QUATERNARY GEOLOGIC MAP OF FLORIDA KEYS 4° x 6° QUADRANGLE, UNITED STATES

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

State compilations by
Thomas M. Scott, Michael S. Knapp, and David L. Weide

Edited and integrated by
Gerald M. Richmond, David S. Fullerton, and David L. Weide

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NOTE 1: This map is the product of interorganizational collaboration. Following a regional meeting of state compilers with the coordinator, during which map units and related matters were established, a Quaternary map and map explanation of this quadrangle were prepared by T. M. Scott and M. S. Knapp of the Florida Bureau of Geology. Supplemental information was added by D. L. Weide, and G. M. Richmond, editors. Significant geologic problems requiring changes in the map were resolved in discussions and by correspondence. Reviewers, to whom the editors are indebted were W. A. White, University of North Carolina, and J. B. Cathcart, U.S. Geological Survey.

NOTE 2: The Pliocene-Pleistocene boundary defined by joint resolution of the International Union for Quaternary Research (INQUA) Subcommission 1–d on the Pliocene/Pleistocene Boundary (the International Commission on Stratigraphy (ICS) Working Group on the Pliocene/Pleistocene Boundary) and the Working Group on 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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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 Florida Keys 4°x 6° quadrangle and other published maps of the Miscellaneous Investigations Series (I–1420).
- An illustration showing the responsibility for state compilations.
- An illustration showing the correlation of map units.
- An illustration showing tentative correlation of Quaternary and upper Pliocene lithostratigraphic and morphostratigraphic units of the Florida Keys and Jacksonville quadrangles with stratigraphic units in South Carolina.

LIST OF MAP SYMBOLS

CONTACT

BEACH RIDGES—Mapped along Atlantic coast and discontinuously along central carbonate ridge

DESCRIPTION OF MAP UNITS

HOLOCENE

acd ALLUVIAL CLAY AND SILT—Light- to dark-gray, yellow to brown, poorly to well-stratified, clayey silt and silty clay alluvium. Deposit contains varying amounts of interbedded or admixed fine sand, especially in channels along upper parts of regional drainages. Locally it also includes clay balls, lenses of kaolinitic clay, and scattered phosphatic pellets and quartz sand. Mapped areas include organic muck and swamp deposits (**hs**) on flood plains and, locally, colluvium along margins of valley floors. Thickness generally 5–10 m

hs SWAMP DEPOSIT—Dark-brown to black muck, mucky peat, and organic residue mixed with fine to very fine quartz sand, silt, and kaolinitic clay. Commonly thinly laminated; locally includes lenses of mottled clay. Large deposits extensively bioturbated. In topographic depressions, intermittently covered by 0.5 to 1 m of standing water. Where these areas have been drained for agriculture, oxidation of the swamp deposits has resulted in subsidence as much as 3 m. Small, discontinuous areas of slightly higher ground are covered with light to dark-brown, unconsolidated, medium to fine quartz sand. Thickness 3–10 m

hpc FRESHWATER MARSH PEAT AND CLAY—Gray to black herbaceous peat and clay, intermixed and interbedded. Color darkens as content of organic matter increases. Includes interbedded freshwater and brackish-water deposits. Mapped in part from distribution of freshwater vegetation. Thickness 1–3 m hp PEAT—Dark-gray to black undecomposed to partially decomposed organic matter compacted into thick mats interbedded with thin layers of fine sand and silt. Mapped areas confined to deposits in which volume of organic matter exceeds that of mineral matter. Thickness 2–5 m

hpd DRAINED AND COMPACTED PEAT—Light- to dark-gray fibrous peat mixed with other organic material and interlayered with lenses of silt and fine to medium sand. Where areas are drained for agriculture and urban development, burning, oxidation, and compaction of the deposits has resulted in subsidence of as much as 4 m. Thickness 2–3 m

hcm ALGAL MUD AND CARBONATE—Blue, green, or gray, freshwater, algal matte overlying algal calcitic mud interbedded with thin layers of crystalline low-magnesian calcite. Deposit forms a rhythmite resulting from annual growth and death of calcite-secreting blue-green algae (Gleason, 1972, p. 34–38). Thickness approximately 1 m

hmm COASTAL MANGROVE SWAMP DEPOSIT—Dark-gray to black organic muck intermittently covered by as much as 1 m of sea water. Overlies wave-beveled surfaces cut on soft, porous, shelly limestone of late Pleistocene Anastasia Formation and Tertiary limestone. Mapped only in areas that support dense stands of both red and black mangrove along the Gulf of Mexico. Thickness 0.5–1 m

he SWAMP DEPOSIT AND DUNE SAND—Swamp deposit is dark-gray to orange mottled, silty, smectitic clay with abundant organic debris. Present in parallel, linear, interdune depressions along Atlantic coast. Dune sand is white, unconsolidated, and fine to medium grained. It is composed of quartz mixed with moderate amounts of shell debris. Deposit forms linear beach and dune ridges parallel to shore. Dunes are chiefly stabilized by vegetation though some are locally active. Map unit overlies the Anastasia Formation in northeast part of the quadrangle. Deposit is compacted throughout most of eastern Florida, as a result of drainage for agriculture. Thickness 5–15 m

els DUNE SILT AND CLAY—Light-gray to light-yellow, fine to medium crossbedded sand and sand-size aggregates of silt and clay particles forming a complex of large dunes. Mapped only along northeast, east, and southeast shores of Lake Okeechobee where dunes have accumulated because of intense storm activity. Thickness 5–10 m

be BEACH AND DUNE SAND—Light-tan, angular, medium to fine sand, well-sorted, crossbedded, mostly quartz with traces of heavy minerals. Upper layers locally contain crushed shell that increases gradually in proportion from north to south. Occurs along coast at and above modern beach. Also present as thin deposits, too small to map, on coastal freshwater marsh deposits (**hpc**). Thickness 2–7 m

bc BEACH SHELL-FRAGMENT AND SHELL SAND—White to light-gray shell fragment and shell sand including minor amounts of fine quartz sand, silt, and clay. Locally the deposit may be weakly cemented by calcium carbonate. Where exposed along the Florida Keys, the unit commonly consists of foraminiferal tests. Thickness 1–5 m

bd BEACH MUD—Gray to black silt and clay; contains shell fragments and very fine grained organic matter; color darkens as amount of organic matter increases. Underlies beaches bordering saline marsh, estuaries, and lakes from which it has been transported. Thickness 0.5–1.5 m

HOLOCENE TO MIDDLE WISCONSIN

lfm LAKE FLIRT MARL—Light- to dark-gray freshwater, calcareous fine silt and clay interbedded with soft, white, freshwater marl and thin layers of organic material, peat, or muck. Locally may be covered with swamp deposits or very thin discontinuous patches of quartz and calcareous sand. Thickness as much as 3 m

LATE PLEISTOCENE

ANASTASIA FORMATION—Present mostly in subsurface and shown by pattern on map. Light-gray to yellow, complexly interbedded, sandy marine limestone, calcareous sandstone and sand; cemented to friable coquina. Locally contains thin, discontinuous lenses of black silty muck and decayed organic matter. The Anastasia Formation is about 110,000 years old as determined by a Th^{230}/U^{234} dating method (Osmond and others, 1970). Exposures of the formation, too small to show at scale of map, occur discontinuously along the Atlantic coastal ridge of eastern

Florida, but most of unit is covered by thin swamp deposits (**hs**) and dune sand (**he**). Thickness as much as 30 m

mol MIAMI OOLITE—White to light-yellow, crystalline, oolitic limestone interbedded with thin layers of soft, unconsolidated oolitic sand. Locally this unit is perforated with numerous solution holes and channels now filled with fine to medium quartz sand. Oolitic limestone portions of the formation are commonly brecciated and re-cemented as a result of solution. Th^{230}/U^{234} ages on the Miami Oolite range from about 90,000 to about 145,000 years old (Broecker and Thurber, 1965; Osmond and others, 1965). The oolite is exposed at the surface throughout much of southeast Florida; in places it is covered by thin, discontinuous patches of eolian oolite and quartz sand (indicated by pattern). Thickness as much as 20 m

LATE PLEISTOCENE TO MIDDLE PLEISTOCENE

bmk BEACH AND MARINE SAND, WEATHERED AND OXIDIZED—Light-yellow to dark-orange quartz sand mixed with and stained by organic matter. Underlain at depths of as much as to 0.5 m by fine quartz sand compacted and mixed with insoluble clay; locally, weakly to strongly cemented with calcium carbonate. Basal part of unit consists of as much as 7 m of consolidated sand containing abundant whole but rotted bivalve shells. Deposit overlies sand, clayey sand, or shelly sand of older Pleistocene beach ridges. Much shell material has been leached from upper part of the deposits, resulting in reduction of thickness by as much as 1.5 m. Locally, the dissolved shell material has been redeposited with insoluble clay to form a subsurface hardpan. Thickness 6–9 m

mba BEACH SAND AND LAGOONAL DEPOSITS, UNDIFFERENTIATED—Light-gray, yellowish-gray and brownish-gray, poorly to well-sorted sand, silt, and clay, intermixed and interbedded. Locally includes thin stringers of well-rounded quartz pebbles and shell hash in remnants of old tidal channels. In places, also contains the insoluble residues of beach sand and sandy lagoonal deposits associated with older Pleistocene shorelines. Mapped areas include numerous small swamp deposits (**hs**), organic muck, shell debris, and thin patches of eolian sand. Thickness 10–25 m

kls KEY LARGO LIMESTONE—Light-gray to light-yellow, coralline limestone. Highly fossiliferous with molds and casts of boring marine organisms. Locally composed of coral heads and algal mounds surrounded by amorphous limestone, coral detritus, and limestone breccia. Contains thin lenses of dense, hard, freshwater limestone in places. Upper surface brecciated and recemented. Th^{230}/U^{234} ages on coral and on oolite are mostly between about 95,000 and 145,000 years (Broecker and Thurber, 1965; Osmond and others, 1965). Maximum thickness about 20 m

FORT THOMPSON FORMATION—-Present only in subsurface and shown by pattern on map. White to very light yellow, sandy limestone and calcareous sandstone, interbedded with layers and pockets of fine-grained, well-sorted quartz sand, and thin beds of dense, hard, freshwater limestone. Exposed in numerous small outcrops but is mostly covered by thin swamp deposits (**hs**) and deposits of weathered and oxidized beach sand (**bmk**). Maximum thickness about 25 m

MIDDLE PLEISTOCENE TO EARLY PLEISTOCENE

bml BEACH SAND AND SANDY CLAY—White, yellow, reddish-yellow to reddish-orange, well-sorted phosphatic sand and clayey sand. Locally contains lenses of red to orange-red, well-sorted, coarse sand stained and cemented with iron. Deposit reworked from the Pliocene Bone Valley Formation; in places overlies Tertiary limestone and fills many of the karst depressions along ridges underlain by the limestone. Locally overlain by small deposits of white, very well sorted quartz sand and thin deposits of black to blue-gray organic muck Thickness 1–10 m

EARLY PLEISTOCENE AND PLIOCENE

CALOOSAHATCHEE MARL—Present in subsurface only and shown by pattern on map. Grayish-green or greenish-gray, silty, sandy marl with interbedded lenses of sand, silt, and clay. Locally may contain lenses of carbonaceous material that suggest former mangrove swamps. West of

Lake Okeechobee, consists of a series of reefs composed of sandy shelly limestone and calcareous sandstone. Five radiometric dates on corals from the type locality range from 1.78 Ma (million years) to 1.89 Ma and average 1.84 Ma; a single date from the St. Petersburg area is 2.53 Ma (Bender, 1973). All are older than the estimated age of the Pliocene-Pleistocene boundary (1.65 Ma). A Pleistocene age is indicated by the presence of *Equus* (cf. E.) *Leidyi* (DuBar, 1958a). Map unit is overlain by very thin, discontinuous patches of shelly sand. Maximum thickness 15 m

msa MARINE AND ALLUVIAL SAND (Facies of Citronelle Formation)—Upper part is white to light-yellow, fine to coarse, loose quartz sand, but most of unit is red, orange, yellow, or brown, crossbedded, pebbly, coarse to fine, kaolinitic quartz sand, casehardened by iron oxide. Deposit includes red- and yellow-banded lenses of generally poorly sorted, slightly kaolinitic, pebbly, coarse to fine sand, and thin beds of white, highly kaolinitic, well sorted, fine quartz sand containing numerous shrimp burrows. Locally includes pockets of white, kaolinitic clay, and thin stringers of discoid quartz and quartzite pebbles. Locally deposited on and collapsed into karst terrain developed on limestone. Coextensive with and forms an important part of Lake Wales Ridge (Pirkle and Yoho, 1970), a major topographic feature that forms the divide of the central Florida peninsula for 250 to 300 km. Considered in part to be of marine littoral and delta origin and in part of alluvial origin. Has been correlated with the Citronelle Formation (Grogan and others, 1964; Pirkle and Yoho, 1970; White, 1970) which, in its type locality at Citronelle in Alabama, contains a vertebrate fauna assigned a Pliocene Hemphillian age by F. C. Whitmore (Isphording and Lamb, 1971) and fossil leaves of Pleistocene age (Berry, 1916; Stringfield and Lamoureaux, 1957; Doering, 1958). Thickness 12–15 m

LAND PEBBLE PHOSPHATE DEPOSIT—Present only in subsurface and shown by pattern on map. Phosphatic pellets and nodules, quartz sand, and smectitic clay; chiefly massive and structureless but locally crossbedded or with horizontal laminations in places. Locally includes pockets of clay that fill sinkholes in underlying limestone. Phosphate deposit is believed by Cathcart and others (1952) to be a residuum derived from underlying Pliocene Bone Valley Formation; by Sellards (1915) to have been deposited in a shallow marine environment following erosion of the Miocene Hawthorn Formation. Overlain by wave-reworked beach sand and sandy clay (**bml**) as thick as 10 m. Thickness as much as 18 m

QUATERNARY AND TERTIARY

zsc SAND AND CLAY DECOMPOSITION RESIDUUM[2]—White, light-yellow, grayish-orange or grayish-red, commonly mottled, poorly sorted, fine quartz sand and small lenses of clay, interbedded with light-gray, yellowish-gray, very pale orange, or light-reddish-brown, micaceous, medium to coarse sand; locally includes lenses of kaolinitic sandy clay that contain leached and partly decomposed oyster shell fragments. Mapped areas include some bedrock outcrops and alluvial terrace deposits too small to map separately, the latter are formed chiefly on the south side of the mouths of major rivers flowing into the Gulf of Mexico. Thickness 1–2.5 m

rsi CALCAREOUS SAND SOLUTION RESIDUUM[1]—Yellowish-gray to grayish-white quartz sand and calcareous sand residuum on soft sandy limestone and shell-hash limestone. Locally, where deposit mantles an underlying karst topography, it includes the clay-filling of sink holes. Mapped areas include some locally derived colluvium, and scattered bedrock outcrops. Thickness 1–3 m

[1]Decomposition residuum, for purpose of this map, is defined as material derived primarily by in-place chemical decay of clastic rock with no appreciable subsequent lateral transport.

[2]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.

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