A GEOLOGIC ATLAS OF THE CENTRAL GEORGIA KAOLIN DISTRICT

by

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GEOLOGIC ATLAS 6

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INTRODUCTION

Geologic maps of the Coastal Plain sediments in the Macon-Sandersville area are especially important because the area: 1) is a major source of commercial kaolin, 2) contains a large portion of the recharge area of the Cretaceous Aquifer System, and 3) contains smectitic clays which (a) have potential commercial value and (b) present localized construction difficulties due to their load bearing instability.

The map area also includes some of the metamorphic and igneous rocks which occur north of the Fall Line and are the source materials for a number of active quarries producing crushed aggregate and building stone. However, the emphasis of this atlas is on Coastal Plain sediments and no differentiation of rock types was made for the Piedmont.

The bulk of the data was compiled from open-file reports (Buie and others, 1979; Hetrick and Friddell, 1983) which were published at different scales (1:24,000; 1:62,500; 1:100,000). Additional field mapping was done by the current authors; however, this mapping resulted in only minor alteration to the outcrop patterns found in the open-file reports. The atlas includes one geologic map at a scale of 1:100,000 and two structure contour maps at the same scale.

ACKNOWLEDGEMENTS

The authors are appreciative of information and assistance provided by employees of kaolin companies located within the map area. All of the companies contacted readily supplied information and other assistance. Some of the individuals who were especially helpful are David Avant, Peter Edenfield, Russ Foote, Randy Hughes, Bill Mallory, Walter Payne, Sam Pickering, and Paul Thiele.

DESCRIPTION OF GEOLOGIC MAP UNITS

The following is a general description of the lithostratigraphic units exposed in the map area. For further information on the mineralogy, stratigraphy, regional correlations, paleontology, and possible origin of these sediments, the reader is referred to discussions by LaMoreaux (1946), Carver (1966), Pickering (1970), Austin (1972), Tschudy and Patterson (1975), Buie (1978a), Buie (1987b), Huddlestun and Hetrick (1978, 1979, 1986), Buie and others (1979), Hetrick (1982), Hetrick and Friddell (1983), and Huddlestun and Hetrick (in prep.).

Alluvium (Quaternary)
The alluvium primarily consists of sand bars, clayey sands, clays and silts, and minor stringers and beds of gravel. The sediments are very poorly sorted and range in size from clay to gravel. Bedding is generally massive, but crude bedding and cross-bedding are present locally. The Quaternary alluvium is as much as 30 feet thick in the study area. Commonly these sediments underlie swampy or boggy areas within the flood plains of present-day stream valleys and locally contain abundant organic matter.

Alluvium (Tertiary-Quaternary)
The sediments occur at higher elevations than do the Quaternary alluviums, contain little organic material, and generally have high iron oxide contents. They consist of clayey sands, sands, and gravels. The sands are coarse-grained and commonly contain clay clasts, and all of the sediments are very poorly sorted. Commonly these sediments are distinctly thin-to-medium bedded.

Residuum (Tertiary)
At some localities in the study area, the uppermost portions of the exposed sediments have been weathered to the extent that formation identification is not possible. Typical residuum is a "tough," dark reddish-brown to mottled red-gray-orange, clayey sand; it contains minor amounts of disseminated pebbles and is very poorly sorted. Locally, the weathering has been so severe that some of the quartz pebbles can be crushed with finger pressure. The residuum generally lacks bedding and forms a rather dense, impermeable zone. Based on the locations and elevations of the residuum, it is likely derived from weathering of Barnwell Group sediments (upper Eocene) and Altamaha Formation (Miocene) sediments, both of which are discussed in succeeding sections. There is the possibility that some of the residuum was derived from Oligocene sediments. Just south of the southwestern corner of the map area there are thin-bedded pale-green fissile clays interbedded with fine-grained sands and pebbly coarse-grained sands which have been tentatively correlated with the Oligocene. It is possible that some of these "Oligocene" sediments extend updip into the map area but were not identified due to severe weathering. Within the map area, the thickness of the residuum reaches a maximum of about 90 feet.

At one location (approximately 2 miles southwest of Jeffersonville) on the map, a dashed line separates the Tertiary residuum from the Altamaha Formation. The location of this line is based on the northernmost extent of identifiable Altamaha sediments in the map area.

Altamaha Formation (Miocene)
The Altamaha Formation is fluvial in origin and consists of poorly sorted pebbly, argillaceous micaceous sands, sandy clay, and minor amounts of angular pebbles. Where unweathered, exposures of Altamaha consist of pale greenish-gray clays and feldspathic sands. In the more typically weathered exposures, the sediments are mottled reddish-brown-gray and the feldspar fragments have been altered to kaolinite. This weathering commonly results in induration probably due to remobilization of clay minerals and silicification. This induration is most pronounced east of the Oconee River and south of Tennille, Washington County where the Altamaha is indurated and caps steep-sloped ridges that overlook the Oconee River.

Cross-bedded pebbly sand and sandy clay are locally common within the channel fillings of the Altamaha. In the southern half of Washington County the lower 10 to 20 feet of the Altamaha is composed of pale-green to pale-gray, smectitic, moderately to well-sorted, medium-grained sand. Within the map area, the Altamaha is as much as 80 feet thick.

Barnwell Group (upper Eocene)
Within the study area the Barnwell Group consists of: the Tobacco Road Sand, the Dry Branch Formation, and the Clinchfield Formation.

Barnwell Group sediments differ from both the overlying and underlying sediments in both origin and particle size distributions. Portions of the overlying Altamaha Formation and the underlying Huber Formation may be marginal marine; however, the evidence for this environment is weak in the map area: whereas, the limestone and fossils of the Barnwell Group provide indisputable evidence for a marine origin. In general, sedimentary structures (i.e. herring-bone cross-bedding) and the better sorting of the Barnwell point to a greater degree of size separation and reworking prior to deposition. The most apparent difference between the Barnwell and the underlying Huber is the dominant smectite content of the Barnwell clays, as compared to the dominant kaolinite content of the Huber clays.

Tobacco Road Sand (upper Jacksonian)—The Tobacco Road Sand consists of weathered, reddish-brown, medium-grained, moderately to poorly sorted pebbly sands and is coastal marine in origin. Locally the Tobacco Road is partially indurated by iron oxide and secondary clay. One notable exception to the preceding lithologic description exists in the vicinity of Sandersville, where the **Sandersville Limestone Member** irregularly occurs at the base of the Tobacco Road Sand. The Sandersville is a massive, pale-gray, "tough" limestone which ranges up to 14 feet in thickness. Locally silica-cemented sands that contain silicified fragments of oyster shells overlie the basal Sandersville Member. At most localities, the base of the Tobacco Road is marked by a zone, approximately one foot thick, of very thinly bedded to thickly laminated, clayey sands. Immediately overlying the laminated sand layer is a discontinuous zone of variable thickness containing rounded and flat pebbles. The sands within and immediately above the pebbles are coarse, very poorly sorted and locally cross-bedded. Grain size decreases and sorting increases upward through this pebbly unit. At the western end of the study area (Twiggs County) the Tobacco Road is generally finer grained and occurrences of pebbles are uncommon.

At downdip localities bioturbation commonly is present in exposures of the Tobacco Road Sand. In some cores from southern Washington County, the upper 10 to 15 feet of the sand consists of medium- to finely bedded medium-grained, moderately sorted sands and thin beds of very pale, greenish-gray, dense clay. However, because of weathering, it is very rare to have good exposures of the upper portion of the Tobacco Road Sand. The Tobacco Road Sand is about 85 feet thick near Sandersville; in most areas, however, due to severe weathering or erosion, it could not be established whether the unit exceeded 40 feet in thickness.

Dry Branch Formation (lower Jacksonian)—The Dry Branch Formation consists of well-bedded sand (Irwinton Sand Member), and smectitic clay (Twiggs Clay Member) and is inner neritic marine. These sand and clay lithofacies interfinger in a somewhat unpredictable fashion. However, there is a strong tendency for the lower part of the Dry Branch to consist of Twiggs Clay and the upper part to consist of the Irwinton Sand. Another distribution trend is the thickening of the Twiggs Clay to the southwest at the expense of the Irwinton Sand.

The **Irwinton Sand Member** is a pale-yellow to white, fine- to medium- to coarse-grained sand that is moderately to well-sorted. The Irwinton is thin- to medium-bedded, horizontally to cross-bedded, and contains thin laminae and small thin intraclasts of Twiggs-type (smectitic) clay. The Irwinton is a soft, easily erodable sand which commonly forms low angle slopes; whereas, the overlying Tobacco Road Sand is resistant to erosion. As a result of the different erosional characteristics of the Tobacco Road and the Irwinton, the Tobacco Road caps the higher hills and ridges in the area, and the deeper gullies of the area are commonly formed within the Irwinton Sand. The uppermost one to three feet of the Irwinton is commonly characterized by a clay zone, or zone of thinly interlayered sand and clay. Although evidence of bioturbation is rarely present, an intertidal to shallow marine environment is postulated because of the presence of herringbone cross-bedding and scattered lenses of marine shells. The contact of the Irwinton Sand with the overlying Tobacco Road Sand is sharply conformable.

The **Twiggs Clay Member** is a dense, pale-green to gray smectitic clay which has blocky fracture and contains traces of illite and minor amounts of kaolinite near its base (Hetrick, 1982). The Twiggs Clay contains thin laminae of fine- to medium-grained sand which cause the clay to be fissile when dry. In some areas, there are a few thin (foot thick) continuous layers of dense limestone present within the clay. In some fresh mine exposures, the lowermost 6 feet of Twiggs consists of abundant bryozoan fragments within calcareous clay. Typically, the most commonly found fossils of the Twiggs are impressions of very small, thin-shelled pelecypods; however, in the areas of the extreme northeastern outcrop limit of the Twiggs, plant remains may be found.

Commonly, the Twiggs Clay presents engineering problems because of its high smectite content. Within the map area, there are numerous localities at which slump and land creep of the Twiggs are present. These areas of slump and creep are typically located on steep slopes, road cuts and in kaolin mines. The contact of the Twiggs clay with the underlying Clinchfield (and Tivola in downdip areas) is conformable.

The **Tivola Limestone Formation** of the **Ocala Group** grades laterally into the lower portion of the Twiggs Clay. In the southwestern corner of the study area the Tivola occurs both as irregularly distributed isolated lenses and as an eastern tongue of the Tivola. Due to its very limited and discontinuous distribution it was not possible to include the Tivola as a separate map unit, therefore, it was included in with the Barnwell Group. From a practical standpoint this should not be a problem since it is the same age as the basal Twiggs and has a lithology similar to the bryozoan rich calcareous beds common to the basal Twiggs Clay. The Tivola is a bioclastic limestone with a high diversity of fossils, the most abundant of which are bryozoa. Other fossil types common to the Tivola are echinoids, pectens, gastropods, clams, sharks' teeth, and coral. The Tivola was once mined in Twiggs County, however, typical exposures of it in kaolin mines are as small lenses 10 feet thick or less.

Clinchfield Formation (lower Jacksonian)—The Clinchfield is the basal unit of the lower Jacksonian sediments which unconformably overlie Oconee Group sediments in the map area. The majority of the exposures of the Clinchfield display a massively bedded, pale-yellow, medium-grained, moderately to well-sorted sand that contains dark gray to black patches of manganese oxide. The lower one foot of a typical exposure of Clinchfield is poorly sorted and ranges up to pebble in size. The feature that most readily distinguishes the Clinchfield from the supra-adjacent and sub-adjacent sediments is its very poorly developed bedding. Some clay is present in the Clinchfield, however, it is disseminated within the sand rather than in distinct clay laminae or beds. Although the Clinchfield was probably deposited as a calcareous sand, at most exposures the carbonate has been removed by weathering. The typical thickness of the Clinchfield is 15 feet, however, the thickness varies locally from 2 to 35 feet.

In an area which extends from approximately two miles north of the Bibb/Twiggs County line to several miles south of the county line there has been silicification of the Clinchfield. Within this area many of the hilltops are capped by approximately 15 feet of silica cemented Clinchfield sand, and typically the upper slopes of these hills are strewn with boulders of the Clinchfield. Throughout the map area there are localized zones of silicification of the Clinchfield, while at some localities there has only been selective silicification.

Just south of the Bibb County line in Twiggs County the **Treadwell Member** of the Clinchfield Formation occurs. The Treadwell is a fine- to medium-grained, moderately sorted, calcareous sand, which unlike the remainder of the Clinchfield is thinly bedded and contains no clay. Commonly found within the Treadwell are *Periarchus lyelli*, and rarely found are *Aequipecten spillmani.*

Near the Fall Line, the **Riggins Mill Member** of the Clinchfield makes up the lower one-third or, at some sites, the entire Clinchfield. The Riggins Mill is composed of rounded clay cobbles (8 to 30 cm) with some quartz pebbles (2 to 8 cm) in a matrix of poorly sorted, fine- to very coarse-grained sand. A good exposure of the Riggins Mill with the above features is present at Mountain Springs, Twiggs County, and was referred to as Eocene channel sands by LaMoreaux (1946). However, the authors of this report do not equate the Riggins Mill Member with all of the sediments that LaMoreaux referred to as Eocene channel sands. In Twiggs County, the basal two to eight feet of the Riggins Mill locally contains sandy calcareous nodules and numerous *Ostrea gigantissima.* Commonly overlying the nodular zone is a calcareous clayey silt (2 to 8 feet thick), which contains *Chlamys* cf. *membranosa.*

Oconee Group (Upper Cretaceous-middle Eocene)
Sediments, which were once correlated as the Tuscaloosa Formation (Cooke, 1943) and redefined as the Oconee Group (Huddlestun and Hetrick, in prep.), are represented in the map area by the Tertiary Huber Formation and the Cretaceous Gaillard formation.* The sediments of both of these formations are fluvial to upper-estuarine and crop-out in the vicinity of the Fall Line. In addition to having similar depositional environments these deposits have lithologies which are very similar, with the dominant lithic components being micaceous, kaolinitic sands, sandy kaolins, and kaolins.

Some of the Oconee Group sediments contain lignitic beds with leaf impressions and pollen of biostratigraphic significance. Other fossils are rare and consist mainly of trace fossils. Field discrimination of the two formations making up this group was done mainly on the basis of subtle differences in physical and mineralogical properties, types of bedding, and sedimentary textures (Buie, 1978a; Buie and others, 1979; Hetrick and Friddell, 1983). Most of the stratigraphic correlations used in this mapping were from macroscopic features of the kaolin beds. Generally, Huber (Tertiary) kaolin displays the following features:

(1) physical hardness (difficult to crush to powder by finger pressure)
(2) commonly very faint greenish-gray color on fresh fracture surfaces
(3) irregular fracture
(4) commonly contains *Planolites* (a type of burrow)

In contrast, the Gaillard (Cretaceous) kaolin generally displays the following:

(1) physical softness (easily crushes to powder by finger pressure)
(2) white to very pale tan color
(3) conchoidal fracture
(4) commonly micaceous

Laboratory analysis reveals that in addition to the above criteria the Huber kaolins have a smaller particle size and are less crystalline than the Gaillard kaolins. Hetrick and Friddell (1983) found that in the heavy mineral fractions the Huber kaolins (when compared to the Gaillard kaolins) have significantly higher proportions of tourmaline, (epidote + staurolite), and kyanite; while the Gaillard heavy mineral fractions have higher proportions of zircon.

Although less certain than evidence from the clays, other differences helpful in the separation of the Huber from the Gaillard were mica content and size, sedimentary structures, bedding types, and resistance to erosion. The mica content of the Huber is generally low when compared to that of the Gaillard. At the few localities where the Huber has a high mica content, the mica particles are considerably smaller than those found in the Gaillard. The sands of the Huber are distinctly and thinly bedded and contain numerous cut and fill structures which are replete with kaolin clasts; whereas, the Gaillard tends to contain thick bedding which is indistinct and contains few cuts and fill structures or kaolin clasts. There is a tendency for the contact zone between the Huber and the Gaillard to form a vague erosion resistant bench. This feature is not distinct nor widespread and was only used as an aid in locating potential formation contacts.

The formations of the Oconee Group present in the map area are described below.

Huber Formation (Paleocene-middle Eocene)
The Huber Formation (Buie, 1978a) consists of kaolinitic sand, kaolin, clay clasts, and pebbly sand. The sediments are generally poorly sorted and the particle size ranges from clay-size to boulder-size (for some of the clay clasts). The Huber is moderately micaceous and commonly contains minor amounts of heavy minerals concentrated in the medium-grained sands. Though it is not a ledge-former, the Huber is somewhat more resistant to erosion than the underlying Cretaceous Gaillard formation.

The upper contact of the Huber is an unconformity which is generally undulatory and commonly marked by a line of clay cobbles, some of which are pisolitic, and small amounts of pebbles. The majority of the kaolin in the Huber is hard, very pale greenish-gray, and has irregular fracture. The trace fossil *Planolites* (burrows filled with sediment) is sporadically distributed within the upper few feet of the hard kaolins (Schroder, 1982). These hard kaolins grade downward into alternating thin beds of sandy kaolin and medium-grained, moderately sorted sand. Locally, within or near the base of the Huber, there are thin lenses of semi-soft (or semi-hard) kaolin somewhat similar to those of the Cretaceous clays. Numerous clay clasts, coarse-grained sand, and pebbly sand are associated with these semi-soft kaolins. Within the lower portion of the Huber, the pebbles are generally smoky quartz, many particles of which are fractured and very fragile. Where no kaolin beds are present in the Huber, the sediment is commonly composed of thin- to medium-bedded sands that contain numerous kaolinitic laminae, kaolin clasts, and cut-and-fill structures. The thickness of the Huber ranges from 10 to 90 feet and contains clay beds of up to 60 feet thick.

Gaillard Formation (Upper Cretaceous)
The Cretaceous sediments of the Gaillard formation (Huddlestun and Hetrick, in prep.) are composed of kaolin and micaceous kaolinitic sand. The kaolins are soft, white or very pale tan, and have conchoidal fracture. The sands are similar to the previously described Huber sands except that they are more micaceous and contain few cut-and-fill structures or kaolin clasts. The sandy Gaillard kaolins are also generally very micaceous.

The uppermost exposed Gaillard sediments in the map area are generally kaolin, or very micaceous kaolinitic sand. Commonly, at the upper contact of the Gaillard, spherical shapes (approximately 1 cm in diameter), similar to the texture Hinckley (1961) referred to as "turkey-egg pattern," are present in the kaolin. There are rare occurrences of bauxite cobbles at the upper contact of the Gaillard. Buie and others (1979) asserted that the Gaillard kaolin was more resistant to erosion than the sand, and that where the Gaillard-Huber contact is topographically low, the material just beneath the contact is generally a sand. A good example of this relationship occurs immediately north of McIntyre where there is a large, thick, high knob of kaolin. To the west of the knob, the contact drops rapidly and is underlain by sand.

The maximum thickness of the Gaillard sediments in the study area is not known. However, Buie and others (1979) reported a Cretaceous sediment thickness of 1100 feet at Tarversville, Twiggs County, which is in the southwestern corner of the study area.

Oconee Group Undifferentiated
This designation was assigned to pre-upper Eocene sediments in some areas near the Fall Line where the investigators were unable, either due to lack of exposure and severity of weathering, to differentiate Huber from Gaillard.

Sediments Undifferentiated
In certain portions of the map area the authors were unable to correlate some sediments with established stratigraphic units. Many of these sediments are present in updip areas near the Fall Line and have been subjected to severe weathering. Where relatively rare unweathered exposures of these sediments exist the particle size, sorting, and bedding of these materials are highly variable, and all the features observed are characteristic of a nearshore environment; thus, most of the sediments are similar in appearance. These lithological and sedimentological similarities precluded stratigraphic differentiation.

*in the process of being formalized

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DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

GEOLOGIC ATLAS NO. 6
PLATE 2

A GEOLOGIC ATLAS OF THE CENTRAL GEORGIA KAOLIN DISTRICT

Geology and Compilation
by
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and
Michael S. Friddell

1990

83°

33°

EXPLANATION

Qal — **Quaternary Alluvium**—Clayey to silty fine- to coarse-grained sand, well- to very poorly sorted; contains sand bars, clay beds, lenses and stringers of gravel, and organic material, massive to crudely bedded, locally cross-bedded.

TQal — **Tertiary-Quaternary Alluvium**—Clayey to silty fine- to very coarse-grained sand, very poorly sorted; contains lenses and stringers of gravel, locally high iron oxide content; crudely bedded, locally prominently cross-bedded.

Tr — **Residuum from Upper Eocene and younger sediments**—Slightly pebbly, clayey to silty, fine- to very coarse-grained sand, well- to very poorly sorted; generally non-bedded, generally high iron oxide content, locally indurated.

Ma — **Miocene Altamaha Formation**—Clayey sand to clayey gravel; sands are fine-grained to very coarse-grained, generally very poorly sorted; locally cross-bedded, generally thick and massive-bedded, locally indurated.

Tb — **Upper Eocene Barnwell Group–(Tobacco Road, Dry Branch, and Clinchfield Formations)**—silty to sandy clay, clayey sand, sand, pebbly sand, limestone, generally fine- to medium-grained and well to moderately sorted, locally coarse-grained to pebbly and poorly sorted, bedding varies from laminar to thin distinct to medium indistinct, locally prominently cross-bedded, locally indurated, locally chert replaces limestone, locally sand forms steep gullies.

TKo — **Middle Eocene–Upper Cretaceous Oconee Group–(Huber and Gaillard Formations)**—undifferentiated sediments of the Huber and Gaillard Formations described below.

Th — **Paleocene-middle Eocene Huber Formation**—Slightly pebbly sand and clay; sand is medium- to very coarse-grained, moderately to poorly sorted, medium-bedded, undulatory to cross-bedded; contains numerous clay clasts and cut and fill structures, contains commercial grade "hard" kaolin beds, locally pseudobauxite cobbles occur in upper portions.

UKg — **Upper Cretaceous Gaillard formation**—Pebbly sand and clay; sand is medium- to very coarse-grained, poorly sorted, coarsely micaceous, bedding commonly indistinct and thick, locally cross-bedded; contains clay clasts; contains commercial grade "soft" kaolin beds.

Su — **Upper Cretaceous–Recent undifferentiated**—Sands, clays, and gravels.

Xtl — **Paleozoic undifferentiated**—Gneisses, schists, granites, and phyllites.

Approximate boundary separating geologic units.

Study Area

N

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

1000 0 5000 10 000 15 000 20 000 METERS
5000 0 10 000 20 000 30 000 40 000 50 000 60 000 70 000 FEET

● INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1991

STRUCTURE CONTOUR OF UPPER SURFACE OF UPPER CRETACEOUS SEDIMENTS CENTRAL GEORGIA KAOLIN DISTRICT

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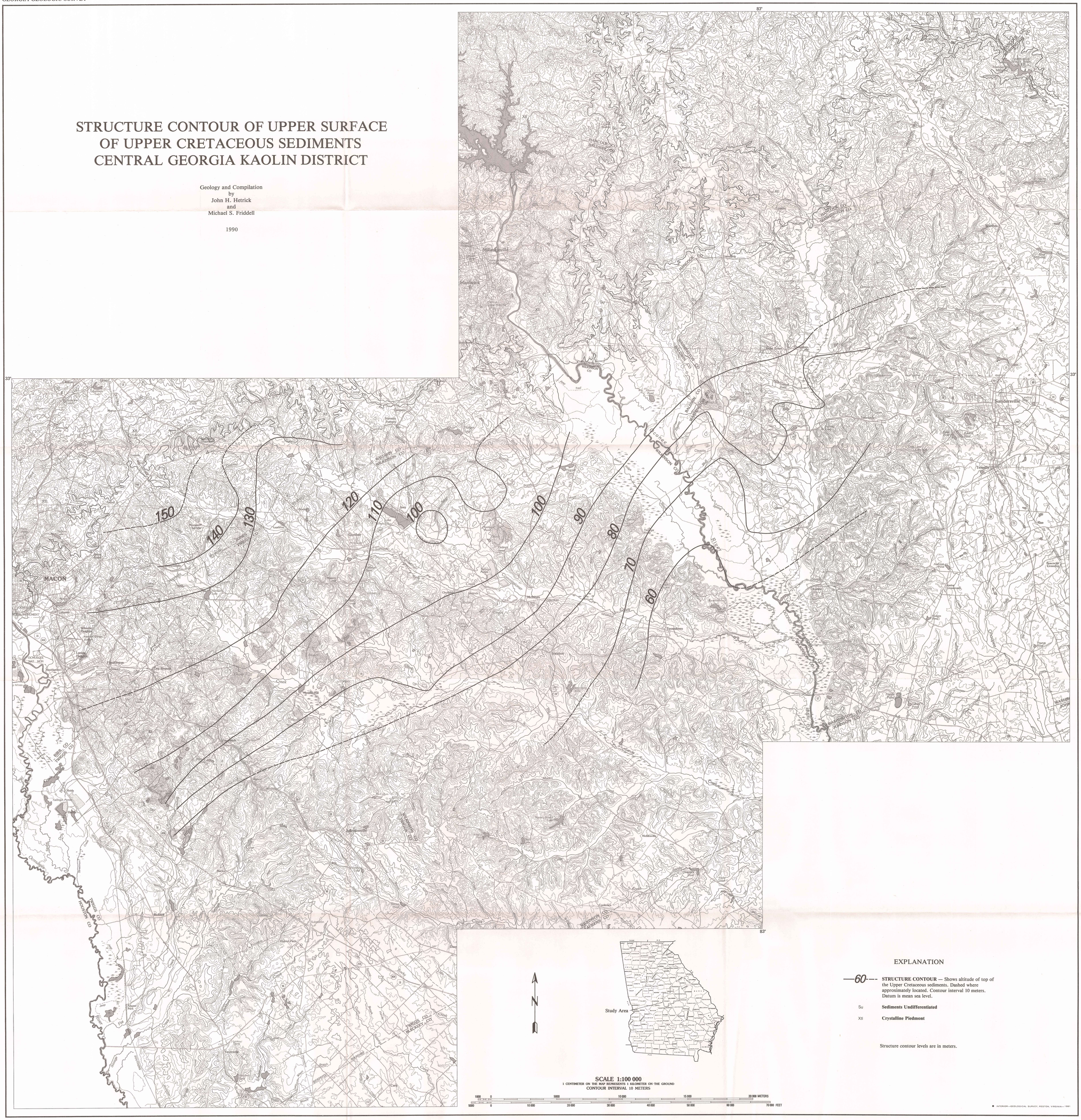

EXPLANATION

—60— **STRUCTURE CONTOUR** — Shows altitude of top of the Upper Cretaceous sediments. Dashed where approximately located. Contour interval 10 meters. Datum is mean sea level.

Su **Sediments Undifferentiated**

XtI **Crystalline Piedmont**

Structure contour levels are in meters.

● INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1981

STRUCTURE CONTOUR OF LOWER SURFACE OF UPPER EOCENE SEDIMENTS CENTRAL GEORGIA KAOLIN DISTRICT

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EXPLANATION

—60— **STRUCTURE CONTOUR** — Shows altitude of top of the Upper Cretaceous sediments. Dashed where approximately located. Contour interval 10 meters. Datum is mean sea level.

Su **Sediments Undifferentiated**

Xtl **Crystalline Piedmont**

Structure contour levels are in meters.

● INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1981