GEOLOGIC ATLAS OF THE BUTLER AREA

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INTRODUCTION

The Geologic Atlas of the Butler Area is part of a series of maps that is being produced by the Georgia Geologic Survey to cover the zone of sediments immediately south of the Fall Line. The area covered by this atlas is directly to the west of the area included in Georgia Geologic Survey Geologic Atlas 7 (Hetrick, 1990). Identical colors were used, wherever possible, on both maps to represent identical or equivalent geologic formations. The names and locations of the 7.5 minute quadrangles covered in the present atlas are shown in figure 1. The scale of the geologic map (plate 1) is 1:100,000.

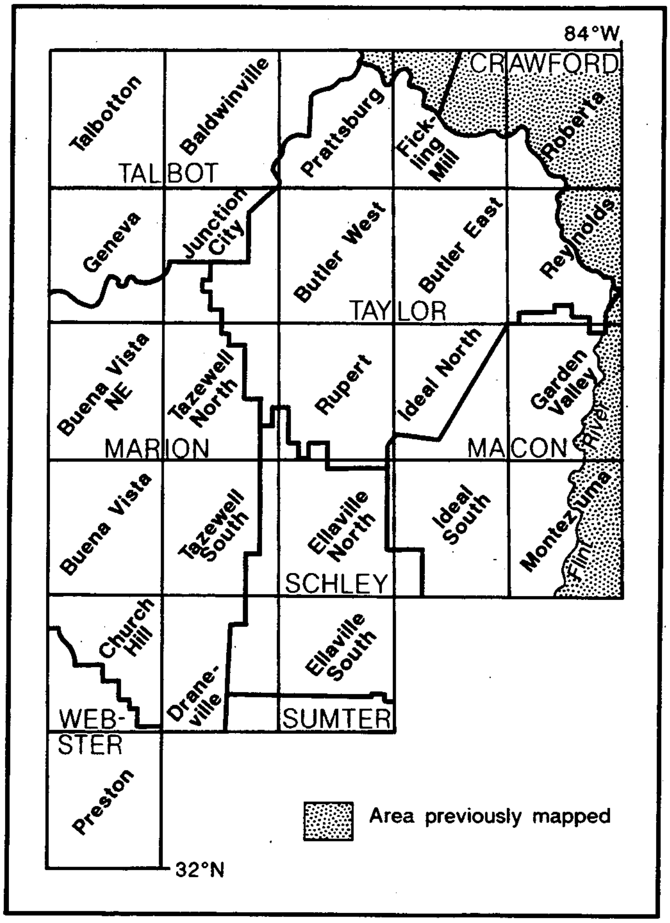

Figure 1. Map area with outlines of quadrangles superimposed.

The map area is within the Fall Line Hills Physiographic District (Clark and Zisa, 1976) and is primarily underlain by Late Cretaceous age sediments, which are shown on the map as northeast-southwest trending bands of sands and clayey sands. The outcrop area of these Cretaceous sediments is environmentally important because it represents a significant portion of the recharge area for the Cretaceous Aquifer System (Pollard and Vorhis, 1980; Karp, 1984), which supplies water to a large area of south Georgia. The southern end of the map area also includes minor portions of the recharge area of the Claiborne Aquifer (McKoy and Mack, 1984) and the Clayton Aquifer (Tuohy, 1984).

The map area contains no municipalities with a population greater than 1,800 (Bachtel and Boatwright, 1993). The map area is sparsely populated, and has a weighted average population density of 20.8 persons per square mile (calculated from data of Bachtel and Boatwright, 1993). In the northern portion of the map, near Butler and Junction City, undifferentiated Upper Cretaceous sediments (Tuscaloosa-Eutaw-Pio Nono Formations undifferentiated) are mined for sand. Agriculture is prevalent in areas bordering the west bank of the Flint River where Tertiary-Quaternary alluvium crops out, and along the southern boundary of the map area, where Tertiary sediments crop out. Outcrop areas of Ripley Formation sediments in the central portion of map area, contain considerable forest cover. There is very little economic activity in the broad outcrop area of the Cusseta-Blufftown Formations undifferentiated. This outcrop belt is covered by very sandy soils and loose sands, which do not lend themselves to agriculture.

Previous geologic maps that included the atlas area are the 1:500,000 scale maps of Eargle (1955), and the *Geologic Map of Georgia* (Georgia Geologic Survey, 1976). The eastern half of the atlas area was included in the 1:250,000 scale geologic map of LeGrand (1962). During the late stages of the publication process of this atlas, the Georgia Geologic Survey first became aware of the recent geologic map of the Americus 30' × 60' quadrangle (Reinhardt and others, 1994). Reinhart and other's (1994) geologic map includes a large portion of the map area of this atlas.

The major differences in the map of this atlas and Reinhardt's, for the map area of this atlas, are as follows: 1) this atlas includes the outcrop area of the Upper Cretaceous Tuscaloosa-Eutaw-Pio Nono Formations undifferentiated up to the Fall Line, whereas, although Reinhardt's map differentiates these formations, with the exception of one small exposure of the Eutaw Formation at the western edge of this atlas's map area, his map does not extend far north enough to include these sediments; 2) Reinhardt's map differentiates the Blufftown-Cusseta Sand Formations, but only extends far north enough to include approximately one third of outcrop area of the Blufftown-Cusseta Sand Formations undifferentiated of this atlas; 3) Reinhardt's map shows more outcrop area for the Providence Formation and less for the Ripley Formation than does this atlas; 4) Reinhardt's map differentiates the Quaternary alluvium of this atlas into Pleistocene and Holocene, Pleistocene, and Pliocene terraces; 5) most of the outcrops of post Lower Eocene sediments and residuum of this atlas are shown as Tallahatta Formation and younger Paleogene deposits, undivided (Oligocene?-lower Eocene) on Reinhardt's map; and 6) what is shown as Clayton Formation-Wilcox Group-Claiborne Group in this atlas is differentiated into the Clayton, Baker Hill, and Tuscahoma Formations.

GEOLOGIC UNITS THAT CROP OUT IN THE MAP AREA

The lithologic descriptions in this atlas are of the geologic units as they were observed within the map area. For more information on the regional distribution patterns, lithologic descriptions, paleontology, and stratigraphic correlations the reader is referred to the following: Huddlestun and Hetrick (1991), Hetrick (1990), Donovan (1986), King and others (1986), Schwimmer (1986), Wheatcroft (1986), Gibson (1982), Reinhardt (1982), Marsalis and Friddell (1975), Huddlestun and others (1974), Toulmin and LaMoreaux (1963), LeGrand (1962), Eargle (1955), and Berry (1923).

Alluvium (Quaternary)

The alluvium consists of sand, clayey sand, clayey silt and minor stringers and beds of gravel. The sediments are generally micaceous, poorly sorted and range in particle size from clay to gravel. Bedding is thin, crude to massive and locally cross-bedded. The alluvium is as much as thirty feet thick in the study area. These sediments are distributed within the flood plains of present-day stream valleys and commonly underlie swampy or boggy areas, where they locally contain abundant organic matter.

Alluvium (Tertiary-Quaternary)

The Tertiary-Quaternary alluvial deposits are similar in lithology to the previously described Quaternary alluvial deposits. However; the Tertiary-Quaternary alluvial deposits differ from the Quaternary alluvium in that the Tertiary-Quaternary alluvial deposits (1) underlie former terrace surfaces; (2) occur at higher elevations above present streams; (3) contain much less organic matter; (4) contain more gravel; and (5) generally have better defined bedding and more occurrences of cross-bedding. The thickness of Tertiary-Quaternary alluvium is estimated to be a maximum of 100 feet thick, with typical thicknesses ranging from 20 to 60 feet.

The author suspects that the Tertiary-Quaternary alluvia were deposited along the Flint River in stages, as the result of several different terrace surfaces, which were formed as sea level rose. However, the field data was insufficient to resolve distributions of the alluvia into discrete levels of deposition. In general, the clastics in the Tertiary-Quaternary alluvium are coarser at higher elevations and at greater distances westward from the Flint River. The coarsest gravels are those found at the highest levels near the Fall Line. The exposure containing the coarsest sediment is located in the southern half of the Talbotton Quadrangle (see the map area in figure 1). This exposure contains rounded quartz particles up to the size of small cobbles and has a basal elevation of 810 feet above mean sea level. No gravel size clastics were observed in the Tertiary-Quaternary alluvium south of Buck Creek (Montezuma quadrangle near Oglethorpe, Macon County). Although beds containing coarse rounded gravel were found distributed throughout most of the outcrop area of the Tertiary-Quaternary alluvium, at low elevations near the Flint River the gravel clasts are mostly small and angular.

Sediments and residuum undifferentiated (Post Lower Eocene)

The Post Lower Eocene sediments and residuum undifferentiated (PLE) of the current atlas were mapped as Eocene and Oligocene residuum undifferentiated on the *Geologic Map of Georgia* (Georgia Geologic Survey, 1976) and as Ocala Limestone and Barnwell Formation by LeGrand (1962). LeGrand's map explanation states that his "Ocala Limestone and Barnwell Formation...includes disarranged beds and residuum of preexisting limestone".

Although most of the exposures of PLE consist of residuum, several good exposures of PLE sediment occur in the Ellaville South quadrangle, Schley County. These exposures are of coarse-grained sand, gravel, and thin kaolin beds. The sorting is very poor and the bedding is flat and vague. Most PLE exposures are reddish-brown, massive-bedded, sandy residuum. No chert particles were found in the outcrop area of the PLE to support the idea that the residuum had its origin as carbonate sediment. The PLE sediments are up to 90 feet thick.

Clayton Formation-Wilcox Group-Claiborne Group undifferentiated (Paleocene-Middle Eocene)

The dominant lithology of the Clayton Formation is gray to brown clay, which is silty to finely sandy, dense and has conchoidal to hackly fracture. Oyster fossils are present in the lower portions of a few of the Clayton outcrops in the map area. The freshest exposures of the Clayton Formation are dense, dark-gray clays and exhibit conchoidal fracture, whereas, more weathered exposures are highly friable and brown. The Clayton clay is typically nonplastic. Most exposures of the Clayton clay are physically stable, with the bare clay supporting roads at several locations. Locally beds of the Clayton up to 6 feet thick are composed of silty, clayey, glauconite oolites. The residuum of the Clayton is a very dark-brown, massive-bedded, sandy clay and commonly contains vuggy ironstone.

Interbeds of fine- to medium-grained, thin- and flat-bedded sands occur within the Clayton clays. Beds of fine-to medium-grained sand, up to 20 feet thick, also occur locally within the Clayton. This sand is very faintly and thinly bedded, and contains laminae of clay. At several exposures, the base of the Clayton is composed of three to four feet of coarse-grained to pebbly, cross-bedded sand. An erosional unconformity occurs between the Clayton and the underlying Cretaceous sediments, and for several feet on either side of the unconformity the sediments are highly weathered. The lowest two to five feet of the Clayton clay in many exposures are weathered to a very light gray and are partially altered to kaolinite. The basal sand of the Clayton and the uppermost few feet of the underlying Cretaceous sediments commonly contain concentrations of iron oxide, which in some cases partially indurates the sediment.

The results of the field work agree with the conclusion of Toulmin and LaMoreaux (1963) that "The Clayton Formation ranges greatly in thickness because of erosion of the top." They also found in exposures along the Chattahootchee that, for the Clayton Formation "The maximum thickness is 150-158 feet a few miles downdip, where the top is not eroded." They further found that solution pits on top of the Clayton are filled with a micaceous quartz sand (Gravel Creek Member of the Nanafalia Formation), and that "The fossiliferous marine sand of the Nanafalia rests directly on the uneroded surface of the Clayton where the Gravel Creek Sand Member is absent. Conversely, the depths of solution pits in the Clayton increase northward and the thickness of the Gravel Creek Sand Member of the Nanafalia increases until it makes up the entire Nanafalia Formation."

Sediments younger (Upper Paleocene to Middle Eocene) than the Clayton Formation that have been mapped in the study area are the Gosport Sand, Tuscahoma Sand, Tallahatta Formation (LeGrand, 1962), the Nanafalia Formation, Tuscahoma Sand, and Claiborne Undifferentiated (Geological Map of Georgia, Georgia Geologic Survey, 1976). East of the Flint River, in the Montezuma quadrangle, Hetrick (1990) mapped sand overlying the Clayton as the Perry Sand.

Although sediments with distinctly different lithologies overlie and are laterally adjacent to the Clayton Formation, the physical distribution of these units in the map area is complex. In view of this complexity and the differences of opinion regarding the stratigraphic correlation of the different lithologies, the current author has grouped these lithologies, along with the Clayton Formation, into the Clayton Formation-Wilcox Group-Claiborne Group undifferentiated (CWC).

The discontinuous nature of the Clayton is most apparent in the southeastern portion of the Ellaville North quadrangle and the southern third of the Ideal South quadrangle. Exposures of cross- to flat-bedded, medium- to very coarse-grained sands occur in those quadrangles where the Clayton is missing. Kaolin balls are common in these CWC sands, and in the Ideal South quadrangle commercial high aluminum kaolin is mined from the CWC. At the southern boundary of the Ideal South quadrangle some exposures of CWC sediments consist of interbedded fine- to medium-grained sands and laminar clays. These interbedded sands and clays contain herringbone cross-bedding indicative of intertidal deposition. Similar herringbone cross-bedding occurs in some exposures of the Perry Sand near Perry, Georgia (Hetrick, 1990). The CWC sediments range in thickness from 60 to 110 feet.

Providence Formation (Upper Cretaceous)

The Providence Formation is composed of fine- to very coarse-grained sand, pebbles, kaolin beds, and kaolin balls. The sand is micaceous, kaolinitic, and generally poorly sorted, with a high variance of particle size and sorting from bed to bed. Bedding in the Providence is distinct, very thin to thin, and quite variable; planar, trough, and channel-fill cross-bedding are all present. Much of the sediment occurs as fill of shallow channels, which are two to three feet deep. The upper several feet of many exposures of Providence are resistant to erosion and are stained and partially cemented with iron oxide. Exposures of the Providence in the Ideal North and Ideal South quadrangles are commonly bioturbated and contain many burrows of *Ophiomorpha nodosa* (trace fossil). Sandy clay beds are common in the Providence Formation, ranging in size from a fraction of an inch to two feet thick. The Providence Formation is 40 to 110 feet thick within the study area.

Only one exposure was found in the map area (in the southwest corner of the Dranesville quadrangle) which agrees with Eargle's (1955) description of the Perote Member of the Providence. This exposure consists of 9 feet (to the base of the exposure) of a medium- to dark-gray, dense, highly micaceous, sandy kaolin. The parting in this exposure is laminar to fissile, and the sediment contains many flakes of organic material. The exposure has a faint smell of hydrogen sulfide.

In an area between the towns of Ellaville and Ideal (Ideal South quadrangle) there was sufficient outcrop data to measure the strike and dip of the top of the Providence Formation. It was found there that the Upper Cretaceous Providence Formation strikes approximately N47°E and dips approximately 30 feet per mile to the southeast.

Ripley Formation (Upper Cretaceous)

The Ripley Formation is composed mostly of beds of micaceous, clayey silt to silty clay, and fine-grained sand. Fresh exposures contain medium- to dark-gray clay beds with thin to laminar interlayers of very pale-gray, fine-grained sand and silt. The clay is fissile, with blocky fracture. Bioturbation has mixed the clay, silt, and fine-grained sand of many zones within the Ripley to a uniform composition. The clay of the Ripley is plastic and most exposures show evidence of slump and mass wasting. Unpaved roads on the Ripley are treacherous during rainy weather, due to the highly plastic nature of the clay. Few good exposures occur within the outcrop area of the Ripley, and most of the exposures consist of clayey residuum or dark clayey soil. The thickness of the Ripley sediments is estimated to be 130 feet in both the Buena Vista quadrangle and in the Ideal North quadrangle.

In some areas, such as the central portion of the Tazewell North quadrangle, exposures of basal portions of the Ripley consist of ironstone-rich residuum. This ironstone is generally sandy and very vuggy (probably due to burrows). One exposure of the basal Ripley Formation in the Tazewell North quadrangle consisted of a three foot thick layer of ironstone casts of burrows.

Locally in updip areas, such as in the northwestern corner of the Rupert quadrangle, exposures of Ripley are composed mostly or entirely of cross-bedded, fine- to coarse-gained sand. The best exposures of this lithofacies are located one mile south of Charing (Taylor County, Rupert quadrangle) on Georgia Highway 137, at the junction with a county road that extends to the east for several hundred yards. Along the county road the basal twelve to fifteen feet of the Ripley is composed of cross-bedded to wavy bedded, fine- to very coarse-grained pebbly sand. This basal sand is very poorly sorted and contains clay clasts, thin clay beds, and the trace fossil *Ophiomorpha nodosa.* The top of the basal bed is marked by a zone of partial induration with iron oxide and a concentration of iron oxide geodes up to three inches in diameter. Conformably overlying the basal bed is eight feet of completely bioturbated, fine-grained sand and clayey silt, which is overlain by five feet of bioturbated, medium- to fine-grained sand containing thin clay interlayers.

Another commonly occurring lithofacies of the Ripley are sands containing little or no clay. One good exposure of the sand lithofacies is near the southern boundary of the Buena Vista quadrangle, along a county road two tenths of a mile east of Kinchafoonee Creek. Approximately 70 feet of Ripley Formation, composed of silty fine-grained sand, is partially exposed along this road. In the northwestern portion of the Church Hill quadrangle some exposures of the Ripley Formation consist of bedded medium- to fine-grained sands with only a few very thin clay layers. The sand in these sand lithofacies is not bound by any interstitial material and probably has a very low resistance to erosion. This easy erodability may explain why good exposures are rare in areas where the sand lithofacies are found, with most of the exposures consisting of loose sand and very sandy soil.

Structure contours (not shown) of the top of the Upper Cretaceous Ripley Formation, near the junction of Schley-Macon-Taylor counties, give an approximate strike of N52°E and a dip of approximately 31 feet per mile.

Cusseta Sand-Blufftown Formations undifferentiated (Upper Cretaceous)

The Cusseta Sand-Blufftown Formations (CBF) stratigraphically correlate to the east with the Gaillard Formation in the

Fort Valley area (Hetrick, 1990; Huddlestun and Hetrick, 1991). In the downdip direction the Cusseta Sand has been correlated with the Demopolis Chalk, and the Blufftown Formation correlated with the Mooreville Chalk (Reinhardt, 1990; Huddlestun and Hetrick, 1991).

LeGrand's (1962) study of the eastern portion of the atlas map area did not identify any Blufftown Formation, and concluded that the "[Cusseta Sand] is not distinguishable from the Tuscaloosa, which underlies it, or from the updip part of the Ripley, which overlies it in the outcrop area. Therefore, it has not been mapped separately but is included in the undifferentiated deposits of Cretaceous age."

The Blufftown Formation was identified at a few outcrops in the map area; however, the author found difficulties in regional stratigraphic differentiation similar to those reported by Eargle (1955) who noted that "...beds of fine sand in the upper part of the Blufftown become coarse in an easterly direction from eastern Chattahoochee County and thus become difficult to distinguish from the Cusseta sand." Eargle (1955) also reports that "[a]bout 2 miles east of Cusseta, coarse sands appear in the upper Blufftown. Farther east the coarse sands occur at increasingly lower positions in the section, so that the entire Blufftown formation and the overlying Cusseta sand becomes nearly indistinguishable through most of Marion and Taylor counties." These two counties make up approximately half of the atlas map area. Although Eargle (1955) did separate the Cusseta from the Blufftown on his map, not enough systematic difference in lithology was found during the field work for the current atlas to justify the separation.

Exposures of CBF generally consist of medium- to very coarse-grained poorly sorted sand, which is thinly cross-bedded and contains small (approximately 1-inch diameter) kaolin balls. Upper portions of the CBF are commonly stained by iron oxide and are weakly indurated. Thin (less than one inch thick) clay beds commonly mark the bedding, and kaolin beds up to eight feet thick infrequently occur. The CBF sediments are estimated to be 375 feet thick in the Buena Vista quadrangle and 240 feet thick on the eastern side of the Butler East quadrangle.

Locally, in lower portions of the CBF, beds occur which are well to moderately sorted, fine- to medium-grained sands. These beds are probably equivalent to the Blufftown Formation of Eargle (1955). These sands are thin- to very thin-bedded, and contain interlayers of black to gray carbonaceous clay, which range in thickness from laminar to 10 feet. The clay layers are sandy and the contact between the clay interlayers and the sand beds is commonly gradational. In weathered exposures the clay is very light gray and plastic. The best exposure of this "Blufftown type" lithology in the study area is a 37 foot thick exposure located 0.45 miles south of the northern boundary of the Rupert quadrangle, on the southwest bank of Whitewater Creek where it is crossed by an unnamed county road.

Tuscaloosa-Eutaw-Pio Nono Formations undifferentiated (Upper Cretaceous)

In areas immediately to the west of the map area, Piedmont crystalline rocks are overlain by the Tuscaloosa Formation, which in turn is overlain by the Eutaw Formation (Eargle, 1955; Toulmin and LaMoreaux, 1963; Frazier, 1982; Reinhardt, 1982). On the eastern side of the map area, sediments that unconformably overlie crystalline rocks were mapped by Eargle (1955) as Tuscaloosa Formation. Huddlestun and Hetrick (1991) renamed these sediments the Pio Nono Formation and considered them stratigraphically equivalent to the Eutaw Formation.

The gross lithologies of the Tuscaloosa, Eutaw, and Pio Nono Formations (TEP) are very similar within the map area. These formations all: (1) contain gravel; (2) contain cross-bedded, arkosic, poorly sorted sand, and sandy mudstone; (3) are locally indurated; and (4) are variably colored with common occurrences of red, maroon, gray, and purple colors. The lithologic criteria Eargle (1955) used to distinguish between the Tuscaloosa and the Eutaw are as follows: "...the Eutaw generally contains white kaolinitic clay balls and lenses, and its clays are not as intensely mottled with purplish red as those of the Tuscaloosa. The sands of the Tuscaloosa are also generally more gravelly throughout than the sands of the Eutaw. Because the basal sand of the Eutaw also contains fine gravel, the two are frequently difficult to distinguish at their contact. Generally, however, the top of the Tuscaloosa contains a bed of intensely mottled clay several inches to several feet thick, and the basal Eutaw, consisting of sand and fine gravel, irregularly overlies this bed of clay."

Another difference between the Tuscaloosa and Eutaw Formations is that, the Tuscaloosa Formation has trace fossils, sedimentary structures, and a distribution of sedimentary facies indicative of a fluvial origin, whereas the Eutaw Formation has sedimentary features indicative of a shallow marine, barrier island environment (Frazier, 1982; Reinhardt, 1982). Criteria for distinguishing between the Tuscaloosa and the Eutaw formations based on trace fossils are given by Eargle (1955) and Frazier (1982). The most detailed descriptions of the differences in sedimentary structure between the Tuscaloosa and the Eutaw are given by Frazier (1982).

No burrows were found in TEP sediments within the map area. Only one exposure was found in TEP sediments in the map area (in the Geneva quadrangle) which contained sedimentary structures possibly indicative of a shallow marine environment. Color differences in TEP exposures may be related to weathering and the amount of clay present in the sediment; gray colors correspond with fresher exposures whereas maroon and red colors correspond with weathered clay or silt concentrations. In summary not enough systematic differences in the sedimentary structures, lithologies, or trace fossils were found to differentiate between the Tuscaloosa, Eutaw, and Pio Nono Formations in the map area.

The Tuscaloosa-Eutaw-Pio Nono Formations undifferentiated sediments are primarily sandy, silty clays to clayey sands. The clays are dense and contain poorly sorted sand. The color of the clayey sediment is variably gray, maroon, and purple, with the colors commonly irregularly distributed in mottled patterns. Another major component of TEP sediment is cross-bedded, coarse-grained, very poorly sorted sand, which commonly contains clay clasts. The sands and very sandy beds are commonly dark reddish-brown. TEP also contains beds of fine to coarse gravel, however, most of the gravel is within the clayey sands. Locally the upper portions of TEP exposures are partially indurated, and blocks of indurated sediment litter the outcrop. The estimated thickness of the TEP sediment at the municipality of Geneva is 140 feet. Near the eastern edge of the map, in the Fickling Mill quadrangle, the estimated thickness of the TEP sediment is 90 feet.

It is difficult to discern whether some outcrops are exposures of TEP clay or exposures of badly weathered Piedmont crystalline rocks. This is especially true near Junction City where some Piedmont rocks may be chlorite schists that have weathered to a maroon to purple clay. At a few outcrops, traces of quartz veins or high angle partings reveal a Piedmont source for the clay residuum. At other exposures the only clues to a Piedmont source are the unusually high clay content and a high uniformity of texture.

Due to a scarcity of formation contacts, no measurements were made for the structural strike and dip of the TEP sediments. However, the outcrop pattern of the TEP sediments parallels the Fall Line in the study area. A rough estimate of the strike of the Fall Line in the map area is N75°E. This differs significantly from the strike of the Providence Formation (N47°E) and the Ripley Formation (N52°E) as seen in the map area.

Depositional Patterns of Upper Cretaceous Sediments

Reinhardt (1982) interprets the depositional environments of the Upper Cretaceous sediments in the map area as: (a) continental for the Tuscaloosa Formation and (b) marginal marine and shelf environments for the other outcropping Upper Cretaceous formations.

According to Reinhardt's depositional scenario, during the first of his four transgressions, fluvial sediment of the Tuscaloosa Formation was overlain by barrier island complex sediments (Eutaw Formation). The second transgression "drowned" the Eutaw barrier system and deposition of inner shelf sand and marl (Blufftown Formation) began. The third transgression occurred within the upper portion of the Blufftown. Deposition of the overlying barrier-bar complex (Cusseta Sand) occurred mainly during the early part of the fourth and final transgression. After the fourth transgression inner-shelf clays and sands (Ripley Formation) were deposited. Sands of the Providence Formation were deposited as the sea regressed at the end of the fourth transgression.

The occurrence of abundant trace fossils in the Ripley and Providence Formations within the map area provides evidence for the final marine transgression proposed by Reinhardt (1982), however, the author found no compelling evidence for the first three transgressions within the study area. It is possible that the paleoenvironments of these transgressions did not extend as far eastward as the atlas map area.

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GEOLOGIC ATLAS OF THE BUTLER AREA

by John Hetrick

SCALE 1:100 000
1 CENTIMETER ON THE MAP REPRESENTS 1 KILOMETER ON THE GROUND
CONTOUR INTERVAL 10 METERS

KILOMETERS 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
MILES 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13

EXPLANATION

Qal	**Quaternary alluvium-** Clayey to silty fine- to coarse-grained sand, well to very poorly sorted; contains sand lenses, clay beds, lenses and stringers of gravel, and organic material, massively to crudely bedded, locally cross-bedded.
TQal	**Tertiary-Quaternary alluvium-** Clayey to silty fine- to coarse-grained sand, very poorly sorted; small gravel to small cobbles, rounded to angular, cross-bedded to massive; very sandy clay beds, very poorly sorted.
Tple	**Post Lower Eocene sediments and residuum undifferentiated-** Very coarse- to fine-grained sand, poorly sorted, angular to subangular, clayey, stained with iron oxide, bedding vague to absent; gravel, coarse to fine, cross-bedded, rounded to angular.
Tcc	**Paleocene-Middle Eocene Clayton Formation-Wilcox Group-Claibome Group undifferentiated-** Clay, silty, massive, conchoidal to hackly fracture, light-to dark-gray, contains oyster shells; sand, fine-grained and well sorted to coarse-grained and poorly sorted, cross-bedded, contains a few small clay clasts, locally contains thick kaolin beds.
UKp	**Upper Cretaceous Providence Formation-** Medium- to very coarse-grained sand, kaolnitic, coarsely micaceous, very poorly sorted, thin- to medium-bedded, cross-bedded, locally contains beds of sandy kaolin, kaolin clasts common, locally contains burrows; clay, sandy, pyritic, lignitic.
UKr	**Upper Cretaceous Ripley Formation-** silty to finely sandy clay, pyritic, very thin-bedded to thin-bedded, contains burrows; sand, fine-to medium-grained, thin-bedded, silty, contains burrows.
UKcb	**Upper Cretaceous Cusseta Sand-Blufftown Formations undifferentiated-** Sand, fine-to very coarse-grained, well to poorly sorted, micaceous, cross-bedded, kaolinitic, locally contains kaolin clasts, locally indurated by iron oxide; clay silty to sandy, locally lignitic.
UKtep	**Upper Cretaceous Tuscaloosa-Eutaw-Pio Nono Formations undifferentiated-** Sand, silty, clayey, fine to very coarse-grained, massive to thinly bedded, locally partially indurated, typically dark reddish-brown; clay, silty, sandy, massive-bedded, rarely lignitic, maroon to reddish-brown.
Xtl	**Paleozoic undifferentiated crystalline rocks.**