QUATERNARY GEOLOGIC MAP OF THE SAVANNAH 4° x 6° QUADRANGLE, UNITED STATES

QUATERNARY GEOLOGIC ATLAS OF THE UNITED STATES
MAP I-1420 (NI-17)

State compilations by
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NOTE 1: This map is the product of interorganizational collaboration. Following a regional meeting of the State compilers with the coordinator to establish map units and related matters, separate Quaternary maps and map explanations of the part of each State included in the quadrangle were prepared by the State compilers. These maps and explanations were then assembled and integrated and supplemented by the editors to produce the quadrangle map and map explanation. Problems related to differentiation and description of saprolite units, and to definition of map units for the Quaternary deposits of the Coastal Plain, were resolved at additional meetings as well as by correspondence. The footnote on saprolite was prepared by E. T. Cleaves, Maryland Geological Survey, and R. B. Daniels, North Carolina State University. The tentative correlation of Quaternary and upper Pliocene stratigraphic units was prepared by G. M. Richmond with the cooperation of D. C. Colquhoun, W. H. Wheeler, G. H. Johnson, and J. P. Owens. Agreement among workers was not unanimous, in part due to difficulties of dating materials. The other diagrams and charts were prepared by the editors. The compilers reviewed the map prior to its submittal for publication.

NOTE 2: The Pliocene–Pleistocene boundary defined by joint resolution of the International Union for Quaternary Research (INQUA) Subcommission I-d on the Pliocene/Pleistocene Boundary (the International Commission on Stratigraphy (ICS) Working Group on the Pliocene/Pleistocene Boundary) and the Working Group of the International Geological Correlation Program (IGCP) Project No. 41 (Neogene/Quaternary Boundary) is that at the Vrica section in southern Italy. The age of that boundary currently is inferred to be 1.65 Ma (Aguirre and Pasini, 1984).

Time boundaries between the early Pleistocene and middle Pleistocene and between the middle Pleistocene and late Pleistocene are being proposed by the INQUA Working Group on Major Subdivision of the Pleistocene. The boundary between the early Pleistocene and middle Pleistocene is placed at the Matuyama–Brunhes magnetic polarity reversal. The reversal has not been dated directly by radiometric controls. It is significantly older than the Bishop Tuff (revised K–Ar age 738 ka; Izett, 1982), and the estimated K–Ar age of 730 ka assigned to the reversal by Mankinen and Dalrymple (1979) is too young. In Utah, the Bishop volcanic ash bed overlies a major paleosol developed in sediments that record the Matuyama–Brunhes reversal (Eardley and others, 1973). The terrestrial geologic record is compatible with the astronomical age of 788 ka assigned to the reversal by Johnson (1982). The boundary between the middle Pleistocene and late Pleistocene is placed arbitrarily at the beginning of marine oxygen isotope substage 5e (at Termination II or the stage 6/5 transition). That boundary also is not dated directly. It was assigned provisional ages of 127 ka by CLIMAP Project members (CLIMAP Project Members, 1984) and 128 ka by SPECMAP Project members (Ruddiman and McIntyre, 1984), based on uranium–series ages of the substage 5e high eustatic sea level stand. A sidereal age of 132 ka is derived by projection of the boundary onto the astronomical time scale of Johnson (1982).

The Pleistocene–Holocene boundary is being proposed by the INQUA Subcommission on the Holocene. Currently in the United States, it is placed arbitrarily at 10,000 B.P. (Hopkins, 1975).

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CLIMAP Project Members, 1984, The last interglacial ocean: Quaternary Research, v. 21, p. 123–224.

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Hopkins, D. M., 1975, Time stratigraphic nomenclature for the Holocene epoch: Geology, v. 3, no. 1, p.

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Izett, G. A., 1982, The Bishop ash bed and some older, compositionally similar, ash beds in California, Nevada, and Utah: U.S. Geological Survey Open–File Report 82–582, 47 p., 1 pl.
Johnson, R. G., 1982, Brunhes–Matuyama magnetic reversal dated at 790,000 yr B.P. by marine–astronomical correlations: Quaternary Research, v. 17, no. 2, p. 135–147.
Mankinen, E. A., and Dalrymple, G. B., 1979, Revised geomagnetic polarity time scale for the interval 0–5 m.y. B.P.: Journal of Geophysical Research, v. 84, no. B2, p. 615–626.
Ruddiman, W. F., and McIntyre, A., 1984, Ice–age thermal response and climatic role of the surface Atlantic Ocean, 40° N. to 63° N.: Geological Society of America Bulletin, v. 95, p. 381–396.

The map contains the following illustrations:

- An index map to the International Map of the World 1:100,000 topographic series showing the Quaternary geologic map of the Savannah 4°x 6° quadrangle and other published maps of the Miscellaneous Investigations Series (I–1420).
- An illustration showing the responsibility for state compilations.
- A chart showing correlation of map units.
- A chart showing tentative correlation of Quaternary and upper Pliocene lithostratigraphic and morphostratigraphic units of the Savannah Quadrangle and of age groupings for the entire Atlantic Coastal Plain

LIST OF MAP SYMBOLS

CONTACT

MARINE SCARP

BEACH OR DUNE RIDGE

CAROLINA BAY—Shallow, oval or elliptical, generally marshy closed depression in Atlantic Coastal Plain; 100 m to many kilometers long. Origin debated; attributed to meteorites, upwelling springs, eddy currents, eolian erosion, solution, or thaw of permafrost
THIN DEPOSIT OF EOLIAN SAND OVERLYING MAP UNIT

DESCRIPTION OF MAP UNITS

HOLOCENE

agg ALLUVIAL SANDY GRAVEL—White, light-gray to dark-brown, poorly sorted, sandy, pebble-to-boulder gravel; grades upward into sandy to silty clay; locally contains lenses of angular, moderately sorted to well-sorted, micaceous sand. Gravel consists predominantly of quartz and quartzite but in places includes some granitic crystalline rock. Deposit underlies flood plains, alluvial fans, and low terraces. Thickness 3–10 m

asa ALLUVIAL GRAVELLY SAND—White to orange-red, fine to coarse sand containing lenses of pebble-to-cobble gravel, and sandy silt containing lenses of kaolinitic clay. Sand chiefly quartz and feldspar, gravel chiefly quartz and quartzite. Deposit is poorly sorted, thin to thick bedded, and abundantly crossbedded. Gravel content increases with depth. Mapped areas include local organic muck and swamp deposits on flood plains, and colluvium along margins of valley floors. Thickness 5–15 m

asf ALLUVIAL RED SAND, SILT, AND CLAY—Reddish-gray, reddish-brown, or purplish-red sand, silt, and clay, intermixed or interbedded. Deposit is poorly sorted to well-sorted, poorly bedded to well-bedded; includes local layers of pebble-cobble gravel that is chiefly of sandstone but contains basalt clasts in places. Clay is chiefly kaolinite; minor amounts are smectite. Deposit underlies flood plains and low terraces. Mapped areas include organic muck and swamp deposits of flood plains and locally derived colluvium along margins of valley floors. Thickness 3–10 m

ala ALLUVIAL SILT AND CLAY—Dark-brown, dark-gray or black, highly organic silt and clay. Clay chiefly smectite on Coastal Plain, kaolinite on Piedmont. Minor lenses of sand and gravel in deposit at depth. Mapped areas include local swamp deposits and organic muck on flood plains. Thickness 5–10 m

hps SALINE-MARSH DEPOSIT—Gray, black, brown, or dark-green, micaceous, kaolinitic to smectitic, organic-rich mud and silty mud containing silt, fine sand, clay, and herbaceous peat intermixed and interbedded. In places includes sand lenses and beds of pure peat. Color darkens as organic content increases. Deposit commonly bioturbated. Locally, it includes interbedded brackish-water deposits. Thickness 1–3 m

be BEACH AND DUNE SAND—White, gray to yellowish-brown, angular to subangular, fine to medium sand; well sorted, laminated, and crossbedded; mostly quartz with traces of heavy minerals; locally includes some organic matter and crushed shell. Occurs along coast at and above modern beach; dunes locally form elongate masses, too small to map, on coastal saline-marsh deposits (**hps**). Thickness 2–20 m

HOLOCENE TO LATE PLEISTOCENE

es EOLIAN SAND—Light- to dark-gray, yellowish-orange to dark-reddish-brown medium sand; well-sorted, massive to crossbedded; mostly quartz. Forms linear sheets and patchy dune fields, both active and stable. Surface depressions commonly contain organic material. Deposit overlies Pleistocene river terraces on east sides of major river valleys. Thickness 1–10 m

LATE PLEISTOCENE

cba GRANITIC OR ARKOSIC METASEDIMENTARY BOULDERY COLLUVIUM[1]—Pale- to dark-brown, yellowish-red, grayish-yellow, poorly sorted, silty, sandy loam to sandy clay. Angular clasts and round to subround cobble- to boulder-size joint-block core stones make up 15–60 percent of deposit. Clasts are of arkosic metasedimentary rocks in western part of map-unit area and of granitic rocks in eastern part. Material mantles steep slopes and includes debris-avalanche, mudflow, landslide, creep, and probably solifluction deposits. Locally, deposit extends over alluvial terrace deposits. Map unit includes some rock outcrops, areas of saprolite, and bouldery alluvial-fan deposits. The colluvium overlies saprolite in places, especially at base of slopes. Thickness ranges from about 2 m to as much as 30 m at base of some slopes

csh SANDY, SHALEY COLLUVIUM[1]—Gray, bluish-gray, greenish-gray, or yellowish-gray sandy loam, locally clayey or silty; contains abundant chips of shale, particles of clay, and small fragments of sandstone. Boulders rare. Sand mostly quartz. Deposit developed chiefly along western margin of Great Smokey Mountains in Tennessee. Thickness generally less than 15 m

ATLANTIC COASTAL PLAIN UNITS

The Quaternary deposits of the Atlantic Coastal Plain (**bma** through **aeg**) are subdivided into four major depositional facies: (1) sand of beaches, barrier bars, and other nearshore deposits; (2) marine silt and clay deposited in lagoons and tidal marshes inland from the barrier bars; (3) marine clay, silt, sand, and gravel deposited in deltas at mouths of major rivers; (4) alluvial and estuarine sand and silt deposited in stream channels and along the margins of estuaries tributary to shorelines during episodes of Quaternary high sea level.

Named deposits within each map unit include both lithostratigraphic and so-called morphostratigraphic units or terraces. The lithostratigraphic units are the Silver Bluff, Princess Anne, Pamlico, Talbot, Penholoway, Wicomico, and Okefenokee Formations. Only a very general correlation of stratigraphic and morphostratigraphic units is intended, for the stratigraphy is incompletely known, and some morphostratigraphic units include deposits of more than one age. Furthermore, problems inherent in dating of coral and other marine shell material permit only broad grouping of deposits in terms of radiometric age.

LATE PLEISTOCENE

bma BEACH AND NEARSHORE MARINE SAND (barrier island facies of Silver Bluff Formation in Georgia and South Carolina and of part of Wando Formation in South Carolina)—White to gray, light-tan to yellowish-brown, well sorted, fine to medium quartz sand; planar-bedded to crossbedded. Basal part is commonly coarse to very coarse sand. Deposit is leached to a depth of about 4 m, below which is unleached calcareous shell debris. Unit consists in part of washover sheet-fan and tidal-inlet channel deposits. Thickness 18–20 m

mla MARINE SAND, SILT, AND CLAY (lagoon facies of Silver Bluff Formation in Georgia and South Carolina and of part of Wando Formation in South Carolina)—Light-gray to tan silty sand or silt that grades down into bluish-gray to gray silty clay or clay. Smectite is predominant clay; kaolinite is subordinate, and illite rare. Deposit is massive to finely laminated and contains thin laminae of silt, well-sorted fine quartz sand, silty sand, and organic debris. Along its seaward border, deposit is locally characterized by washover and tidal-scour structures. It is extensively bioturbated. Near barrier-island sand deposits (**bma**), unit grades downward into and interfingers with poorly sorted, fine to coarse, subangular quartz sand containing minor amounts of feldspar and mica. Mapped areas include small deposits of eolian sand (**es**) on northeast and east sides of river valleys, and alluvial gravelly sand (**asa**) along secondary river channels. Thickness 1–15 m

bmb BEACH AND NEARSHORE MARINE SAND (barrier island facies of Princess Anne Formation in Georgia and South Carolina and of Wando Formation in South Carolina)—White to gray, light-tan to yellowish-brown, fine to medium quartz sand; well sorted to very well sorted, planar-bedded to low angle crossbedded; washover sheet-fan and tidal inlet channel and fill structures common. Basal beds are coarse to very coarse sand. Deposit leached to a depth of about 4 m, below which it includes unleached calcareous shell debris. Thickness 18–20 m

mlb MARINE SAND, SILT, AND CLAY (lagoon facies of Princess Anne Formation in Georgia and South Carolina, and of Wando Formation in South Carolina)—Light-gray to tan silty sand or silt that grades down into bluish-gray to gray silty clay or clay. Smectite is predominant clay; kaolinite is subordinate, and illite rare. Deposit is massive to finely laminated and contains thin laminae of silt, well-sorted fine quartz sand, silty sand, and organic debris. Along its seaward border, deposit locally includes washover and tidal-scour structures. It is extensively bioturbated. Near barrier-island sand deposits, lagoonal silt and clay grades downward into and interfingers with poorly sorted fine to coarse, subangular quartz sand containing minor amounts of feldspar and mica. Mapped areas include small deposits of eolian sand (**es**) on northeast and east sides of river valleys, and alluvial gravelly sand (**asa**) along secondary river channels. Thickness 1–15 m

mdb MARINE DELTA CLAY, SILT, SAND, AND GRAVEL (delta facies of Princess Anne Formation and alluvial facies of Wando Formation in South Carolina)—Light-gray to dark-brown kaolinitic marine clay, arkosic to quartzose sand, and gravel, intermixed and interbedded. Deposit contains saline-marsh flora and fauna, organic matter, and local peat. Topset beds include channel-and-fill structures. Thickness 10–20 m, locally 35 m where deposit fills channels eroded into underlying Tertiary deposits

MIDDLE PLEISTOCENE

bmc BEACH AND NEARSHORE MARINE SAND (barrier island facies of Pamlico Formation in Georgia; of Talbot Formation underlying Pamlico terrace in South Carolina; and of Socastee Formation in North Carolina and South Carolina. Mapped areas locally include parts of Wando Formation (late Pleistocene) in southeastern South Carolina)—White to gray, light-tan to yellowish-brown, fine to medium quartz sand; well sorted to very well sorted; planar-bedded or low-angle crossbedded; washover sheet-fan and tidal-inlet channel-and-fill structures common. Basal beds are coarse to very coarse sand. Deposit is leached throughout, commonly is deeply weathered, and includes yellowish-red, brown, or gray mottled horizons. Thickness 6–10 m

mlc MARINE SILT AND CLAY (lagoon facies of Pamlico Formation in Georgia; of Talbot Formation underlying Pamlico terrace in South Carolina; and of Socastee Formation in North Carolina and South Carolina. Mapped areas locally include parts of Wando Formation (late Pleistocene) in southeastern South Carolina)—Light-gray to tan silty sand or silt that grades down into bluish-gray or gray silty clay or clay. Smectite is predominant clay; kaolinite is subordinate, and illite rare. Deposit is massive to finely laminated and contains thin laminae of silt, well-sorted fine quartz sand, silty sand, and organic debris. Along its seaward border, deposit locally characterized by washover and tidal-scour structures. It is extensively bioturbated. Near barrier island sand deposits (**bmc**), back-barrier silt and clay grades downward into and interfingers with poorly sorted, fine to coarse, subangular quartz sand containing minor amounts of feldspar and mica. Mapped areas include small deposits of eolian sand (**es**) on northeast and east sides of river valleys, and alluvial gravelly sand (**asa**) along secondary river channels. Thickness 1–15 m

mdc MARINE DELTA CLAY, SILT, SAND, AND GRAVEL (delta facies of Talbot Formation underlying Pamlico terrace in South Carolina. Mapped areas locally include parts of Wando Formation (late Pleistocene) in southeastern South Carolina)—Light-gray to dark-brown kaolinitic marine clay, arkosic to quartzose sand, and gravel, intermixed and interbedded. Deposit contains saline-marsh flora and fauna, organic matter, and local peat. Topset beds include channel-and-fill structures. Thickness 10–20 m, locally as much as 30 m where deposit fills channels eroded into underlying Tertiary deposits

bmd BEACH AND NEARSHORE MARINE SAND (barrier island facies of Talbot Formation in Georgia; of Talbot Formation underlying Talbot terrace in South Carolina; of part of Canepatch Formation in North Carolina and South Carolina)—White to gray, light-tan to yellowish-brown, fine to medium quartz sand; well sorted to very well sorted; planar or low-angle crossbedded, washover sheet-fan and tidal-inlet channel-and-fill structures common. Basal beds are coarse to very coarse sand. Deposit is leached throughout, is commonly deeply weathered, and contains yellowish-red, brown, and gray mottled horizons. Thickness 6–10 m

mld MARINE SAND, SILT, AND CLAY (lagoon facies of Talbot Formation in Georgia; of Talbot Formation underlying Talbot terrace in South Carolina; and of part of Canepatch Formation in North Carolina and South Carolina)—Uppermost layers of light-gray to tan silty sand or silt grade down into bluish-gray or gray silty clay or clay. Smectite is predominant clay; kaolinite is subordinate, and illite rare. Deposit is massive to thin bedded and contains thin laminae of silt, well-sorted fine quartz sand, silty sand, and organic debris. Along its seaward border, map unit locally characterized by washover and tidal-scour structures. It is extensively bioturbated. Near barrier-island sand deposits, the silt and clay grade downward into and interfinger with poorly sorted, fine to coarse, subangular quartz sand containing minor amounts of feldspar and mica. Mapped areas include small deposits of eolian sand (**es**) on northeast and east sides of river valleys, and alluvial gravelly sand (**asa**) along river channels. Thickness 1–15 m

bme BEACH AND NEARSHORE MARINE SAND (barrier island facies of Penholoway Formation in Georgia and South Carolina and of part of Canepatch Formation in North Carolina and South Carolina)—White to gray, light-tan to yellowish-brown, fine to medium quartz sand; well sorted to very well sorted; planar-bedded or low-angle crossbedded, washover sheet-fan bedding and tidal-inlet channel-and-fill structures common. Basal beds are coarse to very coarse sand. Deposit is leached throughout, commonly is deeply weathered, and contains yellowish-red, brown, and gray mottled horizons. Thickness 6–10 m

mle MARINE SILT AND CLAY (lagoon facies of Penholoway Formation in Georgia and South Carolina, and part of Canepatch Formation in North Carolina and South Carolina)—Bluish-gray or gray silty clay or clay that grades upward into loamy sand or loam near ground surface. Smectite is predominant clay; kaolinite is subordinate, and illite rare. Deposit is massive to thin bedded and contains thin laminae of silt, well-sorted fine quartz sand, silty sand, and organic debris. Along its seaward border, deposit is locally characterized by washover and tidal-scour structures. It is extensively bioturbated. Near barrier-island sand deposits (**bme**), the silt and clay grades downward into and interfingers with poorly sorted, fine to coarse quartz sand containing minor amounts of feldspar and mica. Mapped areas include small deposits of eolian sand (**es**) on northeast and east sides of river valleys, and alluvial gravelly sand (**asa**) along secondary river channels. Thickness 1–15 m

mde MARINE CLAY, SILT, SAND, AND GRAVEL (delta facies of Penholoway Formation in South Carolina)—Light-gray to dark-brown kaolinitic marine clay, arkosic to quartzose sand, and gravel, intermixed and interbedded. Deposit contains saline-marsh flora and fauna, organic matter, and local peat. Topset beds include channel-and-fill structures. Thickness 10–20 m, locally as much as 30 m where deposit fills channels eroded into underlying Tertiary deposits

LATE PLEISTOCENE TO LATE PLIOCENE

msb MARINE SAND, UNDIFFERENTIATED—Light-gray to light-brown, fine-to medium-grained quartz sand; well sorted. Leached and commonly unfossiliferous but locally includes lenses of coquina and shell-hash limestone. Thickness 0.5–3 m

EARLY PLEISTOCENE TO LATE PLIOCENE

aef ALLUVIAL AND ESTUARINE SAND AND SILT (estuarine facies of Waccamaw Formation in North Carolina)—Medium-gray to mottled, yellowish- or reddish-brown, fine to coarse arkosic sand; medium to thick bedded; crossbedded. Deposit grades downward into massive clayey silt or fine sand that becomes coarser and locally pebbly at base. Map areas include small deposits of alluvial gravelly sand (**asa**), colluvium, and sandy residuum (**zsc**) developed on Tertiary deposits. Thickness as much as 6 m

bmf BEACH AND MARINE SAND (barrier island facies of Wicomico Formation in Georgia and South Carolina, and of Waccamaw Formation in North Carolina and South Carolina)—White to gray, light-tan to yellowish-brown, fine to medium quartz sand; well sorted to very well sorted; planar-bedded to low-angle crossbedded; washover sheet-fan and tidal-inlet channel-and-fill structures common. Basal beds are coarse to very coarse sand. Deposit is leached throughout, commonly is deeply weathered, and contains yellowish-red, brown, and gray mottled horizons. Thickness 6–10 m

mlf MARINE SILT AND CLAY (lagoon facies of Wicomico Formation in Georgia and South Carolina, and of Waccamaw Formation in North Carolina and South Carolina)—Light-gray to yellowish-brown silty sand to silt that grades down into bluish-gray to gray silty clay or clay. Smectite is predominant clay; kaolinite is subordinate, and illite rare. Deposit is massive to thin bedded and contains thin laminae of silt, well-sorted fine quartz sand, silty sand, and organic debris. Along its seaward border, it is locally characterized by washover and tidal-scour structures. It is extensively bioturbated. Near barrier-island sand deposits, the silt and clay grades downward into and interfingers with poorly sorted, fine to coarse, subangular quartz sand containing minor amounts of feldspar and mica. Mapped areas include small deposits of eolian sand (**es**) on northeast and east sides of river valleys, and alluvial gravelly sand (**asa**) along secondary river channels. Thickness 1–15 m

mdf MARINE DELTA CLAY, SILT, SAND, AND GRAVEL (delta facies of Wicomico and Waccamaw Formations in South Carolina)—Light-gray to dark-brown kaolinitic marine clay, arkosic to quartzose sand, and gravel, intermixed and interbedded. Deposit contains saline-marsh flora and fauna, organic matter, and locally peat. Its topset beds include channel-and-fill structures. Thickness 10–20 m, locally as much as 30 m where deposit fills channels eroded into underlying Tertiary deposits

LATE PLIOCENE

aeg ALLUVIAL AND ESTUARINE SAND AND SILT (estuarine facies of Marietta unit in North Carolina)—Medium-gray, yellowish- to reddish-brown, mottled yellowish- to reddish-brown, fine to coarse quartz and feldspar sand; medium to thick bedded, crossbedded. Deposit grades downward into massive clayey silt or fine sand that becomes coarser and locally pebbly at base. Mapped areas contain small deposits of alluvium, colluvium, and gravelly residuum (**zga**) on Tertiary deposits. Thickness as much as 6 m

ase ALLUVIAL SAND—White, light-gray to light-yellow, coarse to fine, slightly clayey sand; poorly to well sorted. Contains local lenses and beds of angular to rounded quartz-pebble gravel and sandy kaolinitic clay. The sand becomes increasingly fine grained and well sorted from north to south. Map unit includes extensive, locally derived, thin surface deposits of eolian sand (**es**) of late Pleistocene and Holocene age. Unit mapped only in Georgia. Thickness 5–15 m

bmg BEACH AND NEARSHORE MARINE SAND (barrier island facies of Marietta unit in North and South Carolina and of Okefenokee Formation in South Carolina)—White to gray, light-tan to yellowish-brown, fine to medium quartz sand; well sorted to very well sorted; planar-bedded or low-angle crossbedded; washover sheet-fan and tidal-inlet channel-and-fill structures common. Basal beds are coarse to very coarse sand. Deposit is leached throughout, commonly is deeply weathered, and includes yellowish-red, brown, and gray mottled horizons. Thickness 6–10 m

mlg MARINE SAND, SILT, AND CLAY (lagoon facies of Bear Bluff Formation in North and South Carolina; and of Okefenokee Formation in South Carolina)—Pale-gray to yellowish-brown silty sand or silt that grades down into bluish-gray or gray silty clay or clay. Smectite is predominant clay; kaolinite is subordinate, and illite rare. Deposit is massive to thin bedded, and contains thin laminae of silt, well-sorted fine quartz sand, silty sand, and organic debris. Along its seaward border, unit locally includes washover and tidal-scour structures. It is extensively bioturbated. Near barrier-island sand deposits, the silt and clay grades downward into and interfingers with poorly sorted fine to coarse, subangular quartz sand containing minor amounts of feldspar and mica. Mapped areas include small deposits of eolian sand (**es**) on northeast and east sides of river valleys, and alluvial gravelly sand (**asa**) along secondary river channels. Thickness 1–15 m

QUATERNARY AND TERTIARY

zga CLAYEY, FINE GRAVELLY SAND DECOMPOSITION RESIDUUM[2]—Gray, yellowish-brown, or yellowish-red, clayey to slightly silty, gravelly, fine to coarse sand. Gravel not abundant, chiefly pea-size, well-rounded quartz. A reticulated mottled zone is present at a depth of 1–2 m near contacts with units **zgb** and **zsl**. Less than 5 percent weatherable minerals in upper 1.5 m, locally throughout the residuum. Clay is predominantly kaolinite. Hematite nodules (plinthite) are absent. The residuum is developed on relatively undissected uplands underlain by Miocene to Pliocene alluvial deposits 6–10 m thick. It is overlain locally by eolian sand of younger Quaternary age. Thickness of residuum about 3 m

zgb CLAYEY, COARSE GRAVELLY SAND DECOMPOSITION RESIDUUM[2]—Gray, yellowish-red to red, clayey, sandy gravel. Color grades down into a red or gray zone, or into a thick, reticulated, mottled zone. Sand is medium to coarse and chiefly quartz. Gravel is well rounded and also quartz. Many clasts as much as 6 cm in diameter. Weatherable minerals absent in upper 3 m of residuum along interstream divides. Almost all feldspar is weathered to kaolin. Hematite nodules (plinthite) 1–2 cm in diameter are abundant. Above mottled zone, clay minerals are kaolinite and gibbsite; below, predominantly kaolinite. The residuum is developed on dissected uplands and slopes underlain by Miocene to Pliocene alluvial deposits 6–10 m thick. It is commonly about 6 m thick on uplands but may be only 1 m thick on valley slopes

zsc SAND AND CLAY DECOMPOSITION RESIDUUM[2]—White, light-yellow, yellowish-orange, or grayish-red, commonly mottled, silty, fine to medium quartz sand; moderately to poorly sorted; grains subangular to subrounded. Includes local zones of light-gray to greenish-gray clay and, in places, contains some well-rounded gravel ranging in size from very fine gravel to pebbles and cobbles. Clasts are of thoroughly weathered crystalline rocks and quartz. Mapped areas include some bedrock outcrops and locally derived colluvium and alluvium. Thickness 1–3 m

zse CLAYEY FINE-TO-MEDIUM SAND AND FINE SANDY CLAY DECOMPOSITION RESIDUUM[2]—Mottled very pale orange, yellowish-orange, reddish-orange, or brick red, clayey, fine to medium sand; locally contains some subrounded fine gravel, and very fine to fine sandy, silty clay. Sand and gravel are chiefly quartz. Mapped areas include some locally derived colluvium, alluvium, and bedrock outcrops; present only in southwest corner of map area, in Georgia. Thickness less than 1 m to about 3 m

zsf MEDIUM TO COARSE SAND AND SANDY CLAY DECOMPOSITION RESIDUUM[2]—Light-gray, yellowish-gray, very pale orange, or light-reddish-brown, micaceous medium to coarse sand; contains local zones of kaolinitic sandy clay or clay, leached and partly decomposed oyster-shell fragments, and subrounded fine quartz pebble-gravel. Mapped areas include some bedrock outcrops and small deposits of alluvium and locally derived colluvium. Present only in southwestern part of map area, in Georgia. Thickness 1–7 m

zsl MEDIUM TO COARSE SAND DECOMPOSITION RESIDUUM[2]—Yellowish-gray, yellowish-red, or orange-red medium to coarse sand; well sorted, slightly micaceous, slightly silty or clayey. Upper 0.5–4 m includes some eolian sand. At greater depth, residuum is more clayey, and on interstream divides it includes a reticulated, mottled zone. Sand is chiefly quartz; clay is kaolinite. Mapped areas include some bedrock outcrops and locally derived colluvium. Residuum grades down into weakly consolidated sandstone. Thickness as much as 10 m along interstream divides but as little as 1–2 m on valley slopes

zsn SANDY SHALEY DECOMPOSITION RESIDUUM[2]—Grayish-brown, yellowish-brown, or reddish-brown sandy loam to clay loam. Lower part contains shale chips or fragments of sandstone. Mapped areas include thin, locally derived stony loam colluvium, especially on steep slopes, and bedrock outcrops, especially along ridge crests. Deposit present only in northwestern part of map area, in Valley and Ridge Province in Tennessee. Thickness commonly less than 3 m but may be as much as 6 m at foot of slopes

zlc RED SILTY SAND TO SILTY CLAY DECOMPOSITION RESIDUUM[2]—Red, reddish-gray, reddish-brown, or purplish-red silty sandy loam to silty clay loam. Locally includes rounded pebbles and cobbles, chiefly quartz. Lower part contains chips or larger fragments of red shale and sandstone. Deposit also contains crumbly clasts of diorite along lineaments aligned over underlying diorite dikes. Thickness 0.5–3 m

zle SANDY CLAY AND CLAYEY SAND DECOMPOSITION RESIDUUM[2]—Yellowish-orange to dark-red or light-brown, loamy medium to coarse sand, fine sandy loam, or sandy clay mottled yellowish-brown where developed in quartzose sand, greenish brown where developed in glauconitic sand or clay. Clay is chiefly kaolinite, but where residuum is developed on Twiggs Clay, it is chiefly smectite and has high shrink-swell potential. Residuum is overlain locally by eolian drift sand. Thickness generally 1–3 m, rarely more than 5 m

zrb CHERTY CLAY, SANDY CLAY, AND SILTY CLAY DECOMPOSITION AND SOLUTION

RESIDUUM[2,3], UNDIFFERENTIATED—Map unit comprises three residua that cannot be separated at scale 1:1,000,000. One is yellowish-brown to dark-reddish-brown cherty clay solution residuum developed on limestone. The second is yellowish-brown sandy clay decomposition residuum that is porous and ferruginous or calcareous. It includes slabby sandstone fragments and is developed on sandstone. In Georgia, it locally contains limonitic boxwork and commercial-grade iron ore. The third is pale-yellowish-brown to grayish-brown clay or silty clay decomposition residuum containing shale chips and local hematitic zones. It is developed on shale. Mapped areas include bedrock outcrops and some locally derived colluvium, as much as 8 m thick, on steep slopes in Tennessee. Thickness generally less than 5 m in Tennessee but locally as much as 20 m in Georgia

rsf CLAYEY SAND SOLUTION RESIDUUM CONTAINING CHERT PEBBLES[3]—Yellowish-gray, grayish-pink, orange-red, or reddish-brown, clayey, medium to coarse quartz sand. Locally contains small subrounded to subangular chert pebbles. Deposit is cemented with limonite in places and is residual on sandy cherty limestone. Karst features, including small, clay-filled sinkholes, are common. Mapped areas include some bedrock outcrops and locally derived colluvium and alluvium. Unit present only in southwest part of map area, in Georgia. Thickness mostly 1.5–4 m; locally as much as 10 m in karst depressions

rcc CHERTY CLAY SOLUTION RESIDUUM[3]—Reddish-yellow to yellowish-brown, or pale-brown to light-reddish-brown, commonly mottled, clay or sandy to silty clay; plastic, locally cherty. Contained chert is gray, yellowish brown, or yellowish orange, locally light green or black, and occurs as angular to subround chunks or boulders. Deposit contains solution-surfaced slabs of limestone or dolomite in both the upper and lower parts, which suggest that deposit has been, in part, reworked by colluvial processes. Contact with underlying bedrock is abrupt and pinnacled. Mapped areas include some bedrock outcrops and deposits of locally derived colluvium. Where colluvium overlies the residuum on steep slopes, both deposits may be unstable. Thickness highly variable, less than 2 m to as much as 25 m

rcj RED-CLAY SOLUTION RESIDUUM[3]—Dark-red to reddish-brown clay, clay loam, or silty clay loam; includes some zones of sandy clay. Lower part of deposit commonly contains smooth limestone slabs or boulders and is in abrupt solution contact with underlying limestone bedrock into which it extends along fractures. Mapped areas include local bedrock exposures and large amounts of colluvium derived from reworked residuum. Deposit present only in Valley and Ridge Province in Tennessee. Thickness irregular but as much as 25 m

ssa SILTY TO CLAYEY SANDY SAPROLITE [4], ROCK TORS, AND JOINT-BLOCK BOULDERS—Dark red, reddish-brown, reddish-yellow, or white, slightly micaceous, sandy clay to silty or clayey medium sand. Developed in massive granite or granite gneiss. Quartz abundant. Clay is mostly kaolinite in upper part, but gibbsite may equal or exceed kaolinite in lower part; illite and vermiculite are minor components. Partly weathered feldspar is predominant weatherable mineral in lower part; muscovite or its pseudomorphs predominate in upper part. Saprolite is permeable and strongly acid. It grades into bedrock through a zone of partly decomposed joint-block boulders. Bedrock knobs or tors and abundant joint-block boulders are common in mountain or hill areas. Pavement outcrops, as large as 10 hectares, are common in Piedmont. Mapped areas of saprolite commonly include locally derived colluvium containing numerous boulders, especially at base of steep slopes. Fragments of vein quartz are locally abundant in such deposits. Thickness of saprolite commonly less than 2 m, but may be 5 m on well-drained uplands

ssb SILTY TO CLAYEY SANDY SAPROLITE[4]—Dark-red, reddish-brown, reddish-yellow, or white sandy clay to slightly clayey sand. Developed in gneissic granite, felsic schist interlayered with gneiss, foliated granitic rocks, and felsic metavolcanic rocks. In upper part, clay is predominantly kaolinite, but in lower part, gibbsite may equal or exceed kaolinite. Illite and vermiculite are minor components. Partly weathered feldspar is predominant weatherable mineral in lower part; muscovite or its pseudomorphs predominate in upper part. Unit is permeable and strongly acid. It grades into underlying bedrock through an irregular zone of partly weathered slabby fragments in matrix of micaceous silt to clayey sand. Mapped areas include bedrock exposures, commonly as micaceous rock ribs, and deposits of slabby to bouldery colluvium, especially at base of steep slopes. The colluvium commonly contains numerous vein-quartz fragments. Thickness of saprolite commonly less than 2 m, but may exceed 6 m on well-drained uplands

ssc MICACEOUS, CLAYEY, AND SANDY SAPROLITE, UNDIFFERENTIATED[4]—Grayish-red to moderate-reddish-brown micaceous clay, sandy clay, or clayey sand in areas too small to show at scale of map. Deposit grades down into underlying bedrock through zone of relict thick, slabby boulders. Deposit is developed on metagraywacke, feldspathic sandstone, conglomerate, fine-grained biotite gneiss, other gneisses, marble, mylonite, and felsic metavolcanic rocks. It is graphitic where underlain by carbonaceous metamorphic rocks. Mapped areas include bedrock outcrops and thin mantle of locally derived colluvium. Unit mapped only in Georgia. Thickness less than 1 m to as much as 15 m

ssd SANDY CLAY SAPROLITE[4]—Red, yellowish-red, strong-brown, yellow, light-gray, or greenish-gray, slightly clayey sand to sandy clay saprolite. Developed on metamorphic or igneous rocks of intermediate composition. Clays are mixed smectite and kaolinite and have moderate shrink-swell potential in saprolite developed on more mafic intermediate rocks. On more felsic intermediate rocks, clay is predominantly kaolinite. Sand fraction consists of quartz and partly altered feldspar. Saprolite grades downward into bedrock through a zone of partly weathered core-stones where bedrock is massive, or through a zone of slabby fragments where it is foliated. Soft rock fragments or ghosts of fragments may be abundant. Mapped areas include locally derived colluvium and rock outcrops. Thickness less than 5 m

sse QUARTZ-RICH SAPROLITE[4]—Gray, pale-yellow, pale-brown, or pale-yellowish-red, locally micaceous, slightly clayey to silty, very sandy saprolite. Clay is predominantly kaolinite. Angular or irregularly shaped, partly disintegrated chunks or slabs of rock common in lower part. Saprolite is developed in quartzite, quartz-rich metasedimentary rocks, or quartz-mica schist. Mapped areas include rock outcrops on steep slopes or crests, and areas of locally derived sandy, stony colluvium, especially at base of slopes. Thickness ranges from less than 0.5 m on steep slopes to about 3 m on gentle slopes

sla CLAYEY SAPROLITE[4]—Greenish-gray, pale-yellowish-orange, moderate-yellow, or dark-red, slightly micaceous to micaceous, clayey sand to sandy clay or clayey silt. Developed in mafic metamorphic, mafic metavolcanic, and ultramafic rocks. Clay component is mixed smectite and kaolinite with minor vermiculite. Shrink-swell potential ranges from low to high. Smectite is particularly common in poorly drained areas. Sand component is chiefly partly altered calcic feldspar. The saprolite is relatively impermeable. It grades down into underlying bedrock through zone of partly saprolitized slabs and blocks. Mapped areas include small deposits of locally derived colluvium and widely scattered bedrock exposures. The colluvium commonly contains abundant boulders or slabs of partly weathered bedrock and fragments of vein quartz. It may also include a very thin overlying layer of unconsolidated marine or alluvial sediment at inner edge of Coastal Plain. Thickness of saprolite less than 1 m to as much as 15 m

slb MICACEOUS SAPROLITE[4]—Red, reddish-brown, strong-brown, yellowish-red, or gray, micaceous to very micaceous, clayey to silty clayey sand or clayey sandy silt. Developed in felsic, micaceous schist. Color depends on drainage and abundance of mafic minerals in parent rock. Clay is chiefly kaolinite and illite with lesser amounts of vermiculite and minor gibbsite. Mica mostly weathered to vermiculite and (or) kaolinite near ground surface. Shrink-swell potential generally low. Mapped areas include bedrock exposures and small deposits of locally derived colluvium containing abundant rock fragments and quartz clasts. Thickness less than 1 m on steep slopes to as much as 30 m on well-drained uplands

slc SILTY TO CLAYEY SAPROLITE[4]—Gray, greenish-gray, yellowish-brown, or red fine sandy silt to slightly clayey silt. Developed in phyllite, argillite, and slate. Alteration concentrated along foliation and joints in parent rock Clasts of quartz and slabs and splinters of partly weathered parent rock are common, especially in lower part. Clay predominantly kaolinite but gibbsite present in places. Shrink-swell potential low. Mapped areas include bedrock exposures on slopes and crests, and deposits of locally derived colluvium containing rock fragments, especially at base of steep slopes. Thickness commonly less than 1 m on slate and argillite, but on permeable phyllite it ranges from less than 0.5 m on steep slopes to as much as 6 m on well-drained uplands

[1]COLLUVIUM, for purposes of this map, is a general term applied to material transported and deposited by mass-wasting processes. In this quadrangle the processes are chiefly debris avalanche, mudflow, landslide, creep, and probably solifluction.

[2]DECOMPOSITION RESIDUUM, for purposes of this map, is defined as material derived primarily by in-place chemical decay of clastic rock with no appreciable subsequent lateral transport.

[3]SOLUTION RESIDUUM, for purposes of this map, is defined as material derived by in-place solution

of carbonate rock or carbonate-cemented rock with no appreciable subsequent lateral transport.

[4]SAPROLITE is the product of extensive, long-term chemical weathering of crystalline rocks. The color of saprolite depends on the abundance of dark minerals in the parent rock and on the drainage. Bright reds and yellows are produced above the water table; grays, whitish grays, and greenish blues are produced below. Saprolite grades down through partly weathered rock into fresh parent rock.

The structure and texture of the bedrock are characteristically preserved in saprolite. However, in places, structureless saprolite may occur between structured saprolite below and colluvium or modern soil above. Replication of bedrock features in saprolite results from isovolumetric chemical alteration of weatherable minerals. In weathering, the aluminosilicate minerals alter to clay minerals, density decreases by as much as 50 percent, and porosity increases greatly. Saprolite texture ranges from sandy to clayey depending upon the abundance of minerals, such as quartz, in the parent rock that are resistant to weathering. Quartz veins *are* commonly preserved in place in saprolite.

The clay mineralogy of saprolite depends on the kinds of rock-forming aluminosilicate minerals in the parent rock and the drainage regimen. For example, the clay minerals in saprolite developed in mafic rocks, in which hornblende and plagioclase are the primary minerals, are chiefly smectite and kaolinite in poorly drained areas, kaolinite in well-drained areas, and kaolinite and gibbsite in very well drained areas. In contrast, the clay minerals in saprolite developed on felsic rocks are chiefly kaolinite and illite in both poorly and well-drained areas; gibbsite develops as a persistent minor component only where internal drainage is excellent.

Saprolite thickness is directly related to slope angle and to the lithology and permeability of the parent rock, including the abundance of fractures. For example, the thickness of saprolite developed on felsic gneiss or schist on gently sloping uplands commonly exceeds 6 m (and locally may exceed 30 m); on slopes of 6–12° the thickness commonly ranges from 2–6 m; on slopes exceeding 12° the thickness is generally less than 2 m. In contrast, saprolite developed in quartzite and serpentinite is commonly less than 2 m thick regardless of slope angle.

Saprolite has been subdivided by variety only in very limited areas. For purposes of this map, it is subdivided in accordance with the distribution of different kinds of bedrock from which differing varieties of saprolite are derived. Differences due to slope angle could not be effectively shown at the scale of this map. Information on rock permeability suitable for mapping varieties of saprolite is not regionally available.

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