Bloom

POST MIOCENE STRATIGRAPHY AND MORPHOLOGY

SOUTHEASTERN VIRGINIA

Itinerary for the

FRIENDS OF THE PLEISTOCENE

29th Annual Reunion

May 21 and 22, 1966

Chesapeake, Virginia

by

Nicholas K. Coch
Marine Science Center, L.I.U.
Southampton College
Southampton, New York 11968

and

Robert Q. Oaks, Jr.
Department of Geology
Utah State University
Logan, Utah, 84321

(This itinerary provides a brief description of our stops; it is not intended to be a detailed guidebook or road log)

FRIENDS OF PLEISTOCENE GEOLOGY
1966 Reunion - Chesapeake, Va.

Participants

George F. Adams
C.C.N.Y.

Kenneth F. Bick
William & Mary

Art Bloom
Cornell Univ.

John Burger
Beloit College

Doug Byers
Peabody Fdn.

E. F. Caldwell
Carpenter Constr. Co.

Nick Coch
Southampton College
of L.I.U.

Don Colquhoun
Univ. So. Carolina

G. Gordon Connally
New Paltz U.

Jim Conley
Va. Div. Min. Res.

G. H. Crowl
Ohio Wesleyan

Charley Denny
U.S.G.S. - Wash. D.C.

John Fisher
Univ. R. I.

Jane Forsyth
Bowling Green S. U.

Dave Fullerton
Princeton U.

Erling Gamble
U.S.D.A. - Raleigh

Dick Goldthwait
Ohio State U.

John Hack
U.S.G.S. - Wash.

John Hails
Univ. of London

Vernon Henry
U. Ga. - Sapelo I.

John Hoyt
U. Ga. - Sapelo I.

John Howard
U. Ga. - Sapelo I.

Pete Johnson
Carleton U. - Ottawa

Henry Johnson
So. Car. Div. Geology

Jerre Johnson
William & Mary

Allan Jopling
Harvard Univ.

Dave Krinsley
Queens College

Walt Lyford
Harvard Forest

F. P. Lyford
Univ. Mass.

Clarence Miller
Univ. R. I.

Jim Minard
U.S.G.S. - Wash. D.C.

John Moss
Franklin & Marshall

Bob Oaks
Utah State U.

Walt Newman
Queens College

J. G. Ogden III
Ohio Wesleyan U.

Dick Pratt
Woods Hole O. I.

Louis Quam
Office Naval Research

Ed Rhodehammel
U.S.G.S. - Trenton

Charles Rich
Bowling Green S. U.

D. F. Ritter
Franklin & Marshall

Horace Richards
Phila. Acad. Sci.

John Sanders
Hudson Marine Labs.

Les Sirkin
Adelphi Univ.

Al Sinnott
U.S.G.S. - Trenton

H.T.U. Smith
U. Mass.

Mrs. Smith
U. Mass.

G. H. Springer
Univ. Dayton

Bob Stuckenrath
U. Pa. Museum

Don Swift
Dalhousie U.-Halifax

Bob Teifke
Va. Div. Min. Res.

Bruce Thom
Coastal Studies Inst.
L. S. U.

John Williams
U.S.G.S. - Boston

FRIENDS OF PLEISTOCENE GEOLOGY
1966 Reunion - Chesapeake, Va.

A. 15-minute quadrangles covering the area we will see in the field:

Surry, Yorktown, Smithfield, Suffolk, Newport News, Lake Drummond, Cape Henry, Moyock, Back Bay.

B. Location of Stops:

<u>Saturday May 21, 1966 -- Inner Coastal Plain</u>

STOP 1 -- Exposure on SR 609 at Sunken Meadow Beach, N side of road, Surry County. Alt 71 ft.

STOP 2 -- Exposure in borrow pit, 200 ft NE of SR 609, 0.4 mi SW of SR 626, Surry County. Alt 87 ft.

STOP 3 -- Exposure at NW corner of intersection of SR 609 and SR 610, Surry County. Alt 112 ft.

STOP 4 (#6) - Town of Surry (Lunch)

STOP 5 (#4) - Crest of Surry Scarp, 0.1 mi S of intersection of SR 626 and SR 634, Surry County. Alt 127 ft.

STOP 6 (#5) - Exposure on SR 617, S side of road, 1.35 mi NE of intersection of SR 616 and SR 626, Surry County. Alt 91 ft.

STOP 7 -- Exposure on SR 666, 0.6 mi E of SH 10, west side of bridge over creek, Isle of Wight County, Alt 25 ft.

STOP 8 -- SR 704, 0.1 mi W of SH 10, Isle of Wight County. Alt 31 ft.

STOP 9 -- Exposure in borrow pit, 0.2 mi N of Benns Church on SH 10, Isle of Wight County. Alt 53 ft.

STOP 10 -- Lone Star Cement Company pit on E side of SH 10 just N of Chuckatuck, Nansemond County. Alt 30 ft.

STOP 11 -- Exposure in borrow pit , 0.3 mi N of USH 13, between new interstate highway and large overpass on USH 13, 1 mi. E of Bowers Hill, Chesapeake. Alt approx. 15 ft.

Sunday May 22, 1966 -- Outer Coastal Plain

STOP 1 -- Exposure in drainage ditch, N side of SR 751 just E of USH 17, Chesapeake, Alt approx. 17 ft.

STOP 2 -- Exposure at intersection of SR 625 and SR 626-634, Chesapeake, Alt approx. 15 ft.

STOP 3 -- Exposure in borrow pit SW of SR 603, 0.2 mi SE of SH 190, Virginia Beach. Alt 14-16 ft.

STOP 4 -- Exposure in drainage ditch along E side of SR 633, about 0.8 mi NE of SR 634, Virginia Beach. Alt. 12-13 ft.

STOP 5 -- Exposure in drainage ditch on W side of SR 615, 0.3 mi N of SR 628, Virginia Beach. Alt 16-17 ft.

STOP 6 -- Exposure in borrow pit on E side of SR 615, 0.7 mi N of SR 636. Alt 15-30 ft.

Saturday May 21 Field Leader: Nick Coch

6:30 - 7:30 AM -- Breakfast in rear dining room, Sunset Manor Motel. For rapid service,please fill in partly-occupied tables before starting new ones.

7:45 -- Buses depart from motel.

EN ROUTE TO STOP #1 (1 hr. 45 min.)

From the motel we move westward across the Churchland Flat and Dismal Swamp to Suffolk. The City of Suffolk is the world's largest peanut market and most major producers have plants here. As we enter the City (near the sewerage plant) we pass over the Suffolk Scarp; the scarp is poorly defined here. We continue northwestward across the Isle of Wight Plain. Near Wakefield, we cross the Surry Scarp (imperceptible here) and continue across the Sussex Plain to Waverly, where we turn northeastward and traverse the Sussex Plain to Claremont.

At Claremont we turn south, parallel to the James River, to Sunken Meadow Beach. Wakefield, a colonial plantation, can be seen on our left just before we get to the beach.

STOP #1 -- YORKTOWN, SEDLEY & BACONS CASTLE FMS. (40 min.)

Leave the buses at the base of the hill and walk up the section. At this and all subsequent stops PLEASE STAY OFF THE ROAD AT ALL TIMES.

From the top down, the section is as follows:

Bacons Castle Fm.

Sand and pebble gravel, dark red, channels with cut-and-fill stratification cut into underlying Sedley Fm. Only the lower, coarser-grained (Kilby) facies of the formation is exposed here. We will see the upper, finer-grained facies (Cross Creek) higher in the section at Stop #2. The Bacons Castle Fm. coarsens westward; "a" fabric and cross bedding analysis indicates deposition from the west and northwest.

Sedley Fm.

Silt and fine sand, glauconitic, red, deeply weathered, irregular and sharp contacts above and below.*

Yorktown (St. Mary's?) Fm.

Buff sands with highly fossiliferous beds. Marine mammal bones and shark's teeth are commonly found here. Good fossil collecting.

* The sedimentary structures, textures and areal distribution of the Sedley Fm. support an estuarine-marine origin as suggested by Moore (1956).

EN ROUTE TO STOP #2 (10 min.)

Leaving Sunken Meadow,we proceed south across the Sussex Plain. The flat undissected areas (locally called "pocossins") are underlain by the back-barrier facies of the Elberon Fm.; the rolling topography is erosional, and developed on the Bacons Castle Fm.

STOP #2 -- STRATIGRAPHIC RELATIONS WITHIN THE BACONS CASTLE FM. (30 min.)

The stratigraphic relations between the two lithofacies of the Bacons Castle Fm. are well exhibited in this borrow pit. The coarser-grained Kilby facies crops out in the lower portions of the pit and grades upward into the finely laminated silt and sand of the Cross Creek facies.

Note the deep oxidation of this unit for comparison with other (younger) stratigraphic units we will see later on in the day.

The sedimentary structures, textures, and areal distribution of both facies of the Bacons Castle Fm. suggest a fluvial origin, possibly by aggrading streams. The Cross Creek facies may represent the floodplain (suspension) phase and the Kilby facies the channel (traction) phase of stream transport.

EN ROUTE TO STOP #3 (5 min.)

We proceed across the Sussex Plain to the corner of State Roads 609 and 610. The Sussex Plain rises from 125 feet at the Surry Scarp (8 miles east) to 130 feet at its termination 6 miles west of Stop #3. The Plain in underlain by the silty-clay facies of the Elberon Fm.

STOP #3 -- SILTY-CLAY (LAGOON) FACIES OF THE ELBERON FM. (10 min.)

At this stop we have about 8 feet of the silty-clay facies of the Elberon Fm. exposed . The facies here is represented by a homogeneous yellowish-orange silty clay. In other areas, the facies is laminated silty clay and fine sand which grades into linear bodies of clayey sand. The facies grades eastward into well-sorted dune-and-beach sand at the Surry Scarp. The facies decreases in thickness westward, thinning to a feather edge a few miles west of Claremont.

The sedimentary structures and stratigraphic relations of the silty-clay facies suggest it is a backbarrier deposit. Note the compaction and state of oxidation here for comparison with younger sediments of similar origin which we will see later in the day.

EN ROUTE TO STOP #4 (25 min.)

We travel eastward to Surry across slightly dissected remnants of the Sussex Plain. As we approach the Surry Scarp,note the coarsening of the soil and the morphology characteristic of backbarrier environments.

STOP #4 -- FINE-SAND FACIES OF THE ELBERON FM. (30 min.)

At this location,the crest of the Surry Scarp reaches 128 feet; this is the highest altitude on the crest in Virginia. The fine-sand facies is composed of about 25 ft. of well-sorted fine to medium sand with high dipping laminae of opaque minerals. The facies is oxidized and enriched in clay to a depth of 13 feet; this is about 3 times the depth of weathering in equivalent facies (facies #1) of the Norfolk Fm. at the Suffolk Scarp. According to D. Krinsley, electron microscope examination of quartz grains from this facies shows surface features characterisitc of glacial action with superposed littoral action.

The texture, sedimentary structures, morphology, and stratigraphic relations of this facies strongly suggest a beach-and-dune origin. The presence of "glacial" surface markings on Elberon quartz grains suggest the Elberon may be of Pleistocene age. The lowermost altitude of dune sand in the scarp, and the highest occurrence of lagoon facies (silty-clay) to the west suggest that maximum relative sealevel was about +125 - 130 feet during Elberon time.

If the Elberon Formation is of Pleistocene age,then it represents the highest Pleistocene deposit on the Virginia Coastal Plain.

EN ROUTE TO STOP #5 (10 min.)

Look back at the Surry Scarp as we pull away from Stop #4. The Scarp slopes about 0.5^{o} east. Post-Elberon mass-wasting has probably reduced this slope from a higher figure (1^{o}-2^{o}?)

As we move eastward from Stop #4 on SR 626, the Surry Scarp merges imperceptibly with the Isle of Wight Plain; the plain is underlain by the silty-sand facies of the Elberon Fm.

STOP #5 -- SILTY-SAND FACIES, ELBERON FM. (10 min.)

This stop (Beachland) is about four miles east of the Surry Scarp. The fine sand we saw at our last stop has graded by facies change into a silty sand. The facies here is a gray, clayey, pebbly medium sand with some cobbles. The facies coarsens downward into a basal gravelly sand resting on a remnant of the Bacons Castle Fm.

A marine origin is inferred for the Elberon Formation from its facies associations and morphology. While it is reasonable to expect fossils in a marine unit, their absence does not necessarily imply a non-marine origin. Perhaps the sea bottom was unsuitable for organisms. Or, if the fossils were originally present, they could have been removed by post-depositional leaching.

The great difference in weathering between the Elberon and younger stratigraphic units and the deep, subaerial topography (-92 ft. min.) at the base of the Great Bridge Fm. suggest a long period of time elapsed after the deposition of the Elberon and prior to the deposition of the Great Bridge Fm.

EN ROUTE TO STOP #6 (LUNCH) - (20 min.)

We return to Surry and head northward along Scotland Neck towards the James River. The town of Surry is built on a slightly dissected (+122 ft.) remnant of the silty-clay facies of the Elberon Fm. The rolling topography along Scotland Neck is developed on the Bacons Castle and Sedley Formations.

Our lunch stop (40 min.) will be at Scotland Beach. From here we can see Jamestown across the James River. The exposures provide excellent fossil collecting (Miocene Yorktown Fm.); the lucky ones may find the shark's teeth for which these exposures are famous.

EN ROUTE TO STOP #7 (35 min.)

We proceed southeastward on State Highway 10 across the Isle of Wight Plain, to Smithfield. The town of Smithfield was once a bustling river port, exporting lumber, produce and the famous Smithfield Ham, which we will sample at dinner tonight. The major industries in the area at present are the large pork-processing plants such as the two (Gwaltney and Luter) which we pass between just before arriving at Stop #7.

STOP #7 -- NORFOLK FORMATION - FACIES #2 (15 min.)

At this stop, along a tributary of the Pagan River, a thick section of well-bedded gray and white silts, clays and sands are exposed. The sequence rests unconformably on the Sedley Fm. (dark brown sediment at bottom of drainage ditch). Between the Sedley and Norfolk Fms. is a cobble lag, probably derived from erosion of the Bacons Castle Fm. Where fossiliferous, the facies contains brackish-water forms such as *Mulinia lateralis*.

All of the creeks and rivers west of the Suffolk Scarp contain fills similar to this one. Where preserved, the tops of these fills form accordant surfaces at +45-50 feet. These fills have been traced eastward into Facies #1 of the Norfolk Fm. (beach sand) at the Suffolk Scarp.

The areal distribution and sedimentary structures in this facies suggest a fluvial-estuarine origin. The relation between this facies and Facies #1 of the Norfolk Fm., suggest the former was deposited in creeks and rivers west of the Suffolk Scarp, as the Norfolk Sea rose to a maximum (relative) sealevel of +45-50 feet during Norfolk time.

EN ROUTE TO STOP #8 (10 min.)

We pass through Smithfield and ride along the crest of the Suffolk Scarp to Pagan Pines. The town of Smithfield has many fine colonial homes which will be visible from State Highway 10 as we pass through town.

STOP #8 -- UNCONFORMITY BETWEEN NORFOLK AND SAND BRIDGE FMS. (20 min.)

We are standing on the Churchland Flat, a few hundred feet east of the Suffolk Scarp. The Scarp here has a slope of 2° and is a mainland beach developed on Facies #1 of the Norfolk Fm. Note the sharp change in soil type at the base of the Scarp; the change is clearly visible on either side of the farm road running parallel to the base of the Scarp. The Scarp is composed of well-sorted beach sand (Norfolk Fm.) whereas the Churchland Flat is underlain by silty clay (Sand Bridge Fm.)

Sedimentary structures and facies associations (see Geologic Map) suggest the sediments underlying the Churchland Flat (Sand Bridge Fm.) were deposited in different environments in a backbarrier complex behind a barrier beach at Pungo (Pungo Ridge), 30 miles east of here.

The Suffolk Scarp is believed to be a compound shoreline; it was a coastal shoreline in Norfolk time and an intracoastal shoreline in Sand Bridge time.

The idea that scarps and adjacent plains to the east may be of different ages has not been sufficiently recognized by other workers. In addition, plains ("terraces") seaward of scarps:

1. are not necessarily underlain by nearshore marine sediments.

2. may be underlain by two (or more) post-Miocene stratigraphic units of different ages and origins.

At Pungo Ridge, 30 miles east of here, the silty-clay facies reaches a maximum altitude of +17 ft.; here it reaches an altitude of +32 feet. The significance of this altitude discrepancy will be discussed further when we visit Pungo Ridge tomorrow morning.

EN ROUTE TO STOP #9 (10 min.)

As we travel south on State Highway 10 along the crest of the Suffolk Scarp, note the difference in morphology and soil type between the Isle of Wight Plain (on our right) and the Churchland Flat (on our left).

STOP #9 -- NORFOLK FORMATION, FACIES #1 (30 min.)

The beach facies of the Norfolk Formation is well exposed here in the Benns Church Sand Co. pit. The stratigraphic sequence is as follows:

Facies #1C - fine-medium sand,	45 ft.$^{+}$, (dune)
Facies #1B - medium-coarse sand,	30-45 ft.(beach)
Facies #1A - coarse gravelly sand	25-30 ft.(plunge point)

Only Facies 1C and 1B are exposed; remnants of Facies 1A can be seen in the spoil heaps around the pit. Note the purplish-brown humite layers in the pit walls; perhaps they represent paleosols.

Fossils in the Norfolk Fm., just east of here (Facies #4) include:

Nassarius trivittatus (Say), Epitonium humphreysii (Kiener), Retusa canaliculata (Say), Epitonium rupicolum (Kurtz), Mulinia lateralis (Say), Nuculana acuta (Conrad), Anadara transversa (Say), Noetia ponderosa (Say), Arca sp.

(Identified by H. G. Richards)

STOP #9 (continued)

Maximum relative sealevel during Norfolk time is inferred to have reached +45-50 feet from the highest altitudes of:

1. beach sand (determined by textural, stratigraphic and electron microscope studies)

2. backbarrier deposits where the Suffolk Scarp is a barrier (near the North Carolina State Line)

EN ROUTE TO STOP #10 (20 min.)

We travel southward to Chuckatuck on State Highway 10 along the crest of the Suffolk Scarp. Near the Nansemond-Isle of Wight County Line the Suffolk Scarp changes from a mainland beach (Facies #1 of the Norfolk Fm.) with a slope of 1^{o}-2^{o} to a wave-cut cliff with a slope of 2^{o}-4^{o}, and no associated beach sediments. The beach slope here truncates older sediments (Elberon and Bacons Castle Formations); a good exposure of the Elberon Fm. will be visible (on our right) as we pass the driveway to Mr. Arrat Farm. (Frontspiece of Technical Report #6)

When we reach Stop #10, please do not go over the edge of the pit wall or interfere with dragging operations.

STOP #10 -- YORKTOWN COQUINITE FACIES (40 min.)

Standing on the Churchland Flat (Sand Bridge Fm.) we look westward towards the Suffolk Scarp, which is a destructional shoreline at this point. Note the steepness of the slope here compared to that at Pagan Pines (Stop #8). The rolling surface at the top of the Scarp is probably developed on dunes of Norfolk age.

The Lone Star Cement Co. is mining a 30-60' layer of coquinite overlain in turn by a residium of the Sedley Fm. (dark red) and the silty-clay facies of the upper member of the Sandbridge Fm. (brown, pebbly). The coquinite is composed of more than 99% water-worn shells and shell fragments ($CaCO_3$); all of the forms present here are of Yorktown age (Late Miocene). Steep foreset beds (up to 35^{o}) in the coquinite suggest deposition from the W-NW. The coquinite crops out in a linear belt, just east of and parallel to the Suffolk Scarp, from North Carolina northward at least to the James River. Linear bodies of well-sorted sand occur within the coquinite.

Rogers (1835) suggested that the Yorktown (Late Miocene) sea had a still-stand in this area after its retreat from the Fall Line. If this is true, then the coquinite facies may represent a series of deltaic deposits of streams draining the newly-emerged Yorktown surface west of here in post-Yorktown, pre-Sedley time. The sand bodies may represent accumulations of finer material, washed and reworked by waves, into bars paralleling the shore.

Structure contour maps on the top of the Yorktown Fm., and all overlying units, show "lows" in the vicinities of present streams. This suggests that the locations of existing stream valleys are controlled by topographic lows in the top of the Yorktown Fm., and that drainage was concentrated in these topographic lows through all of the periods of emergence we will be discussing.

EN ROUTE TO STOP #11 (35 min.)

We turn off the Suffolk Scarp in Chuckatuck and move eastward across the Churchland Flat (Sand Bridge Fm.) to Driver. The plantation on our left as we approach the Nansemond River (Holiday Point Farm) is the home of Virginia's present Governor, Miles E. Godwin. We cross the Nansemond River and continue on the Kings Highway cutting across the northern extremity of the Dismal Swamp. In Driver, we turn south across the Churchland Flat and proceed to Bowers Hill. Note the many high towers in this area; the Driver base is the main radio transmitting facility for the Atlantic Fleet.

STOP #11 -- NORFOLK, LONDONBRIDGE (?) AND SAND BRIDGE FMS. (20 min.)

In the west wall of this borrow pit is an 8 foot exposure of the Sand Bridge, Londonbridge (?) and Norfolk Fms. A loamy topsoil (1-2 feet of organic silty fine sand) is developed on the silty-sand facies of the upper member of the Sand Bridge Fm., which overlies 1-2 ft. of light yellow fine sand (Sand Bridge Fm., lower member?). This has a sharp contact with bright oxidized silty fine to medium sand (probably Norfolk Fm.). The sharp color contact about 4 ft. from the surface is not a lithologic break but simply marks the position of a former water table. About 2 feet below the pit surface, the Norfolk Fm. is very fossiliferous and contains:

Astrangia (coral) sp., *Anadara transversa*, *Corbula contracta*, *Mercenaria mercenaria*, *Nuculana acuta*, *Pitar morrhuana*, *Tellina agilis*, *Busycon carica*, *B. caniculatum*, *Crepidula convexa*, *Eupleura caudata*, *Nassarius obsoleta*, *N. trivittata*, *Polinices duplicata*. (Identified by H. G. Richards)

Quite possibly the Londonbridge Fm. clay facies is not present here at all; however, part of the unfossiliferous upper 6½ feet (below the Sand Bridge Fm.) might be Londonbridge which is considerably sandier than usual. Although similar in aspect to the Londonbridge Fm. at first glance, the entire exposed section below the Sand Bridge Fm. is probably Norfolk Fm. nearshore facies (Facies #4). The nearshore facies is silty and clayey because of influx of silt and clay from the James River into a North-South littoral system. Near the James River (north of here) the nearshore facies becomes finer-grained and is characterized by a restricted fauna including brackish-water forms such as *Barnea costata* and *Rangia cuneata*.

EN ROUTE TO MOTEL (10 min.)

Our Annual Dinner will begin in the Sunset Manor Dining Room at 7:15.

- - - - -

Sunday May 22 Field Leader: Bob Oaks

6:30 - 7:30 AM -- Breakfast in rear dining room, Sunset Manor Motel. For rapid service, please fill in partly-occupied tables before starting new ones.

7:45 AM -- Buses depart from motel.

EN ROUTE TO STOP #1 (15 min.)

We proceed down U.S. 17 to Deep Creek, riding on the Sand Bridge Fm. at altitudes of +10 to +15 feet. At Deep Creek, the top of the Miocene Yorktown Fm. lies near -10 ft., but deepens rapidly to -40 feet along the Deep Creek Swale two miles east of here.

As we move down U.S.17 south of Deep Creek, note the spoil banks piled high on the west bank of the Dismal Swamp Canal. This spoil contains shells of the Norfolk Fm., including the following:

Anadara transversa, Crassostrea virginica, Ensis directus, Mercenaria mercenaria, Mulina lateralis, Pitar morrhuana, Rangia cuneata, Venericardia tridentata, Canthara lunata, Crepidula convexa, Eupleura Caudata Nassarius trivittata, Olivella mutica, Polinices duplicata, Prunum rascidum and Retusa canaliculata

(Identifications by H. G. Richards)

The Norfolk Fm. was named by Clark & Miller (1906) on the basis of this spoil and the occurrence of similar shells in borings elsewhere in the area east of the Suffolk Scarp. Darton (1902) earlier recognized the unit from these same spoil banks and borings but did not name the unit. In some places the canal was dredged deep enough to encounter the underlying Yorktown Fm., and the resulting mixtures of shells of Miocene and Pleistocene age are believed to be the reason early workers (Woolman, 1899; Clark & Miller, 1906; Darton, 1902) assigned a Pliocene age to the Norfolk Fm. An analogous situation exists in South Carolina, where the probable Elberon Fm. equivalent, the Waccamaw Fm., contains reworked Miocene microfossils, predominantly Pleistocene molluscs, and several reworked Miocene "guide-fossil" molluscs, which have led to a Pliocene age assignment for the Waccamaw Fm. by early workers. (J.R. Du Bar, verbal comm.)

STOP #1 -- DEEP CREEK NIKE SITE (15 min.)

The Nike installation just east of this stop is near the axis of the Deep Creek Swale, where the top of the Yorktown Fm. is near -30 feet. To the west, the Dismal Swamp Peat thins as it approaches the Dismal Swamp Canal. To the east, the Sand Bridge Fm. marsh facies is highly organic in its upper few inches. Just south of here, the road traverses a minor re-entrant of the Dismal Swamp across the axis of the Deep Creek Swale. Peat borings in the Dismal Swamp show a dendritic drainage pattern at the peat base converging eastward into Northwest R., Indiantown Creek and Pasquotank R., each of which crosses the Fentress Rise via a narrow channel. Damming of these narrow channels, perhaps by beavers, caused water to be impounded in the area of the present Dismal Swamp at a time slightly prior to 8,900 ± 160 yrs. B.P. (Y-1390). Lake clay and peat began to form in the former stream courses and, as water levels rose, the peat covered the low interfluves and coalesced over most of the depression bordered by the Suffolk Scarp, Fentress Rise, and Churchland Flat.

EN ROUTE TO STOP #2 (20 min.)

We turn onto State Road 625 heading towards the Fentress Rise. One quarter mile east of U.S. 17, the ditch banks on our right show that the Dismal Swamp Peat has thinned to a feather edge; it was 8 ft. thick at the corner. As we proceed to the east, the ground surface rises to a nearly flat plain between +17 and +19 feet. About 4 miles eastward the ground drops to between +10 and +5 feet as we cross a small tributary to Northwest River. From here on, we rise gradually onto the Fentress Rise. The contact between the Sand Bridge Fm. and the Norfolk Fm. on the flanks of the Fentress Rise is nearly imperceptible because the soil zone developed on the silty sand of the Norfolk Fm. is clayey at the surface. In areas of sparse control, such as this, the contact was picked on soils and topography.

STOP #2 -- DRAINAGE DITCH ON FENTRESS RISE (NORFOLK FM) (10 min.)

In this exposure, we see the typical weathering profile of the Norfolk Fm, exhibiting two periods of soil development - a thin immature zone (black) at the top, enriched in organic material developed in the top of an oxidized zone of sandy clay that grades into clayey silty sand and then into unaltered silty sand. The parent material is a shallow marine facies with *Andara transversa*, *Ensis directus*, *Mactra solidissima*, *Mulinia lateralis*, *Nucula proxima*, *Phacoides crenella*, *Tellina texana*, *Busycon carica*, *Nassarius trivittata*, *Olivella mutica*, *Polinices duplicata*, *Retusa canaliculata*, *Terebra concava*, *Turbonilla sp.*, sand-dollar fragments, Bryozoa (*Discoporella?*), Arthropods (*Balanus amphitrite nivcus*) and crab claws, identified by H. G. Richards from jet-rig (flush-boring) samples taken 0.1 mile east of here. This unit has a basal coarse-grained zone directly overlying stiff clay of the Yorktown Fm. at -10 ft. (30 ft. below ground surface), containing *Pecten* sp. and corals other than *Astrangia* sp.

EN ROUTE TO STOP #3 (30 min.)

We continue north along State Road 634 through Great Bridge. This is the municipal center for the newly-formed city of Chesapeake, which includes the entire former Norfolk County (excluding Norfolk, and Portsmouth). It is also the location of the modern Intracoastal Waterway.

As we descend from +20 feet to +5 feet near the new shopping center we cross first a narrow band of sandy Kempsville Fm. and then a narrow band of Sand Bridge clay, that follow the E-W breach through the Fentress Rise along the South Branch of the Elizabeth River; and then we proceed onto Recent sediments. Along the Intracoastal Waterway, 5 to 15 feet of organic clay overlies fine to coarse sand that grades downward to gravel.

The rise on the North side, coming into Oak Grove, is steeper, and only a narrow band of Sand Bridge sediments appears to separate the low Recent Sediments from high-standing Norfolk sediments of the central Fentress Rise segment. At Oak Grove, we turn and follow State Highway 190 across the southern end of the Fentress Rise segment.

EN ROUTE TO STOP #3 (continued)

The road turns sharply to the North at the east side of the Fentress Rise and follows the Hickory Scarp. Near this curve is the type section of the Great Bridge Fm. lower member (North Landing mbr.). The road is built on the Kempsville Fm., which overlies the Norfolk Fm. a short distance to the west. Immediately east (on the right) the Sand Bridge Fm. overlaps the Kempsville Fm. up to the base of the Hickory Scarp, where the Sand Bridge Fm. thins rapidly to a feather edge. In the field to the right, 4 to 5 feet of Sand Bridge clay overlies 9 to 10 feet of Kempsville sand above 25 feet of Norfolk Fm. (to -22 ft.) which overlies 35 feet of angular sand, gravel, clay and peat of the lower member of the Great Bridge Fm. (type section) and rests at -58 ft. on stiff green clay with Miocene Turritella variabilis and Pecten sp. We continue along the Hickory Scarp to Indian River Road and turn onto the Mt. Pleasant Flat, heading for the Mears Corner borrow pit of the W. C. Womack Co.

STOP #3 -- MEARS CORNER BORROW PIT, +14 -16 FT. (40 min.)

In this pit immediately east of the Hickory Scarp, the stratigraphic sequence is well displayed. Dark gray laminated clay with some pebble gravel (marsh facies) of the Sand Bridge Fm. unconformably overlies white, cross-laminated parallel-bedded sand and fine gravel of the Kempsville Fm. (beach facies). Abundant articulated Mercenaria mercenaria of probable Kempsville age occur in growth position just within the top of the Norfolk Fm. throughout the entire pit. The Norfolk Fm. here contains a great variety of fauna including echinoid spines, two species of Astrangia (coral), Anadara transversa, Chione cancellata, Corbula contracta, Crassostrea virginica, Cumingia tellinoides, Ensis directus, Mactra solidissima, Mercenaria mercenaria, M. campechiensis, Noetia ponderosa, Nucula proxima, Petricola pholadiformis, Rangia cuneata, Venericardia tridentata, Busycon carica, B. canaliculatum, Columbella lunata, C. obesa, Crepidula formcata, C. plana, Eupleura caudata, Nassarius obsoleta, N. trivittata, Olivella mutica, Polinices duplicata, P. heros, Prunum roscidum, Terebra concava, Urosalpinx cinerea serpulid worm tubes, hydrozoa, fenestrate bryozoa, Balanus (barnacle) and crab claws (identified by H. G. Richards).

Driftwood from the Kempsville Fm. here gave an age greater than 40,000 years B.P. (Y-1194). A continuously sampled core boring by John Sanders and Joseph Kravitz penetrated clay of the upper member of the Great Bridge Fm. here between -20 and -54 feet, the base of the boring. The unit contained a restricted open-bay fauna chiefly of Mulinia lateralis with a few specimens of Phacoides crenella and Thais floridana (identified by H. G. Richards). A serpulid-worm bioherm occurs a few inches to 2 feet beneath the (eroded) top of the Norfolk Fm. beneath much of this pit.

EN ROUTE TO STOP #4 (20 min.)

We continue moving southeastward on State Road 603 travelling along typical undissected Mt. Pleasant Flat topography. A series of closely-spaced borings along this road shows appearance of the soft clay of the Londonbridge Fm. between the Kempsville Fm. and the Sand Bridge clay, then the appearance of the lower sand member of the Sand Bridge Fm. between the Londonbridge Fm. and the upper member of the Sand Bridge Fm., then the irregular surface developed in the top of the Kempsville Fm., and finally eventual erosional disappearance of the Kempsville Fm. to the east, where the Londonbridge Fm. lies directly on the Norfolk Fm. We turn left on State Road 605 and turn right on State Road 634 and proceed to State Road 633 where we turn left and proceed about a mile to Stop #4.

STOP #4 -- MOUNT PLEASANT FLAT (10 min.)

The topography here is typical of the Mount Pleasant Flat, with altitudes around +12 -13 feet. A good section of the silty upper member of the Sand Bridge Fm. (tidal flat?) and part of the sandy lower member of the Sand Bridge Fm. is exposed in the drainage ditch here. Ditches are common on the Mt. Pleasant Flat because the land has little relief, and the Sand Bridge clay at the surface is virtually impermeable. In fact, water in the sandy lower member of the Sand Bridge Fm. is under pressure and will rise 1 to 3 feet into holes dug through the upper member.

EN ROUTE TO STOP #5 (20 min.)

We proceed to Princess Anne, the municipal center for the new city of Virginia Beach, comprising all of the former Princess Anne County. The Princess Anne Courthouse, on our right as we pass through town, is one of the oldest in America. Princess Anne is built on a low, arcuate ridge which rises gently 3 to 4 feet above the Mount Pleasant Flat to the west, but descends rapidly on the east, towards West Neck Creek. Wentworth (1930) named a scarp (Pungo Ridge and Oceana Ridge combined), a surface (Mt. Pleasant Flat), and a formation based on morphology for this community. The arcuate ridge probably was the ocean shoreline in the earliest part of late Sand Bridge time, with inlets both to the SW and NE.

We turn right on State Road 165, left on State Road 627, left on State Road 615. As we enter the village of Pungo we move off the Mt. Pleasant Flat onto Pungo Ridge.

STOP #5 -- PUNGO RIDGE (15 min.)

The Sand Bridge Fm., upper member, sand (beach) facies is exposed in the deep ditch on the left. Note the slight weathering and extremely immature soil zone at the top. Ditches dug this deep into sand are difficult to maintain; please be careful not to strip away the brush covering the ditch walls any more than necessary.

EN ROUTE TO STOP #6 (15 min.)

We continue north on State Road 615 following the crest of Pungo Ridge at an altitude of +15 -20 ft. Just south of Nimmo Church, Pungo Ridge exhibits a slight offset (with the northern segment west of the southern portion). Closely-spaced borings along State Road 632 clearly show the interfingering between the clay (marsh) facies and the sand (beach) facies of the upper member of the Sand Bridge Fm. Pungo Ridge formed the shoreline when most of the Sand Bridge clay (marsh) facies was being deposited farther west.

Just north of State Road 631, the road swings left and crosses a low area (near +15 feet) between Pungo Ridge and Oceana Ridge, which trends NNW. The road then follows the crest of Oceana Ridge. The clay (marsh) facies of the Sand Bridge Fm. forms the surface of this gap between the ridges, and continues to the north and east between Oceana Ridge and the low eroded remnants of Pungo Ridge. Pungo Ridge continues to the NNE to where it is intersected by the present coast, at the southern end of Virginia Beach. The southern (exposed) limit of the Londonbridge sand (barrier) facies is reached near State Road 633. A series of closely-spaced borings along State Road 633 established the onlap relations of Sand Bridge sediments onto Londonbridge sand, and interfingering relations of the sand with the Londonbridge clay (open bay-lagoon) facies in the subsurface just west of Oceana Ridge (beneath the Mt. Pleasant Flat). We continue northward until we reach the Oceana borrow pit.

STOP #6 -- OCEANA RIDGE BORROW PIT (15 min.)

This pit contains the type section of the Londonbridge Fm. sand (barrier) facies. The weathering profile at the top of the section is somewhat better developed than that on Pungo Ridge. The section shows typical beach stratification with gently-dipping, east-thinning beds of well-sorted sand and pebble gravel. Leached shell imprints are present, as well as a burrowed chocolate-brown layer near the top of the section; the latter may be a thin soil zone. The highest occurrence of definite beach sand in this pit is +22 ft.

EN ROUTE TO STOP #7 -- Lunch (20 min.)

We continue north on State Road 615 following the west side of the crest of Oceana Ridge at an altitude of 25-30 ft. The Ridge trends at an angle to Pungo Ridge, stands at a higher altitude along its entire crest, is two to three times as wide, and is related to an older stratigraphic unit than Pungo Ridge. Although Wentworth (1930) believed the two ridges formed at the same time, they are demonstrably separated stratigraphically through the low area between the ridges.

At Allanton, we pass the Baillio Sand Co. pit (Londonbridge barrier facies); we will make a short stop if time permits. The pit has an excellent section of the Londonbridge Fm. near its northernmost extent. The pit section shows east-dipping and thinning beach facies with a few leached shell imprints. The weathering profile at the top of the section is noticeably thicker than that on Pungo Ridge (Sand Bridge Fm.)

After passing the Allanton Pit we continue slowly on State Road 615 around the wide curve north of Allanton. The roadcut on our left exposes the clayey backbarrier sediments of the Londonbridge Fm. near +18 feet. This is one of the few places in southeastern Virginia where the barrier facies and backbarrier facies can be seen in outcrop so close together.

We continue north to our lunch stop at Seashore State Park. Picnicking is not allowed in the Park, but we have special permission for "camping". Please make sure you place all refuse in the receptacles provided, and heed all posted signs. We will have 40 minutes for lunch.

The area from Seashore State Park eastward to Cape Henry is a very historic one. It was at Cape Henry that the Jamestown settlers first landed in 1609. They studied the area, deemed it unsuitable and proceeded further up the James River, where they established Jamestown.

The view from the shore of the Park is one of the best on the Atlantic Coast and includes views of the Norfolk Naval Base and the Chesapeake Bay Bridge-Tunnel. If time permits, we may take a short ride to Cape Henry on the way back to the Motel.

EN ROUTE TO MOTEL (45 min.)

We have several possible return routes to the Motel. Appropriate commentary will be given by the field leaders depending on which route the driver chooses.

ARRIVE SUNSET MANOR MOTEL - 1:15 --- END OF FIELD TRIP

FRIENDS OF PLEISTOCENE GEOLOGY 1966 Meeting, Chesapeake, Va.

AGE							Participants own guess
Recent	RECENT SEDIMENTS DISMAL SWAMP PEAT						
Port Talbot			Sand Br. Londonbr.	Sand Br. Londonbr.	Sand Br. Londonbr. Kempsville		
Sangamon	Sand Br. Londonbr. Kempsville Norfolk Great Br.	Sand Br. Londonbr.	Kempsville	Kempsville Norfolk Great Br.	Norfolk Great Br.	Sand Br. Londonbr. Kempsville Norfolk Great Br.	
Yarmouth	Elberon	Kempsville Norfolk Great Br.	Norfolk Great Br.	Elberon	Elberon	Elberon	
Aftonian		Elberon	Elberon	Bacons Castle	Bacons Castle	Bacons Castle	
Pliocene	Bacons Castle	Bacons Castle	Bacons Castle Sedley	Bacons Castle Sedley	Sedley	Sedley	
Miocene	Yorktown Sedley	Sedley Yorktown	Yorktown	Yorktown	Yorktown	Yorktown	

TABLE SHOWING POSSIBLE CORRELATIONS OF VIRGINIA STRATIGRAPHIC UNITS

Table summarizing characteristics of stratigraphic units in southeastern Virginia[1]

Formation	Thickness (ft) Max.	Av.	Altitude (extremes, ft) Top	Base	Composition	Source of Name
			RECENT			
Recent (undifferentiated)	80	Var.	+60	<-180	Dune- and beach sand and fine gravel; lagoon clay and silt; peat; alluvial silt	
Dismal Swamp Peat	12	6 to 7	+27W +15E	+5	Freshwater peat (underlain by lake clay and/or fluvial sand)	Oaks and Coch, 1963
			PLEISTOCENE			
Sand Bridge						
upper member (western area)	8	4	+27W +18E	+4W -2E	Lagoon clay and silt; delta sand and tidal-channel sand and clayey sand	Oaks and Coch, 1963
(Sd.-Ridge complex)	25(35?)	18	+21	-25	Variable lagoon sand and clay and barrier sand	
lower member	8	5	+20W +15E	+3W -3E	Clean to clayey and/or silty fine- or fine- to med-gr. sand	
Londonbridge	13W		+15W	-4W	Lagoon clay and silt	
(western area)	12E	5	+10E	-4E		
(Oceana Ridge)	47	Var. >20	+30	-17	Dune- and beach sand and gravel with shells	Oaks and Coch, 1963

Table summarizing characteristics of stratigraphic units in southeastern Virginia

Formation	Thickness (ft) Max.	Thickness (ft) Av.	Altitude (extremes, ft) Top	Altitude (extremes, ft) Base	Composition	Source of Name
Kempsville	17	Var.	+25	-2	Beach sand, gravel, and shells; lagoon peaty clay (restricted)	Oaks and Coch, 1963
Norfolk						
upper member	45W 50E	Variable: >20W Gen. 10 to 30E	+70W +25E	+5W -35E	Lagoon and fluvial-estuarine clay and sand, dune- and beach sand and gravel in west; variable sand, silty- to clayey sand, and sandy silt in east	Clark and Miller, 1906
lower member	8	4	+14W -14E	-8W -22E	Beach sand and fine gravel	
Great Bridge						
upper member	55	Var., Gen. 10 to 25	-4W -8E	-94W -74E	Open-bay lagoon clay, silt, and silty fine sand, some shells, peaty in places	
lower member	25	Var.	+3W -38E	-65W -79E	Fluvial sand and gravel, freshwater peat	Oaks and Coch, 1963
Elberon	30	15	+130W +70E	+103W +45E	Lagoon clay and silt and barrier sand in west; nearshore marine silty sand in east	Coch, 1965

Table summarizing characteristics of stratigraphic units in southeastern Virginia

Formation	Thickness (ft) Max.	Thickness (ft) Av.	Altitude (extremes, ft) Top	Altitude (extremes, ft) Base	Composition	Source of Name
Bacons Castle						
Kilby facies	20	highly variable 8	highly variable +85W +40E	highly variable +75W +30E	Fluvial-channel silt, sand, pebble gravel, cobble gravel	Coch, 1965
Cross Creek facies	18	highly variable 5	highly variable +103W +45E	highly variable +85W +40E	Floodplain clay, silt, and fine sand	
Sedley	35	highly variable 10	highly variable +75W +20E	highly variable +65W -5E	Marine clay, silt, and fine sand	Moore, 1956
LATE MIOCENE						
Yorktown	37 max. exposed		highly variable +65W -180E		Marine clay, silt, sand, and coquinite	Clark and Miller, 1906

[1] Table compiled jointly by N. K. Coch and R. Q. Oaks, Jr.

Figure 15

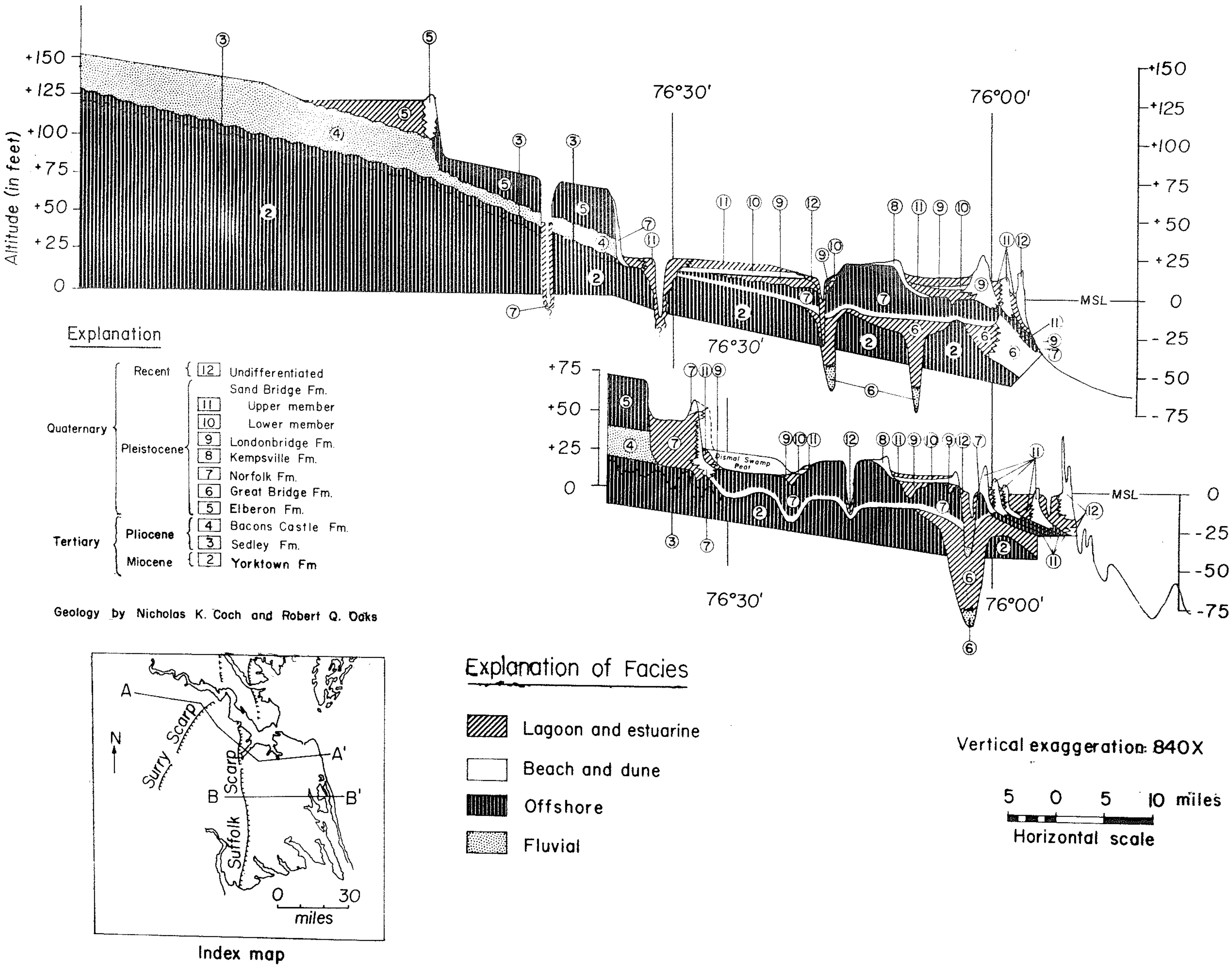


Figure 15 Diagrammatic geologic sections through coastal plain of south-eastern Virginia, showing facies of post-Yorktown stratigraphic units.

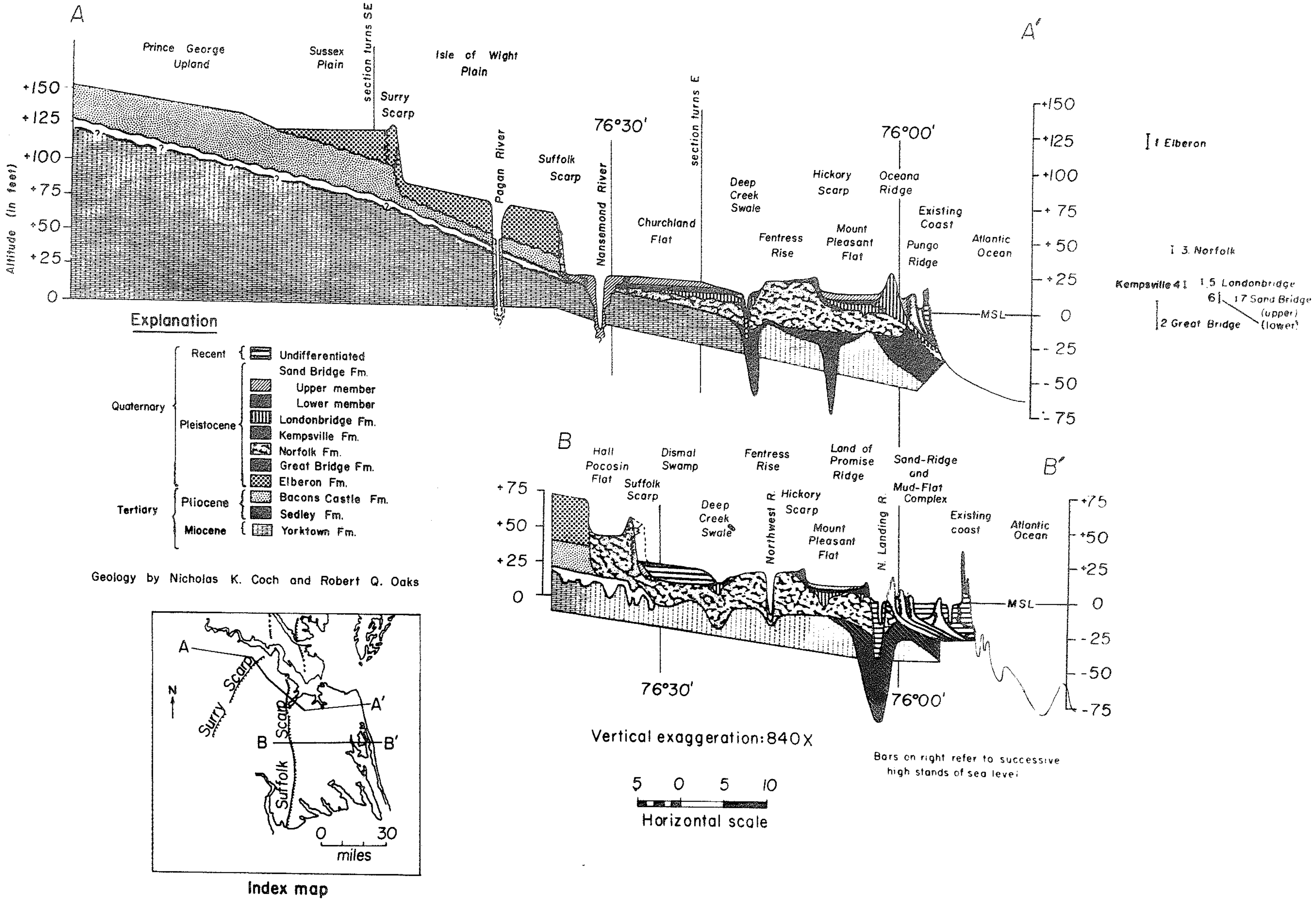
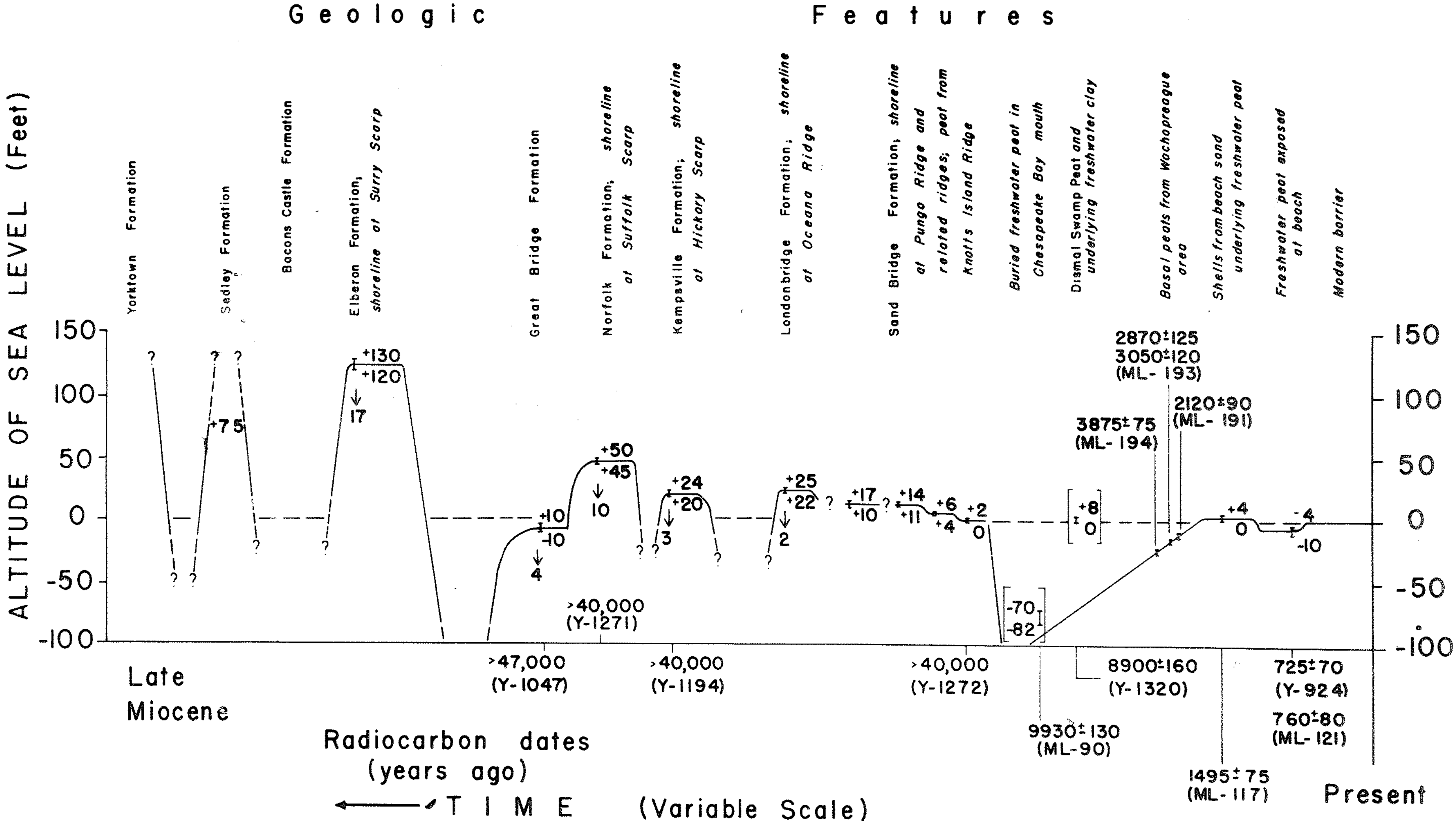


Figure 16

Diagrammatic geologic sections through coastal plain of southeastern Virginia, showing relations of post-Yorktown stratigraphic units.

Figure 16



Relative positions of land and sea level in southeastern Virginia through time, showing geologic features and radiocarbon dates. Arrows indicate the adjustment of data necessary, relative to Pungo Ridge, to compensate for eastward post-Sand Bridge tilting suggested by stratigraphic evidence.

(Compiled jointly by Robert Oaks and myself)

Figure 40

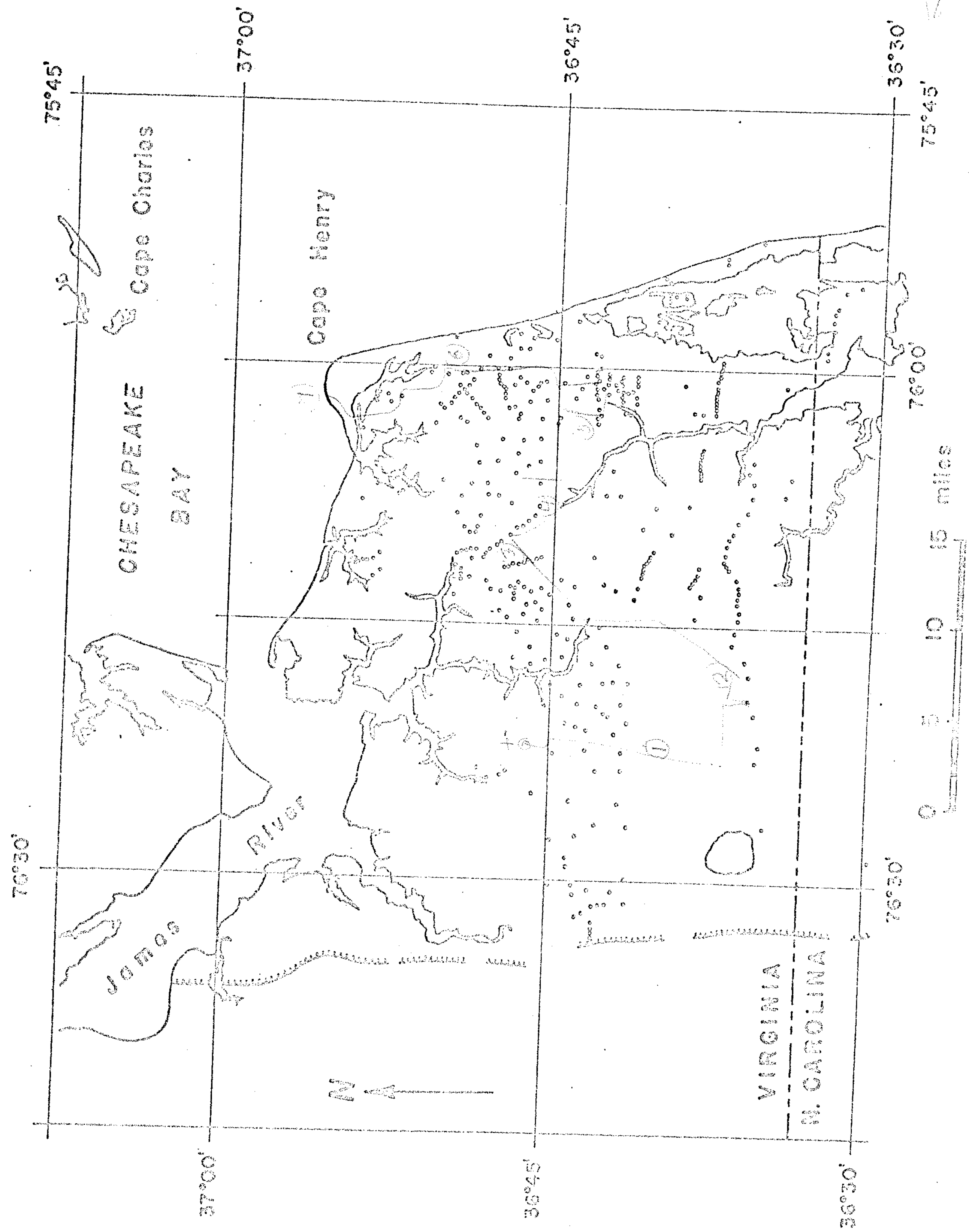


Figure 6. Locations of exposures and of shallow borings made with soil (hand) auger and plastic tubes.

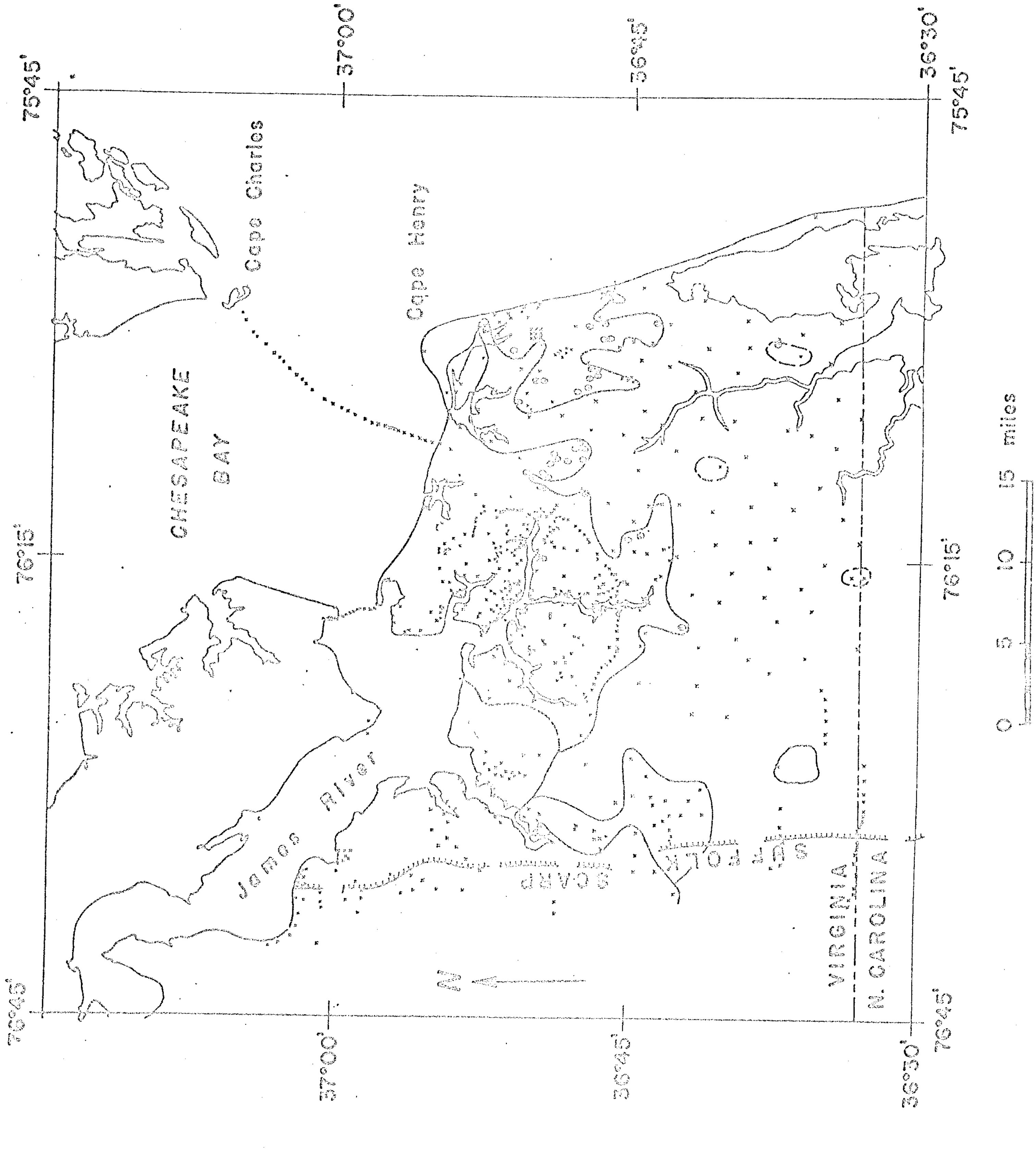


Figure 7. Locations of control points for top of Yorktown Formation (Upper Miocene), chiefly jet-rig borings south of solid line and engineer's (soils-test) borings north of solid line and east of dashed line. Small circles denote logs of jet-rig borings given from memory.

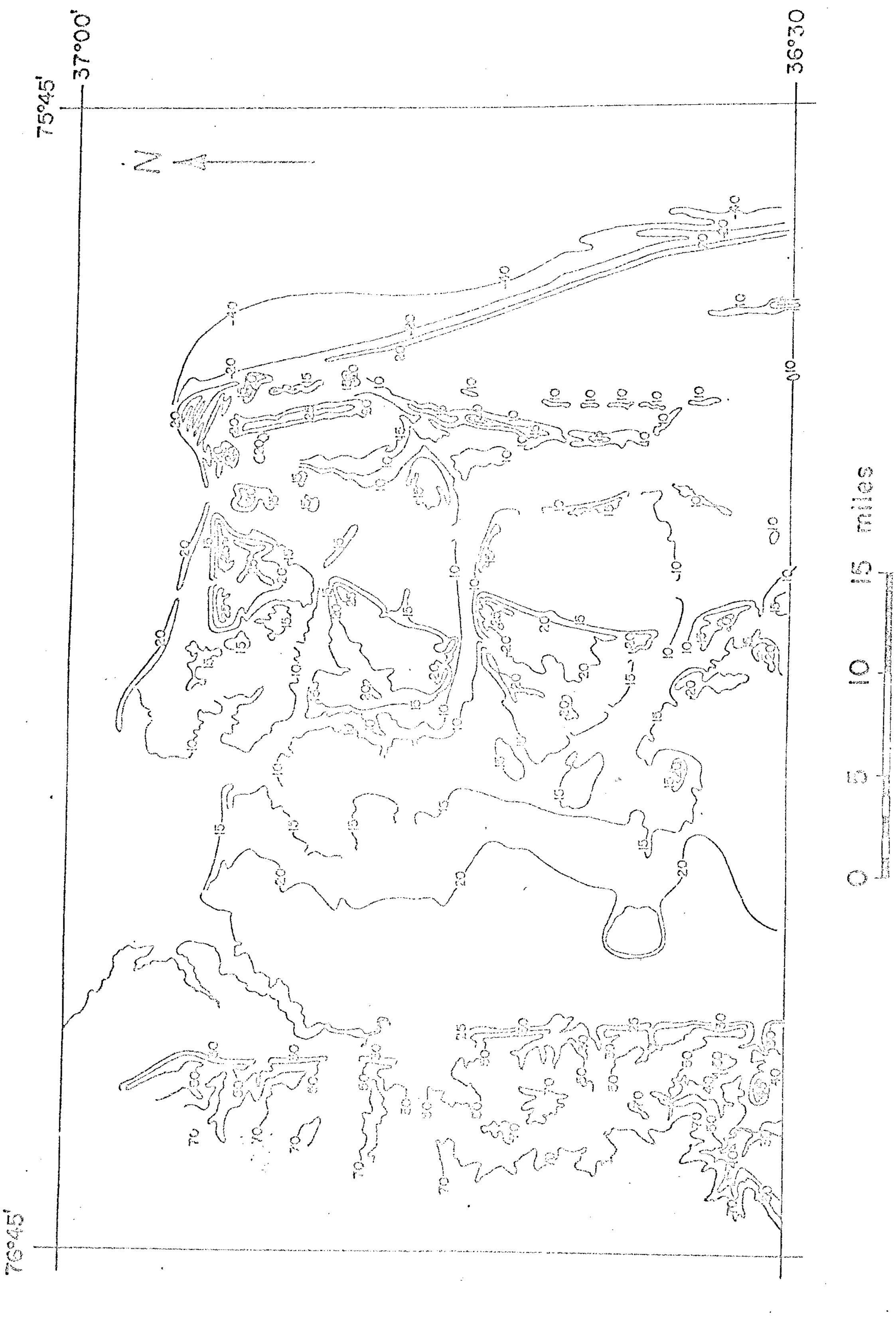


Figure 8. Map showing generalized topography east of Suffolk Scarp, southeastern Virginia. Contours in feet.

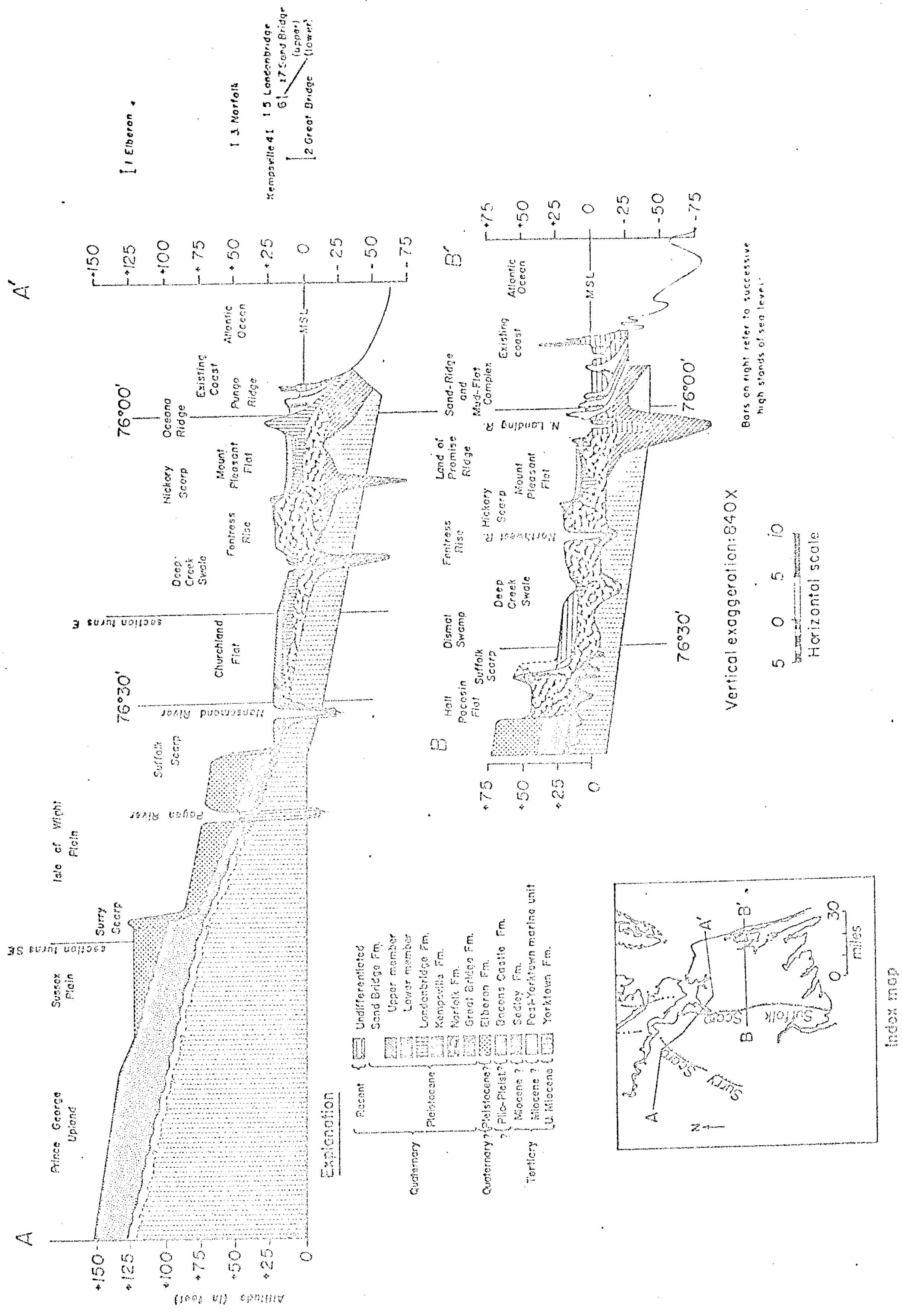


Figure 25. Diagrammatic geologic sections through coastal plain of southeastern Virginia, showing relations of post-Yorktown stratigraphic units.

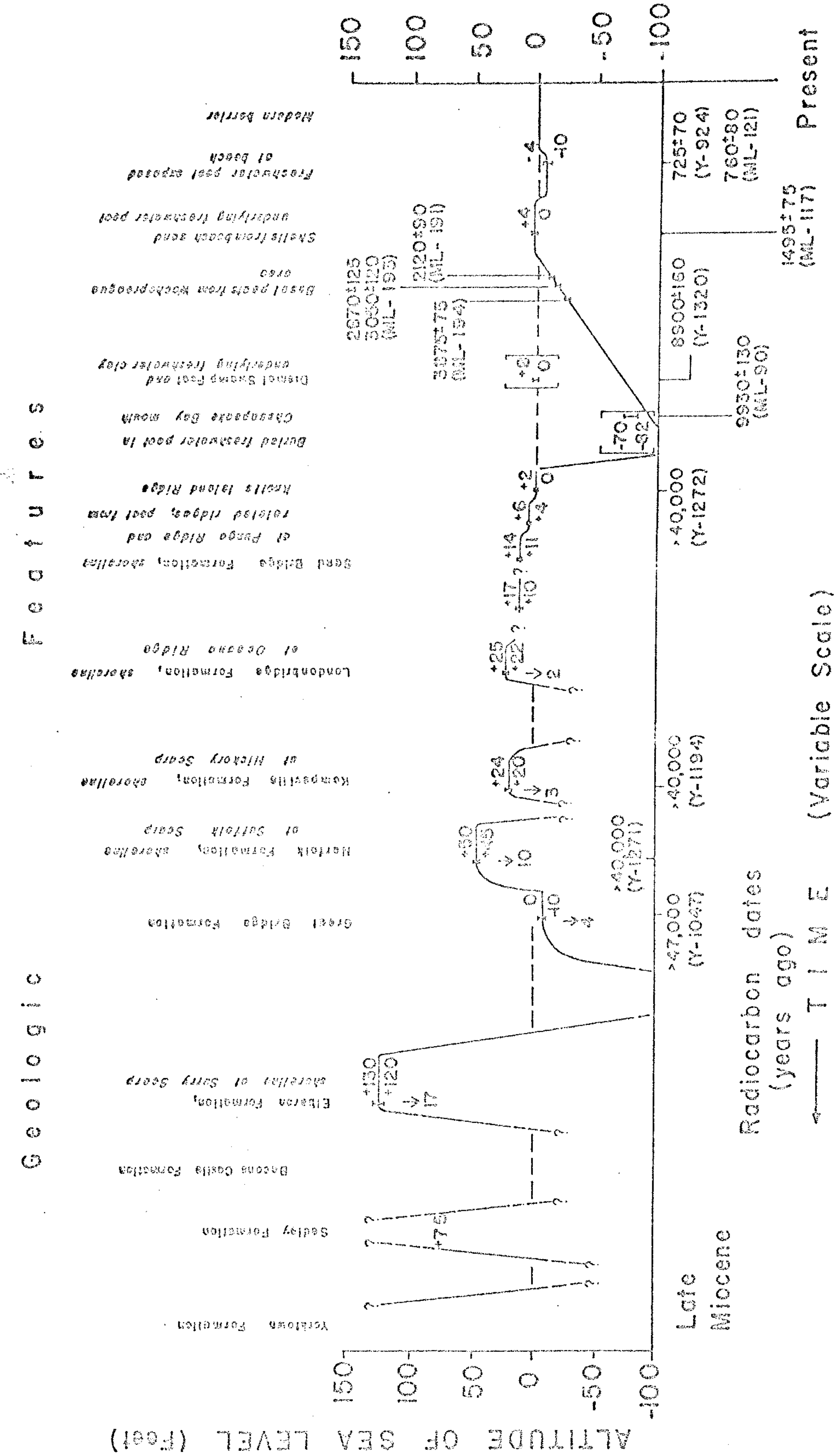


Figure 26. Relative positions of land and sea level in southeastern Virginia, showing geologic features and radiocarbon dates. Arrows indicate the adjustment of data necessary, relative to Pungo Ridge, to compensate for eastward post-Sand Bridge tilting suggested by stratigraphic evidence.

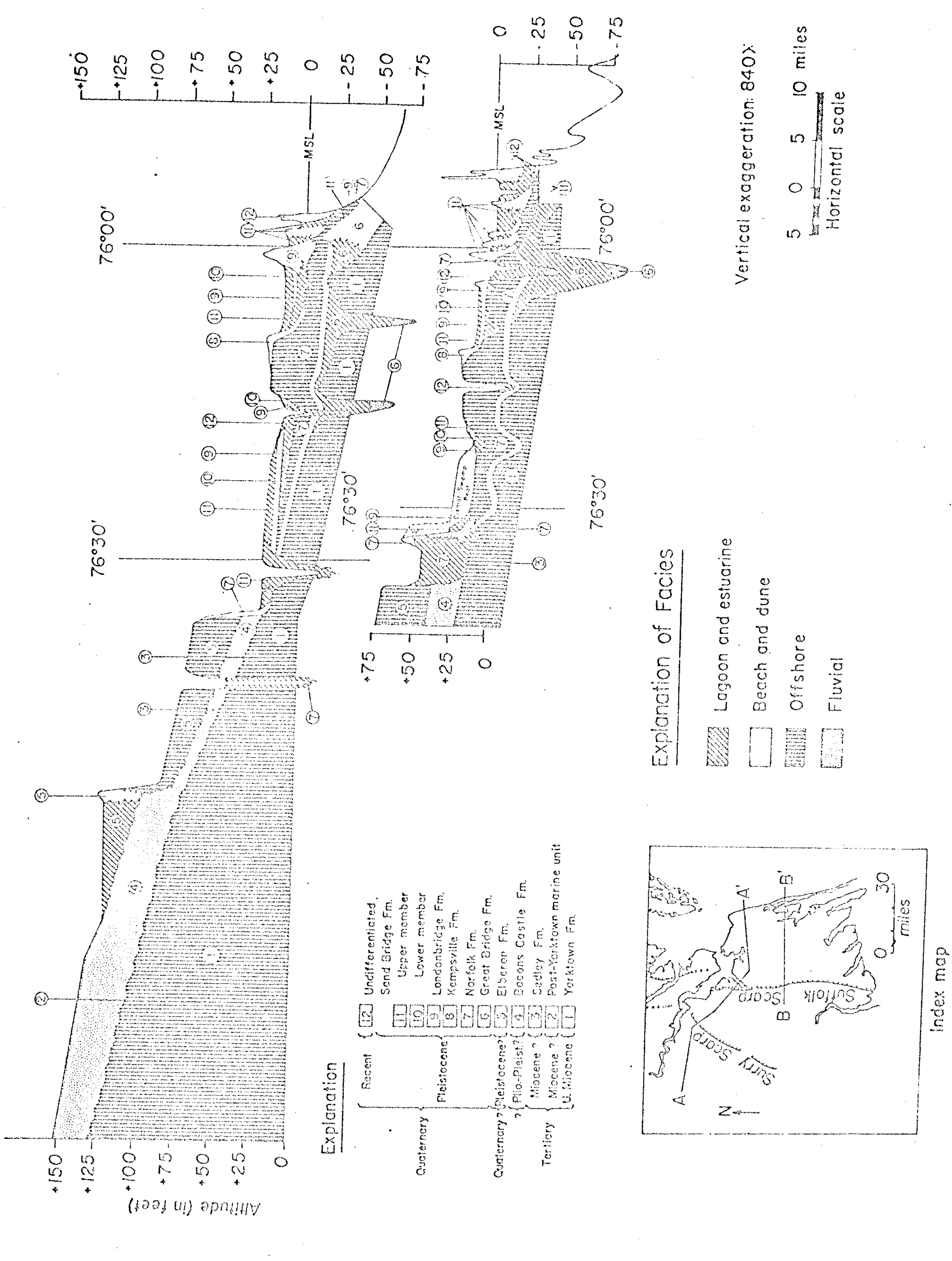


Figure 28. Diagrammatic geologic sections through coastal plain of south-eastern Virginia, showing facies of post-Yorktown stratigraphic units.

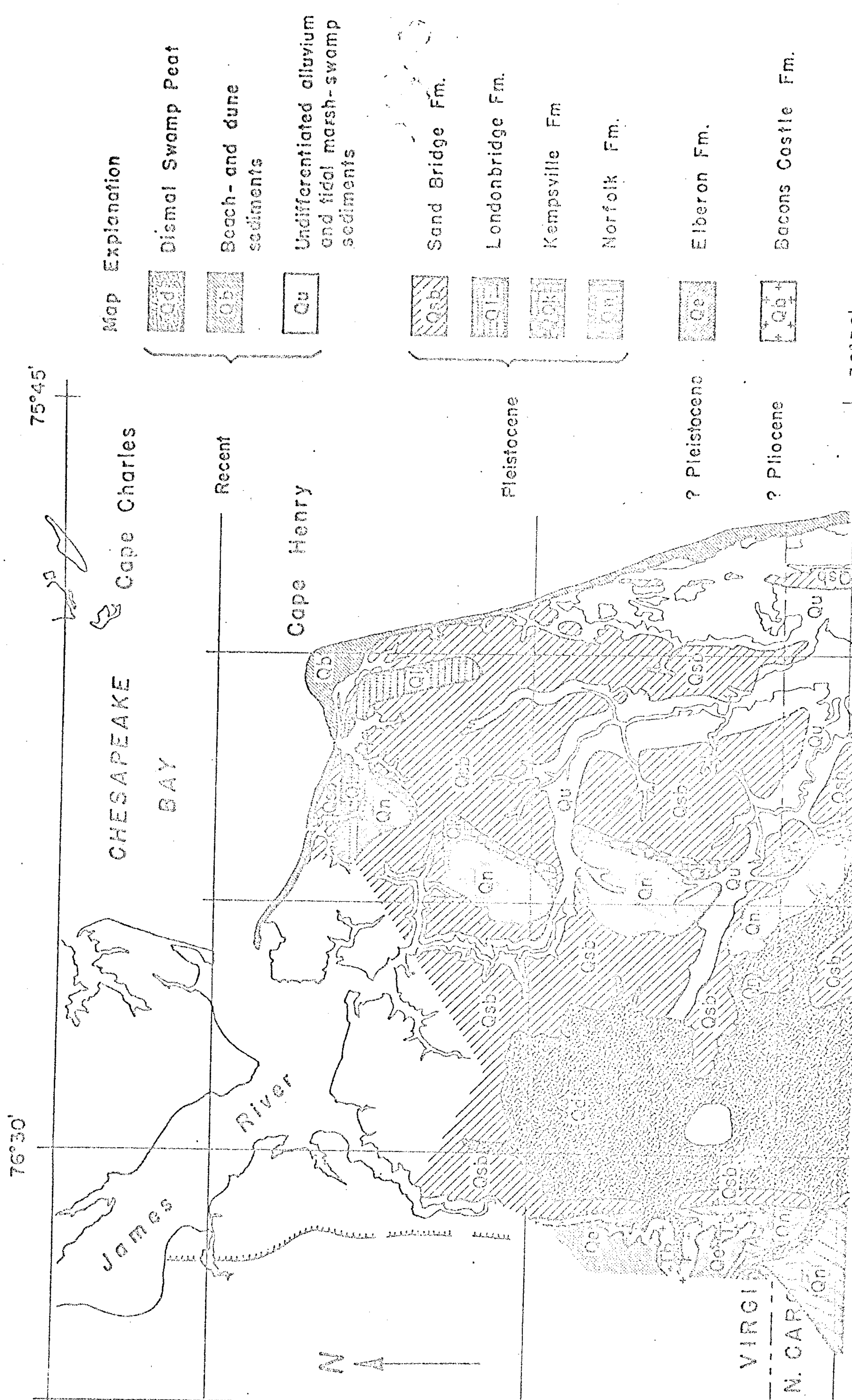


Figure 29. Generalized geologic map, outer coastal plain, southeastern Virginia.

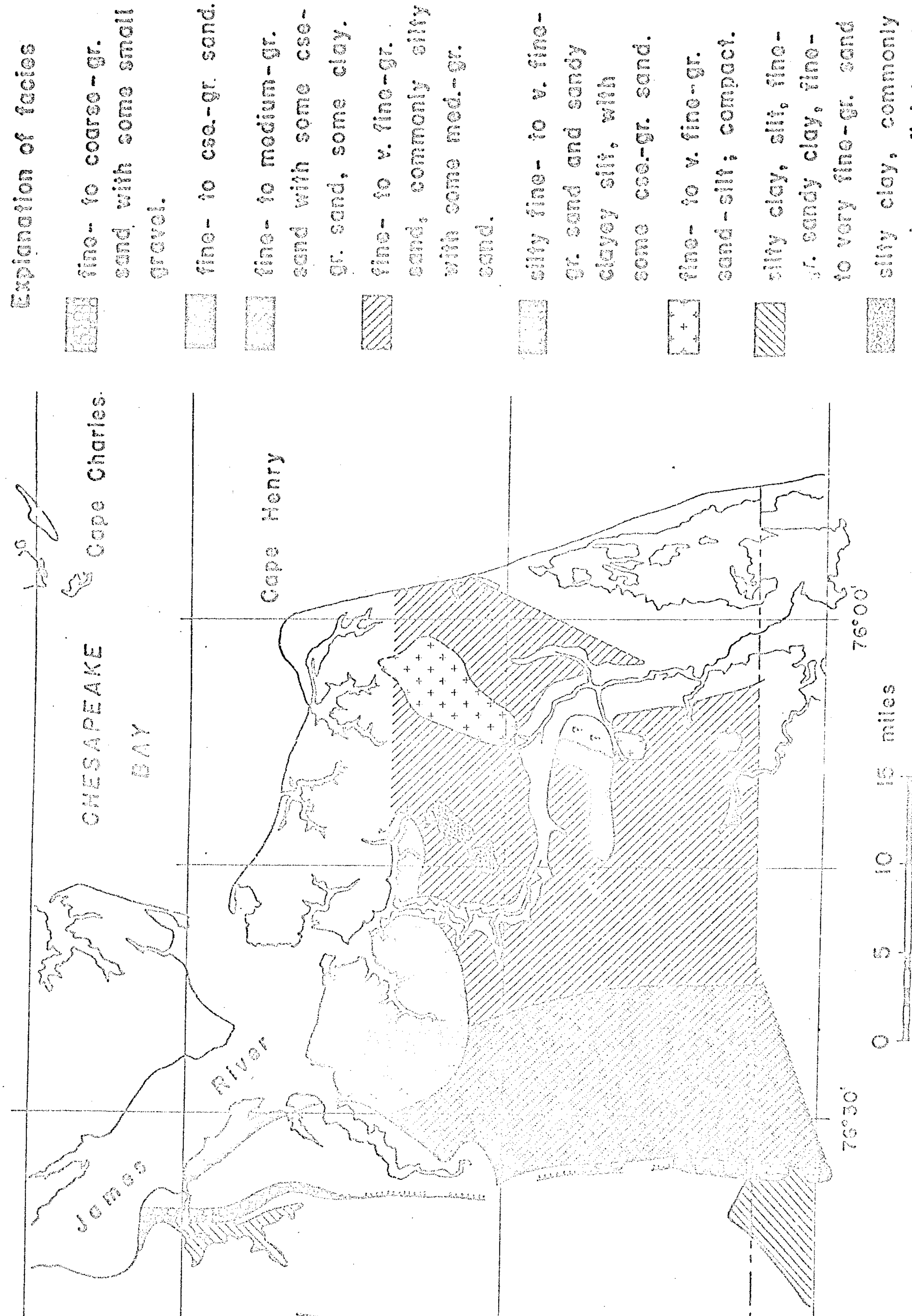


Figure 33. Distribution of major sediment facies of Norfolk Formation, southeastern Virginia.

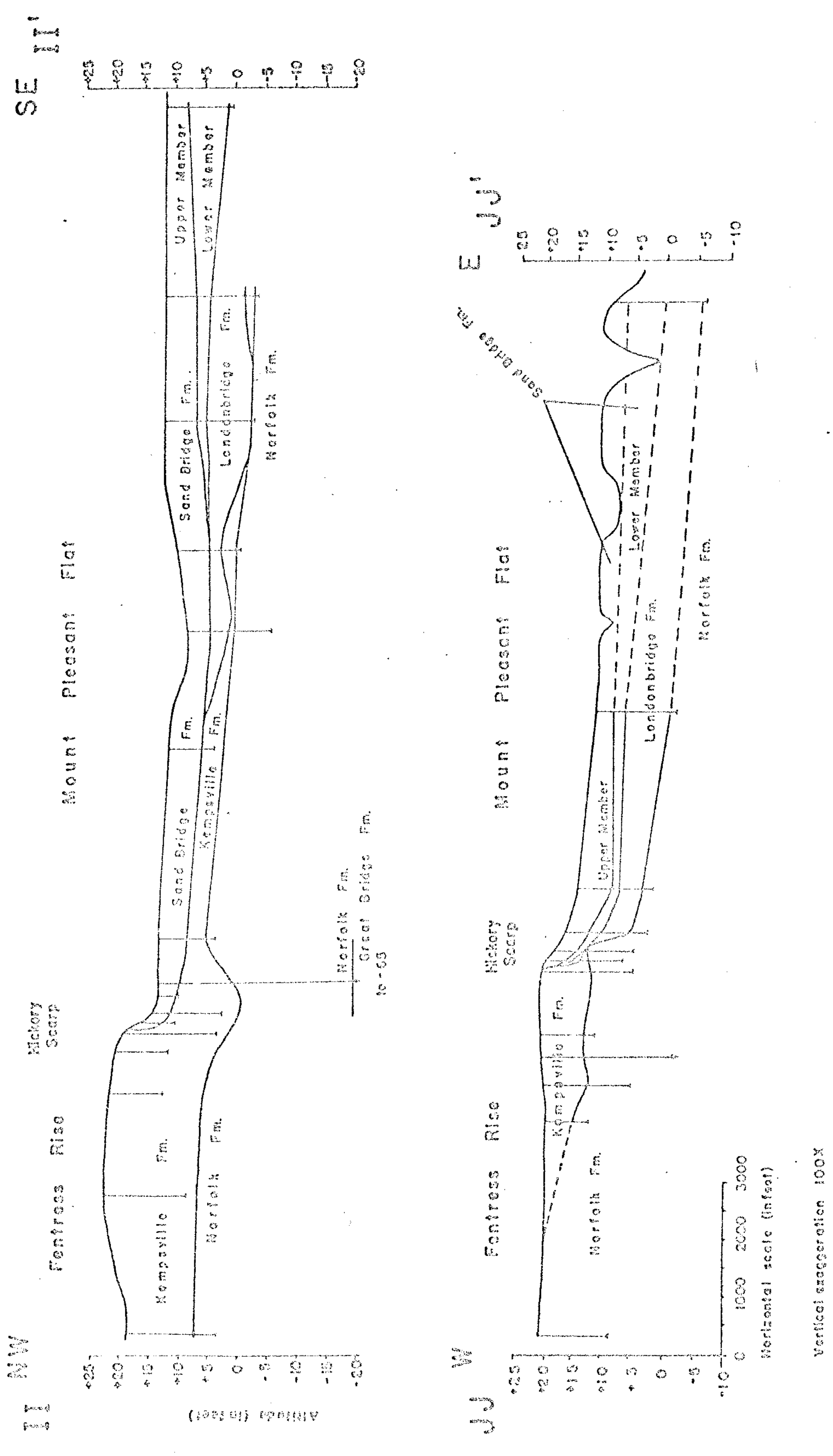


Figure 35. Detailed geologic sections through Hickory Scarp.
See Figure 27 for locations of sections.

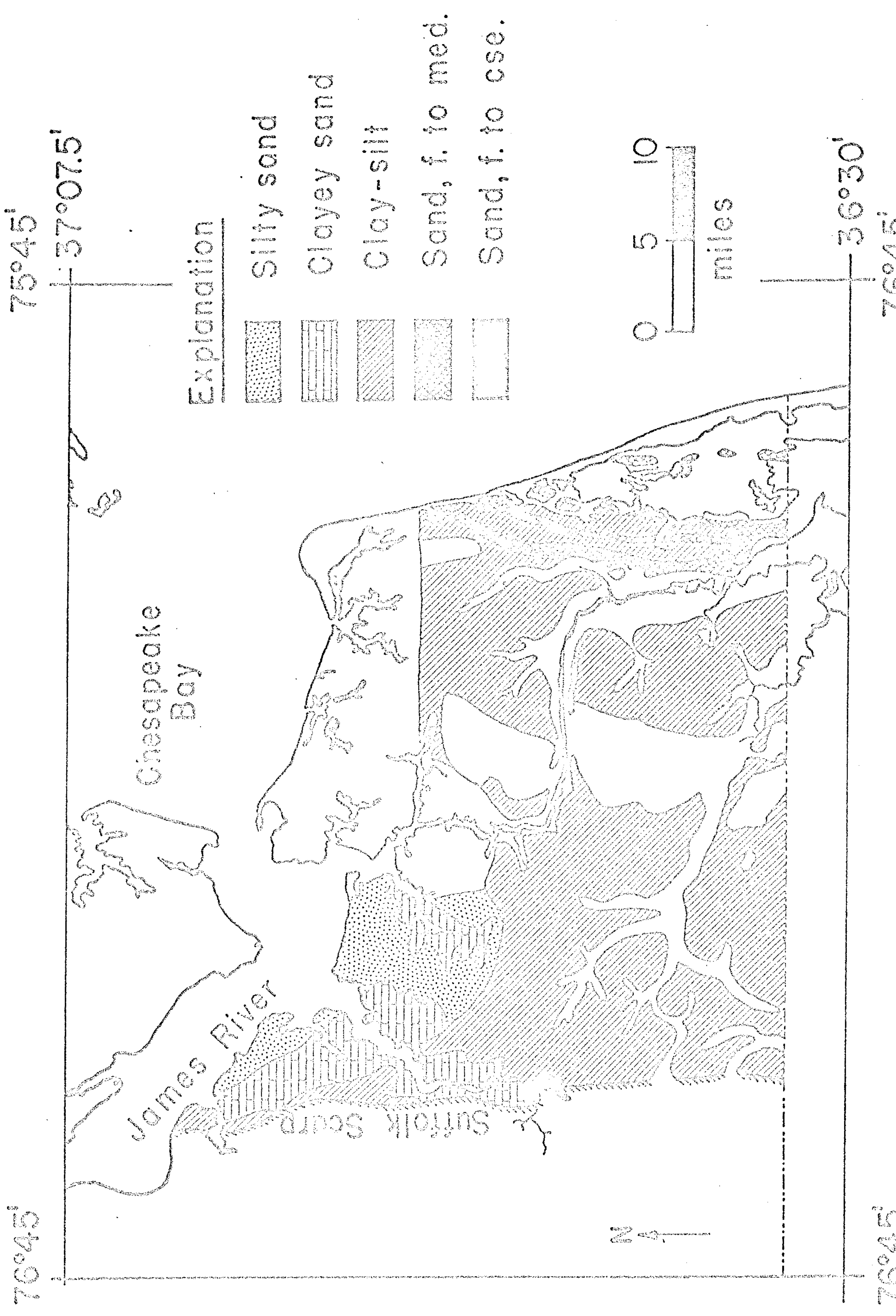


Figure 40. Distribution of major sediment facies of upper member of Sand Bridge Formation, southeastern Virginia.

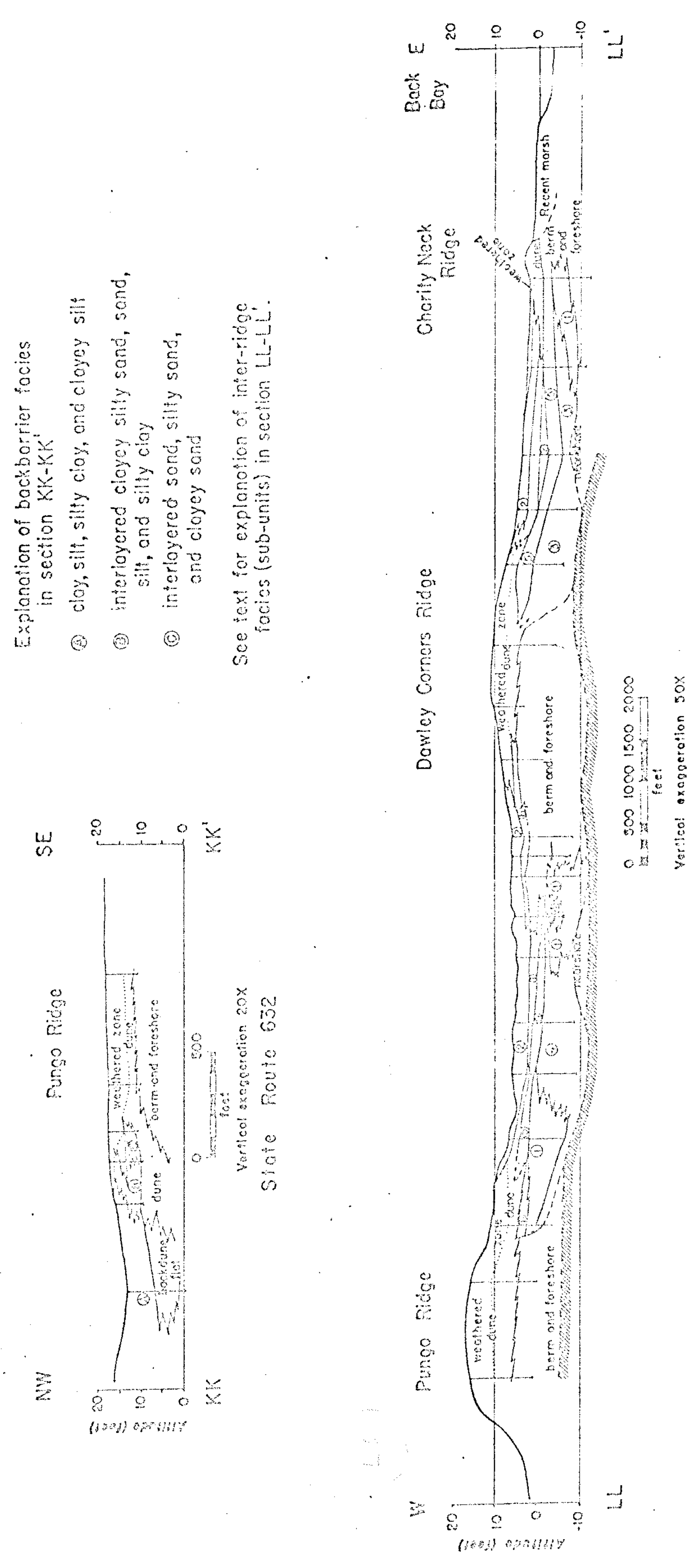


Figure 41. Detailed geologic sections through west side of Pungo Ridge (KK-KK') and through Sand-Ridge and Mud-Flat Complex (LL-LL'). See Figure 27 for locations of sections.