unit (upland unit) that they described as an "updip lithofacies of the Hawthorn Formation of eastern Georgia and western South Carolina".

The Altamaha Formation of Georgia has been re-introduced and redefined by Huddlestun (1985; and in press). In so doing he thoroughly discussed the former usage of that tern and the numerous other terms that have been applied to sediments that now would be part of the unit as redefined. Among those terms were three citations that referred to sediments in South Carolina: the updip Hawthorn Formation (Cooke and MacNeil, 1952), the Hawthorn Formation (Siple, 1967) and the upland fluvial channel deposits (Nystrom and Willoughby, 1982c). It follows that all of the upland unit in South Carolina would be part of the Altamaha Formation as Huddlestun has redefined it.

The Altamaha Formation was described as a multideposit, part deposited in early Miocene time and part during the middle Miocene (Huddlestun, in press). The South Carolina component of the unit was in the lower Miocene part. The age of this part of the Altamaha was based on the apparent gradational transition downdip into sediments of the Tiger Leap Member of the Parachucla Formation in southeastern Screven and northwestern Effingham counties, Georgia. In that are the lower Miocene foraminifera collected from fine sand in drill hole cores.

The middle Miocene part of the Altamaha Formation was geographically restricted to the central and eastern areas of the Georgia Coastal Plain (Huddlestun, in press). The age of this part of the unit was determined from physical correlation and stratigraphic position. In the type area (Huddlestun, in press) the Altamaha appears to grade laterally eastward into the marine middle Miocene Coosawhtchie Formation. Furthermore, it overlies middle Miocene dated sediments of the Hawthorn Group (Huddlestun, in press).

No body fossils have been found in the Altamaha Formation so there is no *direct* evidence for the ages of the two parts of the unit or for there being two parts to the unit. Huddlestun (in press) stated there is no known area where the middle Miocene part overlies the lower Miocene part of the unit. Also, cross-bedded, gravelly, fluvial channel sediments were described as occurring in both parts of the formation. It seems possible that the sediments in this unit represent only one episode of deposition and are all approximately the same age.

The upland unit is younger that the upper Eocene Tobacco Road Sand (Huddlestun and Hetrick, 1978) that it overlies throughout much of the map area (Plate 1). The unit extends continuously and has been traced from the Aiken area (Nystrom and Willoughby, 1982c; Kite and Nystrom, 1983) downdip across the Savannah River Plant into Allendale County (the Hawthorn Formation; Siple, 1967) and southwest of there into Screven County, Georgia (the Altamaha; Huddlestun, in press) where it unconformably overlies the Jacksonboro Limestone (Nystrom, 1986b) at the type locality. Exposures of the Jacksonboro (a local name for the Suwannee Limestones) contain the distinctive sand dollar *Clypeaster rogersii,* a middle and upper Oligocene echinoid (Cooke, 1959). The upland unit is therefore younger than the Suwannee and is probably younger than Oligocene.

The Orangeburg Scarp truncates the upland unit between the Savannah and Congaree rivers. Pliocene sediments have been deposited against the toe of the scarp (McCartan and others, 1984) and must be younger than the upland unit.

Investigations of the Upper Coastal Plain land surface lend indirect evidence for the age of the upland unit and indicate it is pre-Pliocene. Clearly the unit predates the duration of geomorphic processes acting on the Upper Coastal Plain landscape. Newell and others (1980) studied the surficial deposits in the Augusta – North Augusta area and concluded that the evolution of the Upper Coastal Plain occurred over a long period of time extending back into the Miocene. Daniels and others (1971) earlier determined that drainage divides in the North Carolina Upper Coastal Plain may have been stable for 10 million years.

As the upland unit sediments represent rapid and wide-

Figure 18. Within the surficial sand unit, steeply dipping cross-beds are truncated by horizontal beds with scattered burrows.

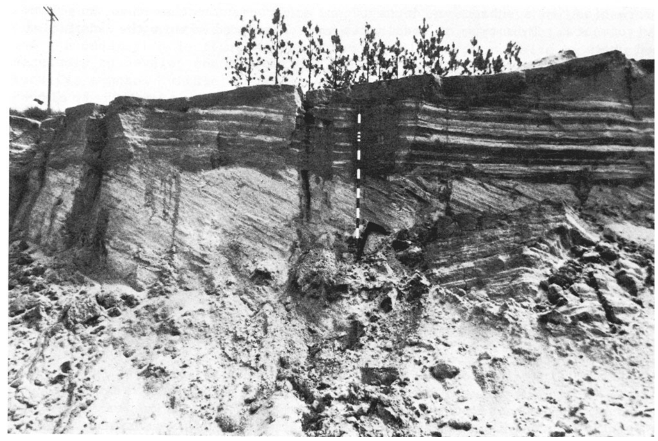

Figure 19. Vertical burrows within the surficial sand unit; irregular dark bands are the result of pedogenic processes.

spread clastic deposition, indirect evidence for the age of the unit is suggested by detrital sediments offshore. Drill holes on the continental margin east of Jacksonville, Florida penetrated sediments ranging in age from middle Eocene to post-Miocene (Hathaway and others, 1970). Only Miocene sediments contained non-carbonate minerals in appreciable quantity. In peninsular Florida the clastic content of the sedimentary section is quite low throughout the Paleogene part, but in the Miocene part the clastic content is very high (Alt, 1974).

SURFICIAL SAND DEPOSITS

Previous work

Deposits of loose, quartz sand are scattered irregularly and discontinuously within the subject area from northern Aiken County eastward to the Congaree River valley. Unconsolidated surficial sand deposits were mapped and described in the Fort Jackson North quadrangle, South Carolina by Pooser and Johnson (1961) as post-Eocene sand, but were not assigned a formational name. Unconsolidated post-Middendorf sands n the Upper Coastal Plain of northeastern South Carolina were referred to the Pinehurst Formation by Bell and others (1974). The term Pinehurst Formation was first applied by Conley (1962) to sediments in Moore County, North Carolina, and the formation was redefined by Bartlett (1967). Cabe (1980) summarized previous investigations of these surficial sands in Moore County, North Carolina, and applied the new name Eagle Springs Formation to at least portions of Bartlett's (1967) Pinehurst Formation.

In southwestern South Carolina Smith (1980) referred similar unconsolidated surficial sands of Lexington County to the Pinehurst Formation. Kite (1984b, 1985a) mapped the sands as the "Pinehurst" formation in the Lexington, SW Columbia, Pelion East and Gaston to the northeast by Bell and others (1974). Kite (1985d, in review) later referred to the deposits in the Gilbert 15-minute quadrangle as unnamed surficial sands and suggested that correlation with the Pinehurst Formation be dependent upon further study of the origin and age of the sands.

Lithology

The surficial sand deposits typically consist of angular to subangular, fine- to coarse-grained, variably sorted sand with varying amounts of white mica and dark heavy minerals. The best and freshest exposures are found in pits where the sand is being mined commercially, and these exposures typically show well-developed bedding which includes large sets of steeply dipping cross-beds and gently dipping or horizontal, finely laminated beds. Burrows (approximately 2 cm diameter and of varying length) are locally abundant (Figure 18) and commonly weather out in relief from the loose sand. In several localities the burrows are concentrated in the gen-

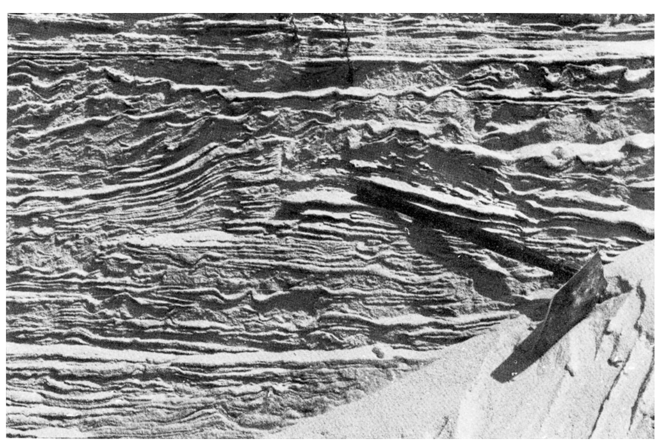

Figure 20. Highly irregular, crumpled bedding suggests soft-sediment deformation in a subaqueous depositional environment rather than an eolian environment. This type of bedding is very localized within the surficial sand unit.

tly dipping to horizontal beds, and these beds overlie and truncate the steeply dipping cross-beds (Figure 19). Lateral variations include channel structures and soft-sediment deformation features (Figure 20).

Weathering of the loose sands produces a massive, structureless sand, commonly with irregular, dark-colored, clay-enriched bands (approximately 2-10 cm thick) which form as a result of pedogenic processes in which illuvial clay is concentrated by percolating groundwater. These dark-colored bands commonly crudely follow the textural changes of the original bedding features and help to accentuate them. In several of the sand pits, a weathered horizon of massive, structureless sand has developed above well-bedded sands. At other localities, such as shallow roadcuts where the total thickness of the sand unit may be less than 3-4 m, the entire exposure may consist of massive, light-colored sand containing the darker-colored, wavy, clay-enriched bands.

The extremely low clay content of these sands makes them of significant economic value where the deposits are sufficiently thick. Though outside the map area of Plate 1, the sand deposits of the Dixianna area southwest of Columbia are considered the same as the Tss map unit, and Dixianna has long been an area of commercial sand mining. The deposits here range up to more than 15 m in thickness (Buie and Robinson, 1958). Bedding structures are similar to those found in the sand deposits of western Lexington County. Particularly well developed in the thick deposits of the Dixianna area are separate weathered horizons which are stacked one upon another, perhaps representing buried soil profiles. Large sets of cross-beds in loose sand can be seen locally between these weathered, clay-enriched horizons. In western Lexington County the surficial sand deposits have been exploited to a lesser degree, with some commercial mining concentrated near the community of Summit, and most recently, operations have begun just north of Steedman.

Surface exposures and observations from auger holes indicate that the contact between these sand deposits and the underlying stratigraphic units is quite irregular. Lateral continuity of the deposits and elevation control can not be relied upon when mapping the unit. Accurately determining the distribution of these surficial deposits is extremely difficult and their map pattern is based mainly on exposures in sand pits and observations from auger holes.

Environment of Deposition

Determining the origin of the surficial sand deposits of the Upper Coastal Plain of South Carolina is a continuing problem. Pooser and Johnson (1961) considered the sand deposits in the Fort Jackson area to be in part eolian and in part water-laid. Barlett (1967), as cited in Bell and others (1974), regarded the unconsolidated sands as primarily of eolian origin and for evidence pointed to the steepness of dip and unusual length of the cross-bed sets, frosting of the sand grains and lack of any fluvial characteristics. Cabe (1980) cited sedimentary structures, texture and trace fossils as evidence the sands are water-laid deposits. Smith (1980) considered the Lexington County surficial sands to be of residual (soils to colluvium), alluvial and eolian origin.

Some of the physical lithologic characteristics of the Lexington County sand deposits are like those of the unconsolidated Pinehurst to the northeast as described by Bartlett (1967) and Bell and others (1974). Large, steeply dipping cross-bed sets and buried soil horizons suggest an eolian origin like that proposed by Bartlett (1967). Yet the localized channel structures and soft-sediment deformation, the abundant burrows and locally abundant mica and heavy minerals suggest, at least in part, an alluvial or other subaqueous environment of deposition for the Lexington County sands, perhaps like that proposed by Cabe (1980) for similar sands in Moore County, North Carolina. Sands which exhibit eolian and alluvial characteristics, as well as residual and/or colluvial deposits developed from them, are included in the surficial sand deposits as mapped in Lexington and Aiken counties (Plate 1). Both eolian and subaqueous sedimentary structures can be seen within the same sand pit in several localities, but they can not be distinguished beyond the artificial exposures.

Age

There is no direct evidence to indicate the age of the surficial sand unit. The sands so far have proved to be totally unfossiliferous and contain no organic clays. The age of the sands could be restricted by the amount of time necessary to allow significant erosion and development of considerable topographic relief between the base of the surficial sand unit and the underlying Tertiary and Cretaceous sediments, and also by the time necessary to develop the buried soil horizons and deep weathering profiles locally exposed within the sand unit. Suggested ages for the surficial sands of Lexington and Aiken counties include Pliocene (?) to Holocene (Smith, 1980), pre-Pleistocene (Kite, 1985c) and Plio-Pleistocene (Nystrom, 1986a).

QUATERNARY LAKE DEPOSITS IN CAROLINA BAYS

Carolina bays are ellipsoidal depressions, either water-filled or once so, generally oriented with the long axis northwest-southeast, found along the Atlantic Coastal Plain and especially numerous in the Carolinas. In the are of Plate 1, Carolina bays are most numerous along the “ridge” between North Augusta and Batesbury but also occur, to a lesser extent, on other elevated areas. Most of the Carolina bays in the are of Plate 1 lie on the upland unit or on soils derived from it. Most bays have been drained for agricultural purposes, and only a few remain as lakes.

The material that occurs in the bottom of Carolina bays in the area of Plate 1 varies from deeply leached, cream to light gray, kaolinitic soil with quartz sand and locally with quartz pebbles to less deeply weathered, dark brown to black, clayey soil with quartz sand and rich in organic matter. The less deeply weathered, darker materials can be seen in many of the drained bays then they are freshly plowed, and the drained bays that are famed support a richer agricultural crop than the surrounding areas. The drainage ditches leading from some of the bays are more than 3.7 m (12 ft) deep.

Tuomey (1848, p. 143-144) provided the first published reference to the features that later came to be called Carolina bays (Kaczorowski, 1976, p. II-16, II-18; 1977a, p. 13, 19), and his discussion refers to lake features in southeastern Trenton quadrangle that are shown on Plate 1. Kaczorowski (1976, 1977a, 1977b) reviewed Carolina bays and concluded that they originated as wind deflation features that subsequently filled with water and evolved as wind-influenced lakes. Herren (1981) discussed soils in Carolina bays in Edgefield County and mapped more of them than we have shown.

QUATERNARY ALLUVIUM

Pleistocene to Holocene floodplain deposits of sand, clayey sand and clay compose this unit and were mapped along the major streams and rivers. Exposures of these deposits are rare, as the land is commonly swampy and lushly vegetated.

Locally exposed along the valley slopes are thick surficial deposits which obscure the underlying Tertiary and Cretaceous sediments in some places. These deposits, of the type described by Newell and others (1980) as resulting from weathering, mass wasting and fluvial processes, are commonly conspicuous in exposures. No attempt was made to delineate these colluvial deposits in exposures. No attempt was made to delineate these colluvial deposits because of their erratic, discontinuous nature and limited extent.

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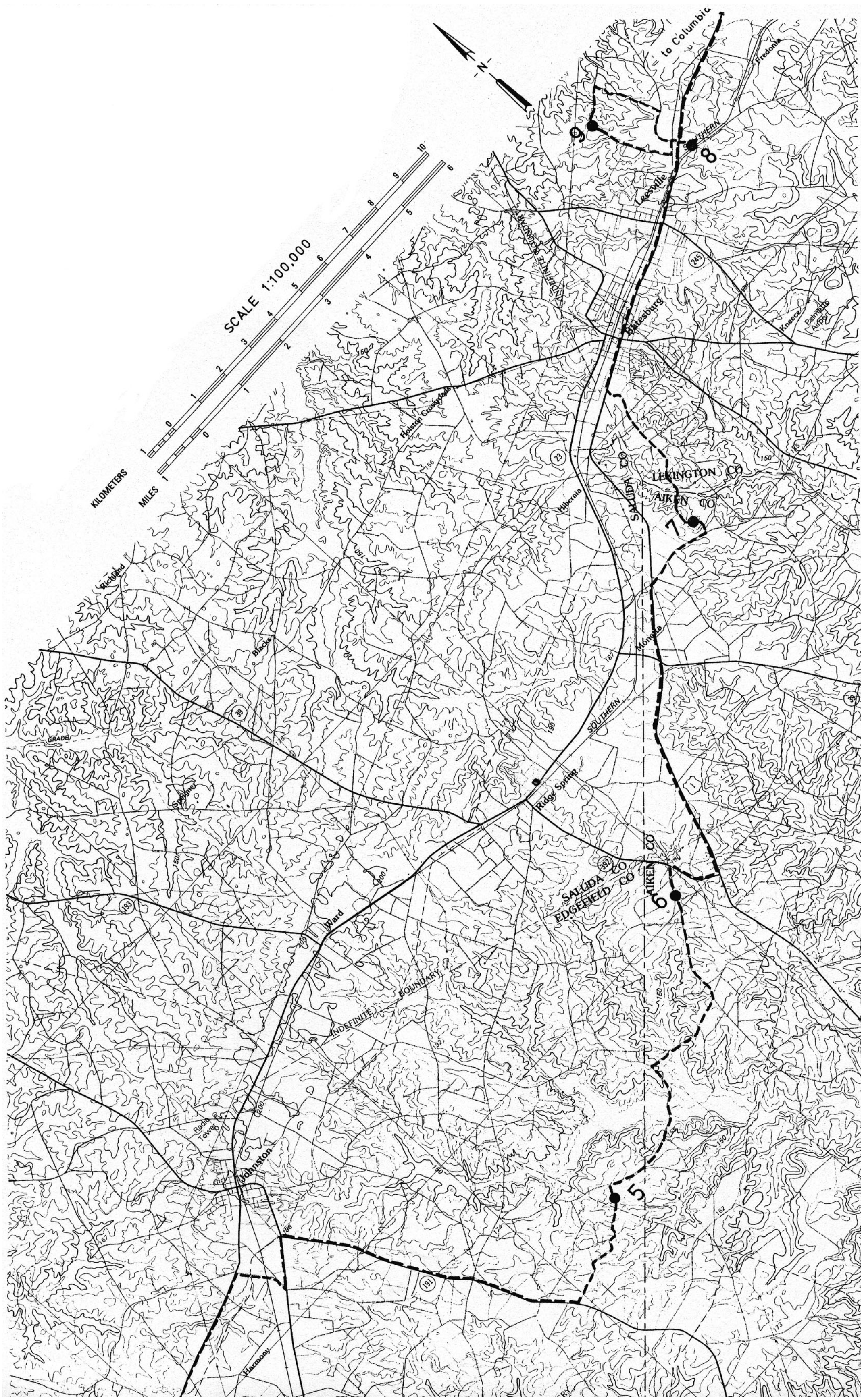
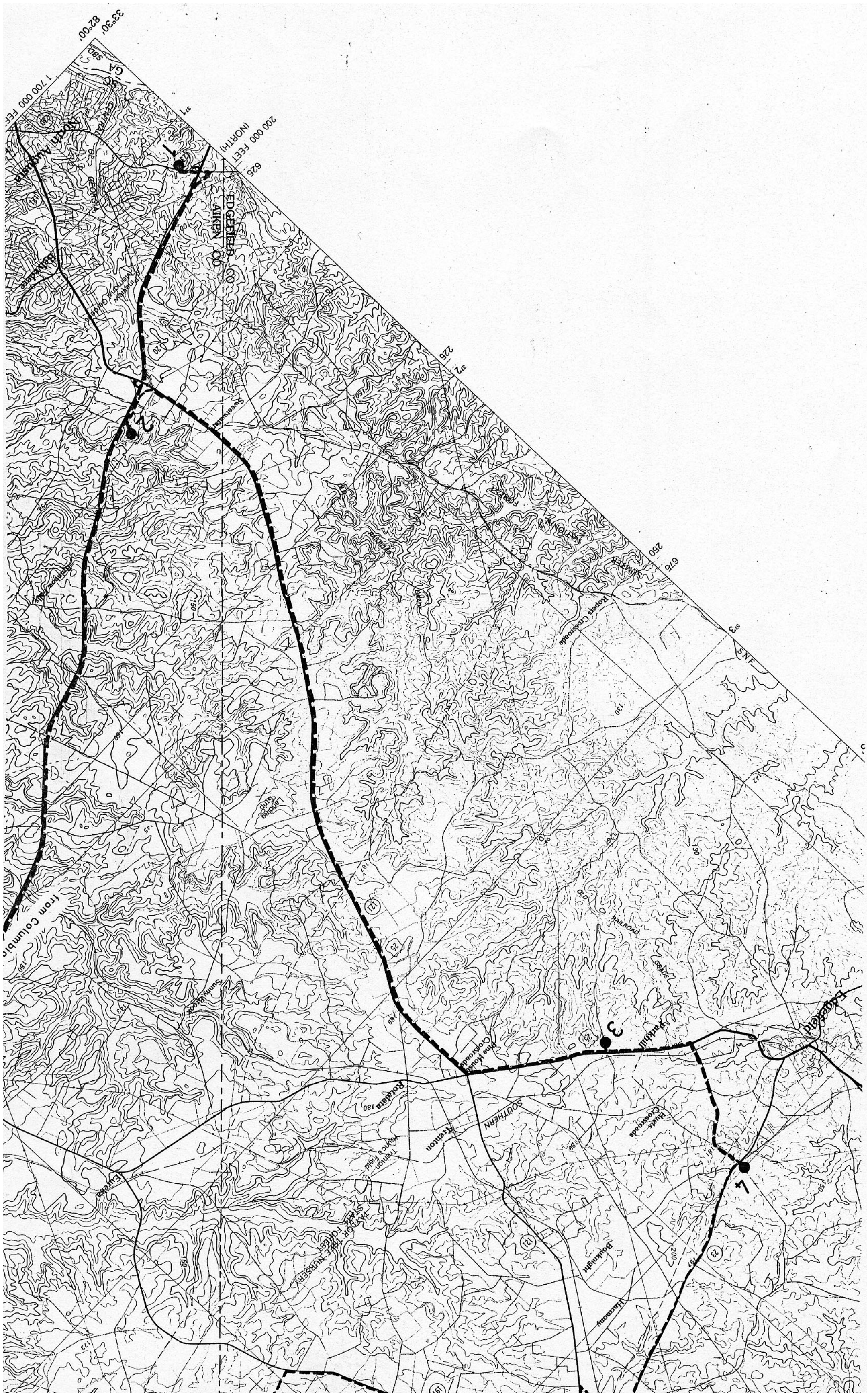


Figure 21. Carolina Geological Society field trip route for Saturday, October 11. Base from U.S.G.S. 1:100,000 Aiken, 1983. Stops shown by large numbers.


North Augusta
EDGEFIELD CO
AIKEN CO
200 000 FEET (NORTH)
1 700 000 FEET
from Columbia
Edgefield
Trenton
SOUTHERN
RAILROAD
1
2
3
4

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FIELD TRIP ITINERARY - - ROAD LOG FOR SATURDAY, OCTOBER 11

Board buses in the parking lot of the Quality Inn located on the south side of Broad River Road (U.S. Highway 176) just west of Interchange 65 on I-20 north of Columbia, South Carolina. Leave parking lot at 8:00 a.m., Saturday, October 11. See Figure 21 for trip route.

Mileage Cumulative	Interval	Itinerary
0		Leave parking log. Road log starts at the entrance to Board River Road. Turn right onto Broad River Road, remain in right lane, and prepare to turn right.
0.1	0.1	Turn right onto entrance ramp to I-20, at Interchange 65 westbound toward Augusta, Georgia. Stay on I-20 to Exit 1.
65.4	65.3	Prepare to exit I-20.

65.6 0.2 Turn onto Exit 1 ramp.

66.0 0.4 Bear left and come to stop. Turn left onto South Carolina Highway 230.

66.15 0.15 Pass over I-20.

66.45 0.3 Turn right into parking lot of gasoline station and ‘ store.

66.55 0.1 Park buses. Exit buses to prominent outcrops of white, coarse, cross-bedded, kaolinitic, Cretaceous sands.

STOP 1. Exit buses to prominent outcrops of white, coarse, cross-bedded, kaolinitic, Cretaceous sands behind the parking lot of Smile Gas, Inc. Discussion by Ralph Willoughby.

The Piedmont-Cretaceous contact occurs at the approximate elevation of 335 ft in the road ditch of the frontage road that intersects South Carolina Highway 230 between the outcrop and Exit 1 on U. S. I-20. There the contact is 1.5 m (5 ft) above the level of the frontage road. The measured section proceeds from there uphill to the southwest and to the top of the hillside behind the parking lot.

Top of Section

RESIDUUM OR COLLUVIUM

Weathered, orange-red to red-orange, medium-grained to very coarse-grained quartz sand with quartz pebbles and quartz cobbles to 7 cm. 1.5 m (5.0 ft)

CRETACEOUS SEDIMENTS

Bed 4 Massive kaolin, as below, with purple and orange-red weathering stains increasing upward. 3.7m (12.0ft)

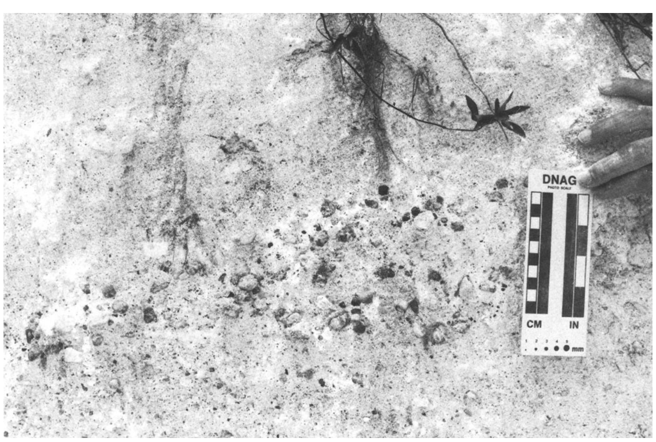

Figure 22. Smoky quartz pebbles in Bed 2 of Cretaceous sediments at stop 1.

Figure 23. Abundant kaolin granules and pebbles in Bed 2 of Cretaceous sediments, Stop 1.

Bed 3 Brilliant white, massive kaolin with minor silt and minor to moderate, interspersed, very fine- to fine-grained quartz sand, with scattered to common interspersed muscovite flakes. 0.6 m (2.0 ft)

Bed 2 Mostly brilliant white to cream quartz sand and quartz granules, locally weathered and stained to light red-orange; dominantly medium- to very coarse-grained quartz sand to quartz granules; with quartz pebbles, commonly of dark, smoky quartz (Figure 22), to 2 cm scattered or more commonly concentrated in pebble size (more easily discernible in the more iron-stained sediment), with some white kaolin cobbles up to 20 cm; mineral grains; with scattered to common muscovite flakes; with minor to moderate, interstitial white kaolin. Bedding is subhorizontal to inclined 25 degrees in cross-bed set to 30 cm thick (Figures 24, 25). The prominent outcrops directly behind the parking lot

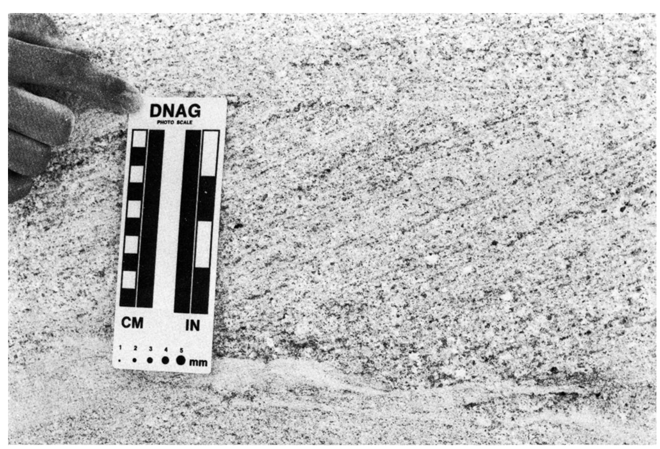

Figure 24. Tabular cross-bedding in coarse quartz sand to quartz granules with kaolin granules and pebbles, Bed 2 in Cretaceous sediments, Stop 1.

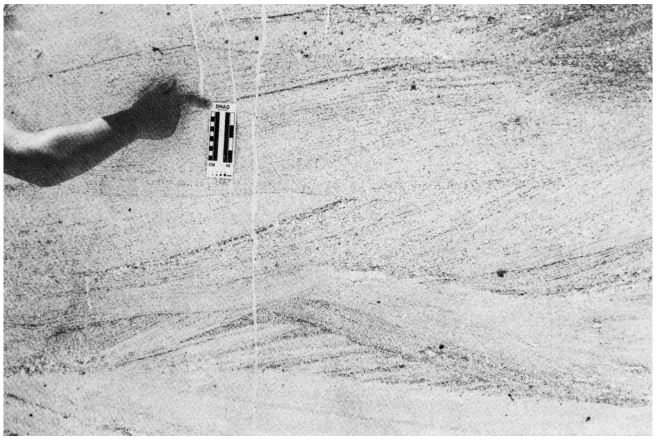

Figure 25. Cut-and-fill cross-beds in Bed 2 of Cretaceous sediments, Stop 1.

begin at approximately 1.5 m(5.0 ft) 1.5 m (5.0 ft) in this interval. 3.6 m (15.0 ft)

Covered interval. Leads to base of the white-wall exposure at the north end of the major exposure. 1.2 m (4.0 ft)

Bed 1 Mostly medium red-orange, fine- to very coarse-grained quartz sand and quartz granules, dominantly coarse- to very coarse-grained sand, with subangular, moderately well-rounded quartz pebbles up to 3 cm, with scattered to common kaolin clasts to 10 cm, with scattered to abundant muscovite flakes, and with minor to moderate interstitial clay; white kaolin clay laminae are discernible locally. The overall color of this weathered sediment is medium red-orange. Quartz pebbles are concentrated in layers in which dark, smoky quartz pebbles are common to abundant. Discernible bedding is essentially horizontal to gently inclined.

At about 2 ft above the base of this 1.8-m (6 –ft) interval, there is an increase in content of clay clasts (white kaolin) from granules and small pebbles to large pebbles (to 3 cm). 1.8 m (6.0 ft)

Covered interval and residuum. Includes a gully at the north end of the exposures (not the main exposures facing the parking lot). 2.4 m (8.0 ft)

Coastal Plain residuum with in-lace quartz pebbles and quartz cobbles. 0.6 m (2.0 ft)

PIEDMONT

The Piedmont here is saprolite of Belair belt slate. The saprolite is a cream to tan-yellow, clay matrix (presumed to be kaolin) with minor interspersed quartz silt and fine- to medium-grained quartz sand. The top of the saprolite is massive and featureless, but the slightly less-weathered saprolite near the base of the original grains or clasts (now weathered to clay) up to 5 mm are shown by differences in color. The saprolite is cream, tan-yellow-ocher, purple, deep orange-red and hematite red. Strike is highly variable between N 10 degrees W and N 55 degrees W; dip is 20 degrees to 37 degrees SW. Quartz veins are discordant and up to 1.5 cm wide. The top of the Piedmont is marked by the occurrence of angular quartz pebbles to cobbles (to 8 cm) along a roughly horizontal level at the base of Cretaceous, Coastal Plain residuum of mottled sand and clay. 1.5 m (5.0 ft)

Residuum	1.5 m	5 ft
Cretaceous sediments	14.9 m	49 ft
Piedmont saprolite	1.5 m	5 ft

66.55 Board buses. Leave parking lot. Turn left (north) onto South Carolina Highway 230, stay in left lane, and prepare to enter I-20.

66.7 0.15 Turn left (west) onto entrance ramp to I-20 eastbound toward Columbia.

67.0 0.3 Enter I-20.

70.6 3.6 Prepare to leave I-20 at Exit 5.

70.8 0.2 Turn right (south) onto Exit 5.

71.05 0.25 Bear right.

71.1 0.05 Prepare to yield. Turn right (north) and enter U.S. Highway 25.

71.4 0.3 Turn right (east onto exit lane to frontage road. Be prepared to yield.

71.4+ 0+ Turn right (southeast) onto frontage road.

72.25 0.85 Turn left (north) into private road.

72.35 0.1 Office of Presley Paving Company on right. Park and leave buses. Walk to end of pavement, then follow dirt roadbed leading eastward to sand pit.

STOP 2. Sand pit of Presley Paving Company. Discussion by Ralph Willoughby.

Top of Section

UPLAND UNIT OR COLLUVIUM DERIVED FROM THE UPLAND UNIT

Bed 8 Bed of in-place quartz cobbles, up to 15 cm, mostly rounded to very well rounded, in a matrix of resid-

Figure 26. Medium- to very coarse-grained quartz and showing intense burrowing and some *Ophiomorpha nodosa* burrows preserved, Bed 5 in Tobacco Road Sand, Stop 2.

ual quartz sand with variable clay content 0.6 m (6.0 ft)

Soil and residuum. 1.8 m (6.0 ft)

TOBACCO ROAD SAND

Bed 7 Dominantly smectitic clay beds and laminae, cream-gray, light tan or purple, with scattered interbeds of fine- to medium-grained quartz sand. Top or near the top of the Tobacco Road Sand 0.5 m (1.5 ft)

Bed 6 Dominantly medium- to very coarse-grained quartz sand, with lesser very fine- to fine-grained quartz sand and scattered quartz granules, with minor to moderate interstitial clay, red-orange, lightly indurated, with common clay laminae up to 1 cm thick. 0.5 m (1.5 ft)

Bed 5 Matrix of dominantly fairly well-sorted, fine- to medium- grained quartz sand with minor (to moderate) interstitial clay; with scattered to common quartz granules especially in the basal 0.5 m; with scattered, rounded to very well rounded, discoidal or elongate, quartz pebbles to 3 cm; light to medium red-orange; cohesive and well indurated at the base where Tobacco Road sand overlies a clay bench in the Dry Branch Formation, generally less cohesive and less well indurated elsewhere; with common to abundant, clay-lined, complete or interrupted *Ophiomorpha nodosa* burrows (Figure 26). The well-indurated base of the Tobacco Road forms a bench in the upper part of the pit and is well exposed in an eroded slope in the northwestern area of the pit. With subhorizontal, crinkly clay laminae, *Ophiomorpha nodosa* burrows and intensely bioturbated beds in upper part. 5.9 m (19.4 ft)

DRY BRANCH FORMATION

Bed 4 Dominantly medium-grained, well-sorted quartz sand, with common coarse- to very coarse-grained quartz sand and scattered quartz granules; with lesser very fine- to fine-grained quartz sand; locally with scattered, rounded quartz pebbles to 3 cm; with minor to moderate interstitial clay, light yellow-tan, with prominent and abundant white, irregular, discontinuous clay laminae, mostly horizontal but locally inclined up to 5 degrees. Some clay interbeds are up to 1 cm thick. The topmost part of the interval consists of beds of weathered, montmorillonitic, laminated clay with interbedded very fine-to fine-grained quartz sand 1.5 m (5.0 ft)

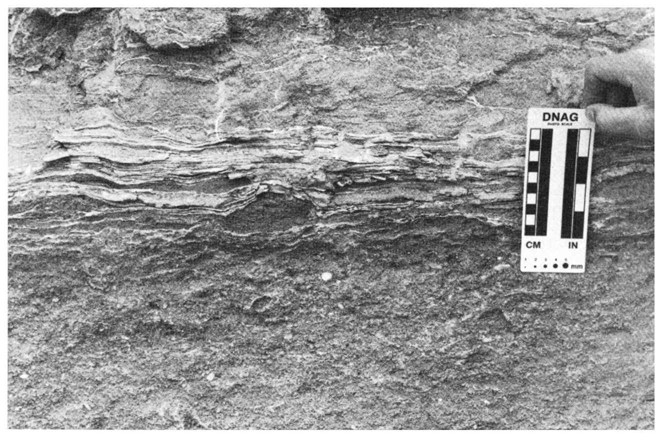

Figure 27. Laminated montmorillonitic clay interbedded with very fine- to medium-grained quartz sand, overlying coarse- to very coarse-grained quartz sand with quartz granules and pebbles; strata laterally equivalent to the interval between Bed 2 and Bed 3, Dry Branch Formation, southwest part of the pit at Stop 2.

Bed 3 Sand, dominantly medium- to very coarse-grained and with common to abundant quartz granules, with common very fine-grained to fine-grained quartz sand with minor to moderate interstitial clay, with scattered, wispy or crinkly laminae and thin beds (up to 3 cm), loose to lightly cohesive; dominantly medium yellow-tan in color but with scattered white to cream interbeds 1.1 m (3.7 ft)

Covered interval. A 0.3-m bed of laminated clay of the Dry Branch is exposed in the lower part of this interval in the southwestern part of the pit (figure 27) 2.3 m (7.5 ft)

Bed 2 Medium- to very coarse-grained quartz sand and granules, with common subrounded to well-rounded quartz pebbles (including discoidal pebbles), with scattered to common kaolin balls, with moderate intersititial kaolinitic clay, plus scattered, dark heavy mineral grains; tan-yellow, mustard-yellow, or red-orange. Basal part included rounded to well-rounded quartz cobbles to 8 cm, typically flattened and discoidal or roller-shaped 0.5 m (1.5 ft)

HUBER FORMATION

Bed 1 Sand, very fine-grained to coarse-grained, and quartz granules to 3 or 4 mm, poorly sorted; with scattered muscovite flakes and books to 5 mm; with scattered dark, heavy mineral grains; with minor to moderate, brilliant white kaolin clay that occurs interstitially as well in sand-size clasts and books up to about 5 mm. The sediment is brilliant white where fresh to yellowish or light red-orange where stained, and it is lightly cohesive. Scattered pebbles of quartz and of kaolin up to 1 cm occur throughout, and larger kaolin clasts up to 20 cm occur in some beds. Beds are from 1 to 10 cm thick and are horizontal to gently inclined. The top of the Huber Formation at an isolated hillock that is a mining remnant (Figure 28) in the southeast corner of the pit is 1 to 2 m above the top of the Huber in this measured section. 1.0 m (3.2 ft)

upland unit or colluvium derived from the upland unit	1.0 m	3.2 ft
Barnwell Group	12.3 m	40.1 ft
Tobacco Road Sand	6.9 m	22.4 ft
Dry Branch Formation	5.4 m	17.7 ft
Huber Formation	1.0 m	3.2 ft

Figure 28. Cross-bed set in medium- to very coarse-grained quartz sand and quartz granules with common to abundant kaolin balls and moderate to abundant interstitial kaolin. Upper part of the Huber Formation in a mining remnant at the southeastern corner of Presley Paving Company pit, Stop 2.

Board buses and leave site, with the buses now turned around.

72.45 0.1 Come to stop. Turn right (west) onto frontage road.

73.3 0.85 Come to stop. Turn right (north) onto U.S. Highway 25.

79.9 6.6 U.S. Highway 25 narrows from 4-lane to 2-lane.

82.8 2.9 Valley of the headwaters of Horse Creek. The Huber Formation, Barnwell Group (Dry Branch and Tobacco Road Sand) and upland unit are exposed here in the east road cut north of Horse Creek. The highway is not suitable for a visit by a large group, but future users of this guidebook might find the exposure helpful.

84.1 1.3 Edgefield County Road 19-120 intersects at left. Continue straight (northeast) on U.S. Highway 25 & South Carolina Highway 121.

85.0 0.9 "Y" intersection with Edgefield County Road 19-29 (Old Plank Road).

86.5 1.5 Pine House Crossroads. Prepare to stop at red light. Turn left (northwest) and remain on U.S. Highway 25.

88.9 2.4 Turn left (southwest) onto Edgefield County Road 19-461.

89.05 0.15 Stop at a near crest of hill. Leave buses.

STOP 3. Discussion by Ralph Willoughby.

Exposures here show saprolite of Piedmont crystalline rocks overlain by the Huber Formation, in turn overlain by in-place cobbles of the upland unit in residuum.

Top of Section

RESIDUUM OF THE UPLAND UNIT

White to light yellow-tan kaolinitic clay with very abundant interspersed medium-grained to very coarse-grained quartz sand and quartz granules; with scattered to common subangular to well-rounded quartz pebbles to 14 cm within the basal 1 ft (Figures 29, 30) 0.6 m (2.0 ft)

HUBER FORMATION

Exposure is obscured by cover and deep weathering. Representative lithologies within the outcrop

Figure 29. Rounded quartz pebbles weathered from the upland unit near the top of the exposure, west side of paved road at Stop 3.

are described below.

(C) Medium-grained to very coarse-grained quartz sand and quartz granules, locally with scattered, angular quartz cobbles to 6 cm, with muscovite flakes to 4 mm, with moderate interstitial clay, light salmon-pink to light yellow-tan; bedding is subhorizontal or in cross-bed sets inclined up to 20 degrees.

(B) White to cream kaolin matrix with trace to minor amounts of interspersed silt and very fine-grained to fine-grained quartz sand. Also as clay matrix with moderate to very abundant, interspersed quartz pebbles and cobbles to 5 cm, with well-rounded white kaolin pebbles and cobbles up to 10 cm, plus moderate muscovite flakes and books to 1.3 cm.

Figure 30. Upland unit in road ditch near the top of the exposure, west side of paved road at Stop 3. Rounded quartz pebbles and small cobbles and a weathered kaolin cobble in weathered, residual clayey sand overlain by iron-oxide-cemented sandstone with included kaolin balls, all in the upland unit.

(A) Fine- to medium-grained quartz sand with minor to moderate interstitial clay, with scattered laminae of white kaolin along bedding planes; some beds include abundant clasts of poorly to well rounded white kaolin pebbles up to 3.5 cm. 2.7 m (9.0 ft)

The base of the Coastal Plain is marked by a matrix of quartz sand, granules, pebbles and small cobbles, with common kaolin clasts in the size range of granules to small pebbles (to 10 mm), with moderate to very abundant interstitial kaolin, stained red-orange, and with bedding crudely defined by differences in grain-size distribution. The contact dips a few degrees to the south 0.9 m (3.0 ft)

PIEDMONT

Saprolite of "Edgefield" gneissic granite. The matrix of the saprolite varies from a matrix of pure white (where fresh) to yellow-tan (where stained) kaolin or deeply weathered feldspar. Interspersed quartz and muscovite grains typically are less than 5 mm in dimension and define a crude gneissic banding; some muscovite grains are up to 10 mm in dimension 0.9 m (3.0 ft)

Upland unit and residuum	0.6 m	2 ft
Huber Formation	3.6 m	12 ft
Piedmont saprolite	0.9 m	3 ft

Board buses, with the buses now turned around.

89.2 0.15 Come to stop. Turn left (northwest) onto U.S. Highway 25.

90.5 1.3 Pass headquarters of National Wild turkey Federation at left.

90.7 0.2 Turn right (north) onto Edgefield County Road 19-257.

90.8 0.1 Prepare to stop. Cross railroad tracks.

91.55 0.75 Intersection with Edgefield County Road 19-90. Continue straight (northeast) on Edgefield County Road 19-257.

92.55 1.0 "Y" intersection with Edgefield County Road 19-40 Continue straight (north) of Edgefield County Road 19-257.

93.0 0.45 Come to stop. Intersection with South Carolina Highway 23. Remain on Edgefield County Road 19-257 and cross the intersection.

93.1 0.1 Park buses in the parking lot of the shopping

Figure 31 (opposite page, top). Quartz-pebble conglomerate in coarse- to very coarse-grained quartz sand with quartz granules possibly representing the base of the upland unit, overlying the Huber Formation. West side of the exposure on Stop 4.

center. Leave buses for the outcrops along Edgefield County Road 19-257 and just west of the parking lot.

Exposures 0.1 mile north of the intersection show slate belt saprolite overlain by the Huber Formation, overlain by residuum that may represent the upland unit.

STOP 4. Discussion by Ralph Willoughby.

At this locality, the Huber Formation lies on the Piedmont. Sandy residuum with quartz granules and pebbles up to 4 cm lies on the Huber Formation and possibly is derived from the upland unit.

Top of Soil

SOIL 0.9 m (3.0 ft)

RESIDUUM, POSSIBLY DERIVED FROM THE UPLAND UNIT

Matrix of clayey, very coarse-grained quartz sand to quartz granules with abundant interspersed kaolin clasts (very coarse sand to pebble size) and quartz pebbles (to 4 cm). This material (Figure 31) exposed in the cut on the west side of the paved road and at a higher elevation than is preserved on the east side, resembles both the lithologies of the upper Huber Formation and the coarser aspect of the upland unit. Although a definitive assignment is difficult to make from these weathered and nondistinctive sediments (or residuum), definitive exposures and auger-hole descriptions of upland unit on Huber Formation nearby in Edgefield (Stop 3) and Johnston quadrangles lend support to this interpretation 3.0 m (10.0ft)

HUBER FORMATION

Relatively fresh exposures on both sides of the road here show the same 3 types of Huber lithologies as at Stop 3, generally with clay-poor, fine-grained quartz sand below (Figure 32) and clay-rich, medium- to very coarse-grained quartz sand with kaolin and quartz granules to pebbles above, and with some pods, beds or lenses of silty kaolin (Figure 33). The base of the Huber Formation here includes angular to subrounded quartz pebbles and pebbles to 15 cm, and dips about 20 degrees to the south. 1.8+ m (6.0+ft)

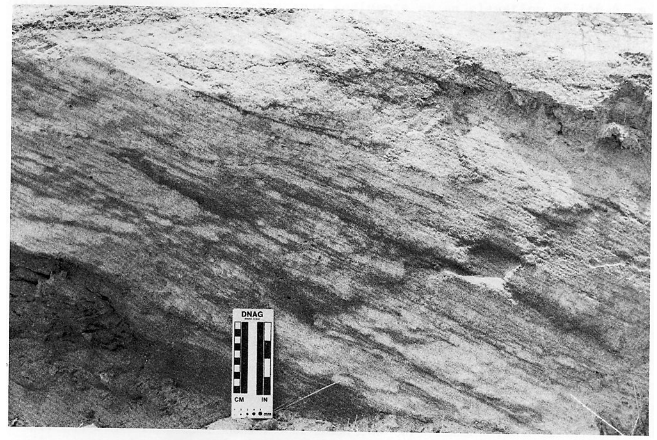

Figure 32. Inclined cross-bed set of fine- to medium-grained quartz sand near the base of the Huber Formation, east side of the road at Stop 4.

PIEDMONT Slate belt saprolite. 0.9 m (3.0 ft)

residuum, possibly of upland unit	3.0 m	10.0 ft
Huber Formation	1.8 m	6.0 ft
Piedmont saprolite	0.9 m	3.0 ft

Board buses and exit parking lot.

Figure 33. Outcrop near the base of the Huber Formation on east side of road at Stop 4 showing fine- to medium-grained quartz sand (lower), coarse-grained quartz sand and quartz granules (upper) and pod of silty kaolin (center, right).

93.2 0.1 Turn left (east) onto South Carolina Highway 23.

94.9 1.7 Strom Thurmond High School on left.

95.6 0.7 Pass Francis Hugh Wardlaw Academy on left

97.2 1.6 Pass intersection with Edgefield County Road 19-237.

97.6 0.4 Turn right at intersection with Edgefield County Road 19-101.

98.15 0.55 Cross railroad tracks.

98.3 0.15 Edgefield County Road 19-163 merges from left.

98.55 0.25 Turn left at stop sign onto South Carolina Route 121.

99.45 0.9 Turn right at intersection with South Carolina Route 191.

100.5 1.05 Pass Providence Baptist Church on right.

102.8 2.3 Pass through intersection with Edgefield County Road 19-75.

104.6 1.8 Turn left onto Edgefield County Road 19-215.

106.6 2.0 Sand pit on right. Park buses and walk down into pit.

STOP 5. borrow pit owned by Mr. Joe Derrick. Discussion by Paul Nystrom.

A 6.1 m (19 ft 11 in) section of the middle part of the Huber Formation (lower middle Eocene) was measured and described in this pit (Figure 34). The main part of the section (Figure 35) is very coarse-grained, thin-bedded and cross-bedded sand that is overlain by very thin-bedded clay and pebbly grit. The floor of the pit is at an elevation of 163m or 535 ft (from topographic map).

The top of the Huber Formation was originally about 4.6 m (15 ft) above the exposed section. Auger hole S.C.G.S. 19-72 (collar elevation 186 m or 610 ft), drilled on the hilltop 610 m (2000 ft) to the northwest, penetrated 7 m (23 ft) of upland unit, 3.9 m (13 ft) of Barnwell Group sand, then intersected the top of the Huber at an elevation of 175.4 m (575 ft). Because the pit is a short distance downdip from the drill site the elevation of the top of the Huber in the area surrounding the pit is about 174 m (570 ft).

Figure 34. Sand pit exposure of the middle part of the Huber Formation (Stop 5).

Another auger hole (S.C.G.S. 19-82) drilled into the floor of the pit, and described in detail below, penetrated 6.7 m (22 ft) of Huber sand and intersected the top of the Cretaceous sediments at an elevation of 156.6 m (513 ft). The thin sequence of clayey sand and grit comprising the Cretaceous was only 3.35 m (11 ft) thick and lay in contact with purple-gray, micaceous, Piedmont saprolite at 153.1 m (502 ft) elevation. The Cretaceous pinches out less than 915 m (3000 ft) to the northwest although this pit is 11.2 km (7 miles) from the edge of the Coastal Plain. The pinchout of Cretaceous sediments between the Piedmont and the Huber Formation has been in its present position since deposition of the Huber in early middle Eocene time.

The section described below was measured up the northeast wall of the pit.

Top of Section

RESIDUUM

Bed 4 Pebbly sand – tan orange, indurated. .6 m (2.0 ft)

HUBER FORMATION

Bed 3 Pebbly grit – orange with white and tan mottles, indurated. .3 m (1.0 ft)

Bed 2 Thin-bedded clay – 1 to 2.5 cm thick layers intercalated with sand layers 2.5 to 5 cm thick, layers are mottled lavender and white. .2 m (0.7 ft)

Bed 1 Sand – orange, tan, pink, pale yellow; loose, virtually no interstitial clay, thin-bedded with intercalated clay laminae, cross-bed sets up to 1.2 m (4 ft) thick; poorly sorted, medium- to very coarse-grained with abundant granules, subangular grains,

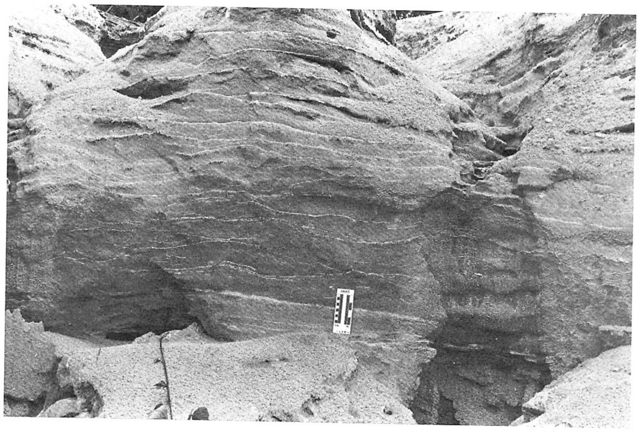

Figure 35 (opposite page, bottom). Thin-bedded, very coarse-grained sand in the Huber Formation (Stop 5).

scattered pebbles; thin clay layers are lavender or white. 5.0 m (16.3ft)

Total 6.1 m (20.0 ft)

Auger hole log SCGS 19-82.

Location: SW ¼ Ridge Spring 7.5' quadrangle; in floor of pit at Stop 5.

Collar elevation: 163m (535 ft).

Huber Formation 0 – 1.5 m (0 - 5 ft)Sand – pale pink; loose, clean, virtually no interstitial clay; very poorly sorted, medium- to very coarse-grained sand with granules, subangular grains, fine-grained heavy minerals fairly abundant.

1.5 – 3.0 m (5 - 10 ft)Sand – white; loose, clean, no interstitial clay; well sorted, fine- to medium-grained, subangular grains; very fine-grained heavy minerals fairly abundant. Interlayered with the above is tan, very poorly sorted, medium- to very coarse-grained, subangular sand with granules.

3.0 – 6.1 m (10 - 20 ft)Sand – like tan sand just above but with scattered kaolin balls and medium- to coarse-grained, angular heavy minerals. Lesser white, well-sorted, very fine-grained sand with abundant fine-grained heavy minerals.

6.1 – 6.7 m (20 - 22 ft)Grit – light gray; loose, clean, no interstitial clay; very poorly sorted, coarse- to very coarse-grained, subangular sand with abundant granules; medium- to very coarse-grained, angular heavy minerals abundant.

Cretaceous sediments 6.7 – 10 m (22 - 33 ft) Glayey sand and grit – very light tan to cream sediments colored; cohesive, interstices clay-filled; poorly sorted, mainly very coarse sand grains and granules, subangular to angular; moderate amount of tine- to coarse- grained heavy minerals. In parts of section exclusively granules. With scattered smoky quartz pebbles up to 1 cm across. Orange-tan clayey grit 3- 33 ft.

Piedmont 10.0 – 12.2 m (33 - 40 ft)Saprolite – purplish gray, with quartz grains up to 1 cm across and abundant mica in a clay matrix. micaceous gneiss.

LUNCH

Board buses and continue straight.

106.9 0.3 Turn right at stop sign onto Edgefield County Road 19 – 146.

107.7 0.8 Cross Edgefield-Aiken county line. Road becomes Aiken County Road 2-720.

108.2 0.5 Turn left at stop sign onto Aiken County Road 2-208.

108.650.45 Cross South Fork Edisto River.

109.1 0.45 Pass Mt. Calvary Church on right.

109.550.45 Turn right onto Aiken County Road 2-106.

110.0 0.45 Yield and merge onto Aiken county Road 2-25.

111.151.15 Bear left at 4-way stop, then continue straight ahead onto unnumbered sand road.

113.1 1.95 Park buses and unload.

STOP 6. Discussion by Paul Nystrom.

This roadcut exposes 4.65 m (15 ft 3 in) of the upland unit (Miocene?) overlying .6 m (2 ft) of upper Eocene Barnwell Group sediments (Figure 36). The indurated, horizontally laminated and cross-bedded sand in the upland unit here (Figure 37) is a less common lithofacies than the typical pebbly grit with large clay

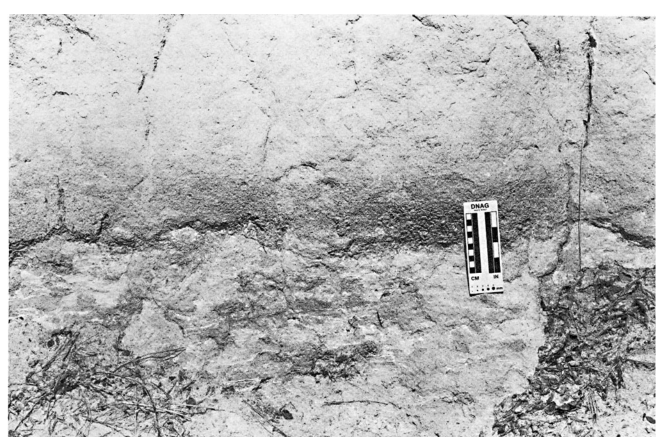

Figure 36. Miocene (?) upland unit pebbly grit overlying Barnwell Group burrowed sand (upper Eocene) (Stop 6).

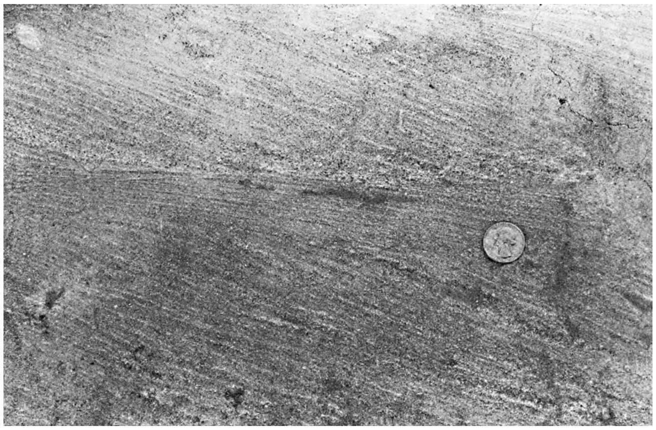

Figure 37. Upland unit cross-bedded sand (Stop 6).

balls exposed, for example, at Stop 8. Some pebbly grit interlayered with sand does occur at the top of this section, and there is pebbly grit at the base of the unit. A close examination of the upland-Barnwell contact reveals large burrows in the top of the Barnwell that contain upland unit grit brought down by organisms (shrimp?) that lived in the basal sediments of the younger unit suggesting marine deposition for this part of the upland. There are some burrows in the upland unit sand itself and fairly abundant indigenous burrows in the Barnwell sediments.

About 7 m (23 ft) of upland unit underlies the top of this hill capping the interfluve as it does throughout the map area. The Barnwell Group is only 2.4 m (8 ft) thick. This was determined by drilling an auger hole (S.C.G.S. 2-197) by the exposure of Barnwell sediments and penetrating loose, powdery, white sand in the Huber Formation just 1.5 m (5 ft) below road level. The Barnwell pinches out about 2.4 cm (1.5 miles) to the northwest, but the Coastal Plain extends updip from here for 10.2 km (6.3 miles). Although the pinchout is not far, the Barnwell lithology is like that seen in exposures downdip. The unit appears to have the same lithofacies right up to its present limit.

In the subsurface the Huber Formation is approximately 20.4 m (67 ft) thick. This was determined by drilling a second hole (S.C.G.S. 2-179) in the road 457 m (1500 ft) to the southeast that intersected the top of the Cretaceous sediments at an elevation of 156 m (510 ft). Exposures of rock to the southwest along Flat Rock Creek indicate the top of the Piedmont is about 21 m (70 ft) below road level at an elevation of approximately 153 m (55 ft). The Cretaceous is, therefore, only about 3 m (10 ft) thick and pinches out less than 1.6 km (1 mile) to the northwest.

A measured section was described beginning at the exposure of Barnwell Group sediments and progressing uphill to the northeast.

Top of Section

RESIDUUM and SOIL 1.8 m (6.0 ft)

UPLAND UNIT

Bed 3 Pebbly grit interlayered with sand – transitional contact, interlayered with sand like that described in Bed 2 below, poorly sorted, fine to very coarse, subangular grains with granules and well-rounded pebbles 1-2 cm in diameter. Many of the pebbles disintegrate readily when struck with a hammer. .5m (1.5 ft)

Bed 2 Sand – pink, orange; indurated, well-packed, minor interstitial clay, horizontally layered and thinly laminated to laminated; moderately sorted, fine- to medium-grained sand with minor very coarse grains and granules, grains subangular; finely speckled with fine- to coarse-grained, white clay flecks; some fine-grained heavy minerals, minor white mica, small cross-beds of poorly sorted, coarse-to very coarse-grained sand with granules; pebbly grit lenses 10-13 cm thick and up to 1.3 m across; a few burrows. Pebbly grit at base of this bed. 4.2 m (13.8ft)

BARNWELL GROUP

Bed 1 Sand – pink-orange, with white, clayey laminae disrupted by burrows, well-packed, minor interstitial clay except in the clayey laminae; fairly well-sorted, fine- to medium-grained with scattered very coarse grains and granules, also some thin beds are poorly sorted, medium- to very coarse-grained with granules; subangular grains; fairly abundant fine-grained heavy minerals. Burrows up to 2.25 cm in diameter contain grit brought down from the upland unit above. These occur up to 8 cm down into the top of this bed. In addition there are more numerous indigenous burrows. .6 m (2.0 ft)

Total 7.1 m (23.3 ft)

Board buses and continue ahead.

113.6 0.5 Turn right at stop sign onto South Carolina Route 392.

114.5 0.9 Turn left at stop sign onto U.S. Route 1 going north.

116.3 1.8 Pass Ridge Spring Monetta High School on right.

118.3 2.0 Pass through intersection with South Carolina Route 39 in town of Monetta.

119.7 1.4 Turn right onto Aiken County Road 2-109.

119.8 0.1 Stop sign at intersection with Aiken County Road 2-266. Continue straight.

120.951.15 Turn left onto unnumbered sand road.

121.3 0.35 Park buses and unload.

STOP 7. Discussion by Paul Nystrom

At this stop, very near the Cretaceous pinchout, 5.2 m (17 ft) of Cretaceous micaceous sand is exposed lying on Piedmont saprolite (Figure 38). The Cretaceous is overlain in turn by 4.4 m (14.3 ft) of Huber Formation

Figure 38. Piedmont saprolite overlain by micaceous Cretaceous sand (Stop 7).

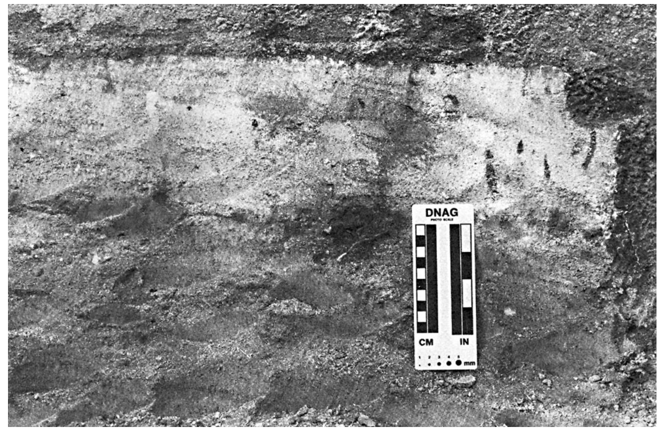

Figure 39. Cretaceous micaceous sand below in contact with Huber Formation pebbly grit (lower middle Eocene) (Stop 7).

pebbly grit (Figure 39). This is a good place to compare and contrast the lithologic characteristics of Cretaceous versus Huber sediments.

The top of the Piedmont is at an elevation of 174 m (570 ft) here but rises sharply and only 488 m (1600 ft) horizontal distance to the northwest was encountered in a drill hole (S.C.G.S. 2-226) at an elevation of 185 m (608 ft). In that drill hole there was no Cretaceous, and Huber pebbly grit lay directly on Piedmont. The pinchout of Barnwell Group sediments also occurs between here and the drill site.

A measured section was made beginning 1 m (3.3 ft) below the top of the Piedmont and measured uphill to the northwest along the road and into the sand pit on the right side of the road.

Top of Section

SOIL

Gritty sand – light gray, poorly sorted, fine – to very coarse-grained with abundant granules and some pebbles, sand grains and granules subangular. .9 m (3.0 ft)

HUBER FORMATION

Pebbly grit – mainly orange or white mottled orange, cohesive to indurated; interstices partially filled with orange or white clay, grains are partially clay- coated; poorly sorted, medium- to very coarse-grained with abundant granules and some pebbles (mainly very coarse grains and granules); sand grains and granules are subangular; scattered Kaolin balls; minor mica. 4.4 m (14.3 ft)

CRETACEOUS SEDIMENTS

Micaceous and – light gray, light gray mottled orange, orange; cohesive to stiff, interstices partially clay-filled to completely clay-filled, interstitial clay may have much fine-grained mica with it; poorly sorted, coarse- to very coarse-grained with abundant granules, or moderately sorted, coarse- to very coarse-grained; grains angular to sub-rounded but mainly subangular; sand-size kaolin grains and scattered kaolin balls. Cross-bedded. Abundant smoky quartz pebbles and granules at base of unit. 5.2 m (17.0 ft)

PIEDMONT CRYSTALLINE ROCKS

Saprolite – white with tan and orange mottles, white clay matrix with abundant, very coarse, subhedral, gray to smoky gray quartz grains, disseminated fine white mica. 1.0 m (3.3 ft)

Total 11.5 m

(37.6 ft)

Board buses and continue straight.

122.0 0.7 Cross Chinquapin Creek (Aiken – Lexington county line). Road becomes Lexington County Road 32-97.

122.650.65 Bear left at stop sign. Intersection with Lexington County Road 32-86.

123.1 0.45 Stop sign at intersection with Lexington County Road 32-85. Continue straight onto paved road.

124.251.15 Turn right at intersection with U.S. Route 1.

Continue straight onto paved road.

125.150.9 Traffic light at intersection of U.S. Route 178 South Carolina Route 391. Continue straight.

126.4 1.25 Enter Leesville.

127.250.85 Traffic signal at intersection with South Carolina Route 245.

128.351.1 Pass under railroad bridge.

128.650.3 Turn right onto unnumbered paved road.

128.9 0.25 Turn right onto unpaved road to sawmill.

129.050.15 Park buses and unload.

STOP 8. Discussion by Paul Nystrom.

Upland unit pebbly grit lying on Barnwell Group sand

Figure 40. Pebbly grit with clay balls in the upland unit (Miocene?) overlying Barnwell Group burrowed sand (upper Eocene) (Stop 8).

(Figure 40) is exposed in the gully along the south side of this gravel road. The contact here is well-defined and typical. An auger hole (S.C.G.S. 32-219), described in detail below, was drilled in the woodyard near the top of the hill at an elevation of 197.6m or 648 feet. It went through 3.1 m (10 feet) of upland unit, 3.1 m (10 feet) of Barnwell Group sand, and 4 m (13 feet) of Huber Formation sand and clay, then intersected the Piedmont surface at an elevation of 187.8 m (615 feet). This locality is only 300 m or less northwest of the overlap of Cretaceous sediments. To the northeast the Tertiary section has been stripped away for the most part, leaving Cretaceous sediments on Piedmont with only isolated remnants of the Tertiary on high parts of the interfluves.

The section described below was measured up the gully from the east end.

Top of Section

UPLAND UNIT

Bed 3 Pebbly, clayey grit – pale orange, pale pink, cream color; indurated, with interstices clay-filled or partially clay-filled; very poorly sorted, coarse- to very coarse-grained with granules and subrounded to well –rounded, 1 to 2 cm quartz pebbles, sand grains are subangular; with clay pebbles and cobbles up to 20 cm near base of unit 3.8m (12.6 ft)

BARNWELL GROUP

Bed 2 Sand-orange, white, pale pink, pale yellow; burrows fairly abundant; bedding and texture varies; thick-bedded, poorly sorted, coarse-grained to very coarse- grained with abundant granules; cohesive, grains partially clay-coated; also laminated, well-sorted, fine-grained with intercalated very thin, white clay-laminae, abundant fine-grained heavy minerals; and thin-bedded orange sand with wavy, white clay laminae, moderately sorted, coarse- to very coarse-grained. 1.9 m (6.3 ft)

Bed 1 Sand – orange, well indurated, indistinctly bedded, very poorly sorted, medium- to very coarse-grained with granules, subangular grains. 1.2 m (4.0 ft)

Total 6.9 m (22.9 ft)

Auger hole log SCGS. 32-219

Location: NW ¼ Gilbert 15' quadrangle; drilled in the woodyard to the right of the gravel road at Stop 8.

Collar elevation: 197.6 m (648 feet)

Soil 0 - .9 m (0-3 ft) Sand – yellow gray, loose, poorly sorted

Upland Unit .9 – 3 m (3-10 ft) Clayey grit – pink, cohesive, moderately stiff, interstices clay-filled; poorly sorted, mainly very coarse grains and granules, but varies from medium- to very coarse-grained, with granules and some subrounded pebbles, sand grains and granules are subangular.

Barnwell Group 3 – 6.1 m (10-20 ft) Sand – light gray, also orange or pink; cohesive, well-packed, little or no interstitial clay; texture varies – fairly well-sorted, fine- to medium-grained with abundant very fine-grained, heavy minerals; also bimodal, fine- to medium-grained groundmass with scattered granules; also poorly sorted, coarse- to very coarse-grained with granules; sand grains subangular. Some very thin clayey laminae.

Huber Formation 6.1 – 7.6 m (20-25 ft) Sand – gray, tan; cohesive, moderately well-packed, very poorly sorted, medium- to very coarse-grained with granules, grains subangular and partially clay-coated.

7.6 – 7.9 m (25-26 ft) Clay – white, very stiff, with some disseminated, coarse- to very coarse-grained sand.

7.9 – 9.2 m (26-30 ft) Clayey sand – white, micaceous, mainly medium-grained, interstices clay-filled, subangular grains.

9.2 – 10 m (30-33 ft) Sand – light gray, cohesive, some interstitial clay (interstices not clay-filled), moderately well-sorted, medium- to coarse-grained, subangular grains; abundant fine-grained heavy minerals.

Piedmont 10 – 13.7 m (33-45 ft) Saprolite – tan with cream mottles, fine-grained, weathered slate (?).

Return and board buses, turn around and leave site.

129.35 0.3 Turn left onto paved road.

129.6 0.25 Stop sign at intersection with U.S. Route 1. Continue straight.

129.7 0.1 Turn left onto Lexington County Road 32-1198.

129.95 0.25 Turn right onto unnumbered paved road.

131.4 1.45 Park and unload buses.

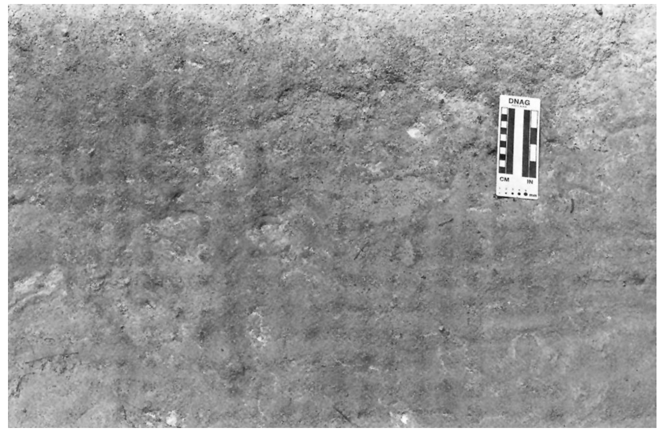

Figure 41. Burrowed pebbly grit in the Huber Formation (lower middle Eocene) a few feet above the Piedmont contact (Stop 9).

STOP 9. Discussion by Paul Nystrom.

In this roadcut burrowed, pebbly grit and sand (near-shore marine?) of the Huber Formation (Figure 41) lie directly on Piedmont crystalline rocks having overlapped the Cretaceous sediments by 2.6 km (1.6 miles). This Huber-Piedmont contact marks the edge of the Coastal Plain for 2.7 km (1.7 miles) to the northeast. From there to North Carolina Cretaceous sediments occur at the edge of the Coastal Plain. Following the Coastal Plain margin to the southwest the Huber-Piedmont contact delineates the edge almost to North Augusta. About 11.2 km (7 miles) north of North Augusta the Cretaceous sediments emerge from beneath the Huber for a short distance. From about 4.8 km (3 miles) north of North Augusta to the Savannah River the Cretaceous lies on Piedmont at the margin.

It is interesting to compare the elevation of the base of the Coastal Plain at this stop (195 m or 605 ft) with elevations on the crystalline terrane to the northwest. In a direction N 33 degrees W, perpendicular to the strike of the Coastal Plain (N 57 degrees E) the Piedmont surface drops approximately 84 m (275 ft) between here and the Saluda River, a distance of 16.7 km (10.6 miles). The land surface then begins to rise, but it is 58.4 km (36.5 miles) before the Piedmont again attains a elevation equal to the contact here. That occurs at a location 6.6 km (4.2 miles) southwest of Joanna, more than two-thirds of the way across the Charlotte belt.

If the base of the Coastal Plain is projected in the same direction (N 33 degrees W) at a gradient of 4.27m/km or 25 ft/mile (the gradient it has to the southeast) it intersects the land surface at an elevation of 970 m (3180 ft) in the Blue Ridge physiographic province along the North Carolina line. The very highest peaks there are just slightly above the projected surface. Therefore in the Piedmont physiographic province the present surface has been eroded well below any pre-existing Coastal Plain cover.

The upland unit caps the ridge at the edge of the Coastal Plain and locally contains cobble deposits that had to have been derived from crystalline terrane at higher elevations. Thus much of the erosion of the Piedmont surface has occurred since the Miocene (?) deposition of the upland unit.

A measured section was described beginning at the north side of the silicified breccia exposure and measured along the east side of the road uphill to the south for 30.5 m. Uphill from there only residuum and soil are exposed.

Top of section

SOIL

Sand- gray, loose, fine- to very coarse-grained with some granules. .6 m (2.0 ft)

RESIDUUM

Clayey grit – orange-tan, indurated. .9 m (3.0 ft)

HUBER FORMATION

Pebbly grit – pink to pink-orange, poorly sorted, medium- to very coarse-grained sand with abundant granules and pebbles, subangular sand grains. Many of the granules and pebbles are smoky quartz. Scattered kaolin balls. Burrows up to 2 to 3 cm or more in diameter. The burrows suggest near shore marine deposition. 1.8 m (6.0 ft)

PIEDMONT CRYSTALLINE ROCKS

Saprolite and silicified breccia – foliated, white to light gray saprolite mottled orange and tan, with medium to coarse quartz grains in a clay matrix. Deformed granite? The silicified breccia is fractured yielding angular pieces and blocks. It is 1.1 to 1.2 m thick with a strike of N 78 degrees E. 1.6 m (5.2 ft)

Total 4.9 m (16.2 ft)

Board buses and continue straight.

131.45 0.05 Turn right onto Walter Shealy Road.

132.1 0.65 Turn right onto Horne Road.

132.55 0.45 Turn right at stop sign onto Lexington County Road 32-1433.

133.3 0.75 Turn right at stop sign onto Lexington County Road 32-158.

134.1 0.8 Turn left at stop sign onto U.S. Route 1 going east.

140.0 5.9 Pass intersection with Lexington County Road 32-24 to Gilbert.

145.7 5.7 Pass Lexington High School on right.

148.8 3.1 Traffic light at junction with U.S. Route 378. Continue straight.

149.4 0.6 Traffic light. Continue straight.

149.5 0.1 Bear right following U.S. Route 378. Continue straight.

150.05 0.55 Traffic light. Continue straight.

150.02 0.15 Traffic light at intersection with South Carolina Route 6, in downtown Lexington. Proceed straight.

152.8 2.6 Bear right onto entrance ramp to I-20 going east to Columbia.

158.2 5.4 Cross the Saluda River.

159.65 1.45 Pass under I-26.

160.4 0.75 Bear right onto exit ramp to Broad River Road (U.S. Route 176).

160.7 0.3 Turn left at traffic signal onto Broad River Road going north.

160.95 0.25 Turn left into Quality Inn parking lot.

END OF SATURDAY'S FIELD TRIP.

FIELD TRIP ITINERARY – ROAD LOG FOR SUNDAY, OCTOBER 12

Meet in parking lot of Quality Inn on U.S. Highway 176 (Broad River Road) in Columbia, South Carolina. Leave

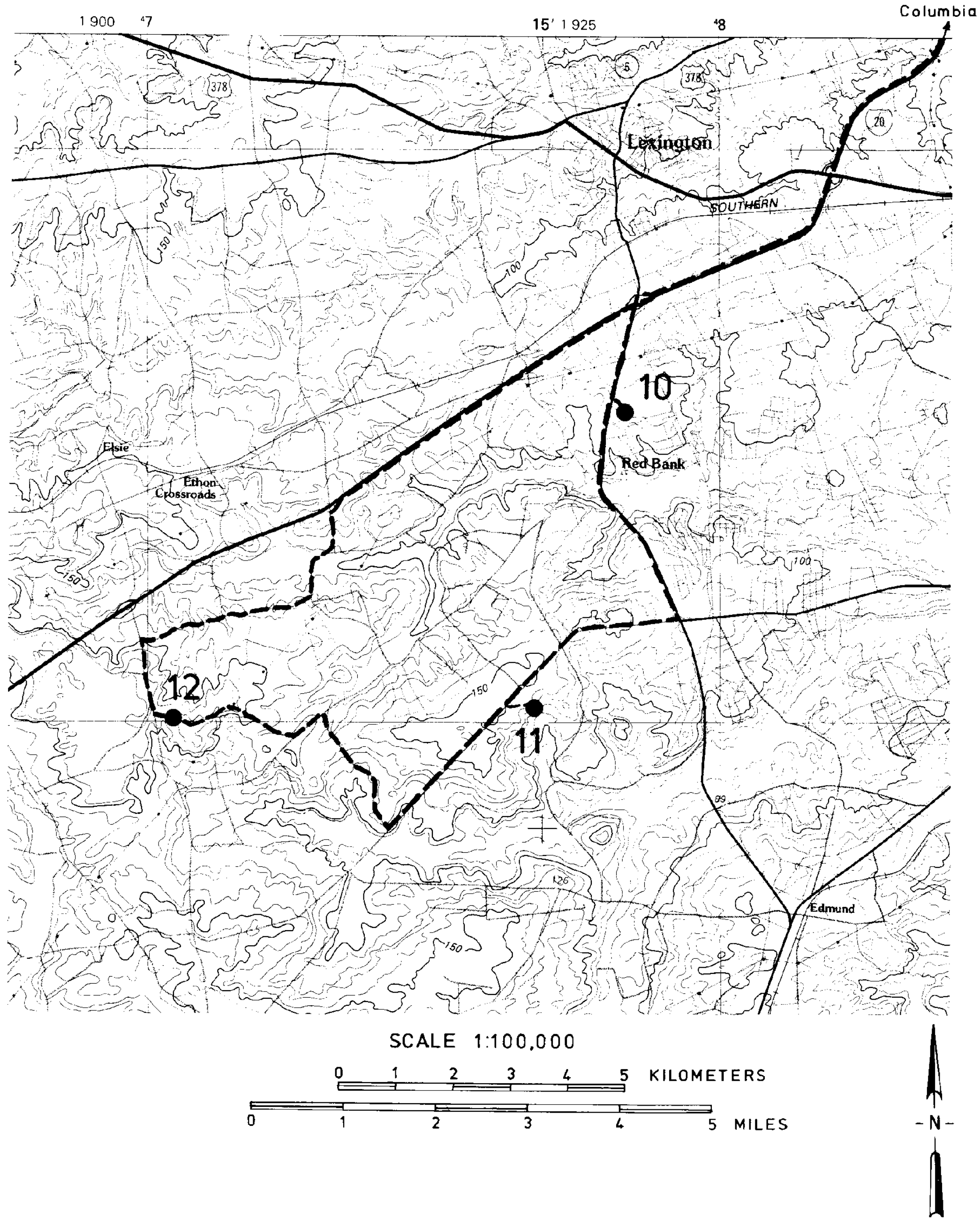

Figure 42. Carolina Geological Society field trip route for Sunday, October 12. Base from U.S.G.S. 1:100,000 Aiken, 1983. Stops shown by large numbers.

parking lot at 8:00 a.m. on Sunday, October 12. See Figure 42 for trip route.

Mileage Cumulative	Interval	Itinerary
0		Leave parking lot, turning right onto Broad River Road.
.1	.1	Turn right onto entrance ramp to I-20 West.
10.2	10.1	Turn onto Exit 55, proceeding up ramp.
10.45	.25	Stop sign. Turn left onto South Carolina Highway 6 east.
11.0	.55	Stop light, intersection with S-32-70 (Two Notch Road). Continue straight on South Carolina Highway 6.
11.6	.6	Turn left onto Carl Lane. Park and unload buses. Walk down dirt road to right into sandpit.

Figure 43. Thinly laminated, subhorizontal to gently dipping beds within the surficial sand unit at the Roland sand pit (Stop 10). Staff is marked in decimeters.

STOP 10. Roland Sand Pit. Discussion by Lou Kite.

(Caution: walls of sand pit may be unstable and subject to collapse and slumping without warning; exercise caution and do not climb sides of pit.)

The Roland sand pit is located in west-central Lexington quadrangle, approximately nine kilometers downdip from the edge of the Coastal Plain. The surficial sand unit is being mined here for construction purposes.

This pit offers good exposures of the sedimentary structures which typify this unit. Steeply dipping cross-beds, as well as thin, horizontal bedding, can be seen where the exposures are freshest (Figures 43 and 44). Abundant burrows locally weather out in relief from the loose sand. The sand varies in size and sorting throughout this pit and reverse-graded bedding can be seen in place.

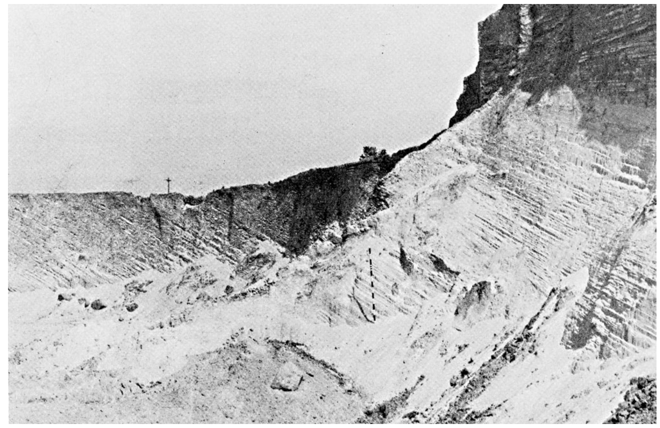

Figure 44. Large set of steeply dipping cross-beds within the surficial sand unit at the Roland sand pit (Stop 10). Staff is marked in decimeters.

At this locality the surficial sand is present on the side of this hill, but not at the top. A power auger hole (collar elevation approximately 400 ft) near the base of the north wall of the pit near the entrance showed Cretaceous sediments of very coarse-grained, clayey sand and sandy clay, and orange clay-sand residuum developed from these sediments is present in the north wall. Also Cretaceous clayey sand can be seen in an auger hole located on the bench above the deepest part of the pit, that area now being worked, showed sand of the surficial deposit present to a depth of thirty four feet, lying directly upon coarse, clayey Cretaceous sands (see auger hole log SCGS 32-128 below).

Natural outcrops of this unit are rarely seen due to the incohesive nature of the sand and normal weathering processes. The erratic distribution and laterally discontinuous nature of the surficial sand deposits make this unit extremely difficult, if not impossible, to map accurately.

A measured section of the eastern wall in the deepest and now active part of the pit showed 6.9 m (22.5 ft) of the surficial sand unit of the following description:

Quartz sand, fine- to coarse-grained, moderately to poorly sorted, angular grains; with scattered dark heavy mineral grains; locally very micaceous. Bedding is variable and well pronounced, includes steeply dipping (up to 30 degrees), large-scale cross-beds and horizontal or gently dipping, finely laminated beds; reverse-graded beds of 6-8 cm thickness are present locally. Vertical burrows (1 to

1.5 cm in diameter and up to 30 cm long) are most abundant in the horizontal beds. Lateral variations in sedimentary structures include small channels and soft sediment deformation. Light tan with irregular, clay-enriched, dark color bands which crudely follow original bedding and are most abundant in uppermost 1 m.

The excavation and removal of sand has locally exposed in the base of the pit very micaceous, fine-grained, very clayey, white sand, presumably the underlying Cretaceous sediments.

Auger hole log SCGS 32-128.

Location: NW ¼ Lexington 7.5' quadrangle; 2 km S 5 degrees W of intersection of I-20 and South Carolina Highway 6, to the east of South Carolina Highway 6, immediately south of Carl Lane, in the sandpit belonging to Mr. Cecil Roland of Lexington; hole located on bench above deepest part of pit where active mining going on.

Collar elevation: approximately 110 m (360 ft).

Surficial sand 0 -.9m (0-3 ft) Residuum of sand, fine- to coarse-grained, poorly sorted; grains clay-coated; brown.

.9 – 10.4 m (3-34 ft) Quartz sand, mostly fine- and medium-grained, with some coarse grains, poorly sorted; fine-grained, dark heavy minerals scattered throughout; no clay, very loose, noncohesive, except for basal 1.8 m (6 ft) where grains are clay-coated; off-white to tan.

Cretaceous 10.4 – 12.2 m (34-40 ft) Clayey sand, fine- to very coarse-grained, sediments poorly sorted; cohesive, with clay content increasing down the rod; orange to orangish-white; wet and soft.

12.2 – 14.6 m (40-48 ft) Kaolinitic clay, slightly sandy; stiff and sticky; grading down into clayey sand, coarse- to very coarse-grained, poorly sorted; with scattered dark heavy mineral grains; wet; off-white.

Return and board buses, turn around and turn left (south) onto South Carolina Highway 6, and proceed through community of Red Bank.

14.4 2.8 Caution light. Turn right onto Platt Springs Road (S-32-34).

16.75 2.35 Pull off to side of road and park. Leave buses and, following sand road to left (southeast) of Platt Springs Road walk through brushy area (350 m) to top of slope, then downhill (125 m) to outcrop in woods.

STOP 11. "Rock House" locality. Discussion by Lou Kite.

The large Cretaceous sandstone exposures (Figure 45) scattered along the hillside at this locality are of interest for several reasons. They have historical significance in that they were mentionedin the scientific literature as early as 1848 by Michael Tuomey, who referred to the locality as "Rock House". Tuomey noted that this rock was quarried here for architectural purposes in Columbia, and evidence of this can be seen today where drill holes remain along some ledges. Silicified sandstone of this type is somewhat unusual in the Coastal Plain; the valley walls at the head of Congaree Creek in Lexington County show several outcrops of this material, of which the "Rock House" locality is perhaps the best and most well known. Tuomey (1848, p. 145) referred this locality to the Eocene, based on the presence of Eocene fossils in exposures of silicified sandstone at other localities in Lexington County. However, no fossils have been found at Rock House, and based on lithology and elevation, this horizon is clearly of Cretaceous age. The quality and quantity of exposure provide a good opportunity to see the sedimentary structures present in the deposits of sand and clay.

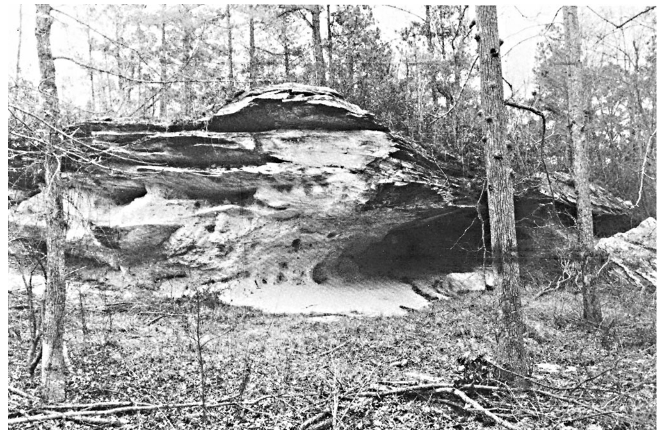

Figure 45. Silicified overhang of kaolinitic, very micaceous Cretaceous sandstone at "Rock House" (Stop 11). For scale note rock hammer resting at base of exposure.

A measured section of the large overhang showed 5.4 m (17.7 ft) of sandstone of the following description:

Sand, fine- to coarse-grained, poorly sorted, to very fine- to fine-grained and silty; fine to coarse flakes of mica are abundant; interstitial clay is abundant, also present are clay-enriched laminae, and very few small (mostly less than 2 cm diameter) clay clasts; well-bedded, with small (mostly less than 2 cm diameter) clay clasts; well-bedded, with small to medium scale cross-beds; white color. Upper half of exposure is silicified, creating overhang above soft and crumbly, unconsolidated material in the lower half. Lateral variations along the hillside include silicified lenses of white kaolin and coarse- to very coarse- grained silicified sandstone.

Return and board buses. Continue on Platt Springs Road.

18.65 1.9 Turn right onto unpaved McCartha Road.

20.25 1.6 Stop sign. Turn left onto Nazareth Road (S-32-243).

20.7 .45 Turn right onto unpaved Pepper Road.

21.55 .85 Stop sign. Turn left onto Ruth Vista Road.

22.2 .65 Stop. Leave buses.

Figure 46. Contact between the silty, clayey, fine-grained sand of the Tobacco Road Sand and the overlying very coarse-grained, clay-flecked sand of the upland unit (Stop 12). Burrows within the Tobacco Road are filled with coarse-grained sand of the upland unit.

STOP 12. Roadcut on Ruth Vista Road. Discussion by Lou Kite.

This roadcut is one of few good exposures of the upland unit in the Girlbert 15' quadrangle. At the base the underlying Tobacco Road Sand is exposed and its silty, fine-grained, yellow-white, clayey sand is in sharp contrast to the much coarser upland unit. A few burrows in the top few centimeters of the Tobacco Road are filled with coarse, poorly sorted, orange sand, this material apparently having been worked down from the overlying upland unit (Figure 46). The upland unit in this exposure consists of mostly coarse- to very coarse-grained and granular, orange sand, with white clay clasts defining cross-bedding. This exposure is a typical example of how the upland unit and its residuum are tough and resistant to weathering.

UPLANT UNIT

Bed 2 b Residuum, with no remnants of original sedimentary structure remaining, grading up into sandy soil. Coarse to very coarse-grained sand with scattered granules and pebbles; interstitial clay present; very tough and resistant to weathering; red-orange color at base grading upward through orange with gray-white mottling, to orangish tan sandy soil from which interstitial clay has been leached out. 4.5 m (14.8 ft)

Bed 2 a Sand, coarse- to very coarse-grained; poorly sorted with local lenses of abundant subangular to subrounded granules and pebbles; interstitial clay present, also with abundant white clay clasts from sand-sized flecks to rounded balls (1-22 cm diameter); clay clasts help to define cross-bedding; somewhat stiff and resistant to erosion; reddish orange; gradual contact with overlying residuum. 3.0 m (9.8 ft)

TOBACCO ROAD SAND

Bed 1 Very fine- to fine-grained sand with silt and clay; moderately well sorted with a few scattered coarse grains; micaceous; upper 6 cm locally contain burrows (1 cm diameter) filled with coarse-grained, poorly sorted orange sand; weathered, appears unbedded; creamy yellow white color; abrupt contact with overlying unit. .5 m (1.6 ft)

Total 8.0 m (26.2 ft)

Return to buses. Continue ahead on Ruth Vista Road.

22.45 .25 Stop sign. Good exposure of Barnwell Group sediments on left on Calks Ferry Road. Turn right onto Calks Ferry Road (S-32-278).

23.25 .8 Turn right onto Sherwood Drive (S-32-1262).

25.25 2.0 Stop sign. Turn left onto Longs Pond Road (S-32-204).

40.75 14.5 Take Exit 65, proceed up ramp.

41.0 .25 Stop light. Turn left onto Broad River Road.

41.2 .2 Turn left into parking lot of Quality Inn.

END OF FIELD TRIP.