FALKLAND QUADRANGLI NORTH CAROLINA

7.5-MINUTE SERIES

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The Atlantic Coastal Plain of eastern North Carolina (Fig. 1) is poorly understood from scientific, stratigraphic, and mapping perspectives. It is mantled primarily MAP-funded positions [one Temporary Geologist I (11-month appointment) and one part-time driller (300-350 hours per year)]. On occasion, the Temp Geologist I led by Pliocene and Pleistocene deposits that have map extents, allostratigraphy, and relationships to global sea level cycles that are mostly undefined. Outcrops are rare, the field operation with assistance from other NCGS permanent and temporary geologists. An additional 11 person days were spent mobilizing and maintaining the and the new subsurface data necessary to define units and map this region is expensive. Except for recent STATEMAP (SM) deliverables, detailed geologic maps at Geoprobe Rig. 1:24,000-scale for the Coastal Plain do not exist. The current geologic map (NCGS, 1985) does not show surficial units for the Coastal Plain, it shows underlying subcrops (Fig. 1A). In recent SM areas (FY10-19), the Pliocene Yorktown Formation is supposedly the principal subcrop (NCGS, 1985); this unit is affiliated with a regional-scale shallow confining unit. Detailed mapping (FY10-19) shows that the Yorktown (Fig. 1A) is thin, absent, or misidentified. Isotopic age dates suggest that basal, clastic carbonate beds that define the base of the Plio-Pleistocene, correlate with the Chowan River Formation, rather than the Yorktown. If this is the case the Yorktown is essentially absent in this area of the NC Coastal Plain. The post-Chowan River section includes several early Pleistocene units in ramp or interfluve settings; younger terraces and alluvium occur in incised valleys.

step down in elevation and age towards the coast (Fig. 2) and into river basins (Fig. 3). This is stairstep topography. Seven river basins dissect the Coastal Plain so ing point data, using Spati that its low-relief, flat, eastward-dipping marine terraces (ramps) are separated by incised valleys with terraced borders. Over the past 5 Ma, glacio-eustatic changes in sea level drove the transgressive-regressive (T-R) cycles that sculpted this landscape. Fluvial, estuarine and marine deposits occur in the incised valleys. The stratigraphy in valley fills differs from that of the ramp or interfluve (Farrell and others, 2003), and forms the "alluvial aquifer system" (Tesoriero and others, 2005). The Surry Scarp, a Pleistocene paleoshoreline complex, trends north through Fountain quad (Figs. 1, 4A). Regional-scale conceptual models (Mixon and others, 1989; Winker and Howard, 1977; Oaks and DuBar, 1974; Daniels and others, 1966) and NCGS SM data suggest that the Surry shoreline is the highstand position for the main early Pleistocene T-R cyclic event. Stratigraphic relationships near the scarp are complex and include several early Pleistocene units; each contains similar The geomorphic analysis provided a guideline for planning new core holes using the NCGS's Geoprobe Rig. The subsurface analysis of stratigraphy included extending

tigraphy emphasizes facies relationships and stratal architecture within a chronological framework (Catuneanu and others, 2009).

Strategy for Performing the Investigation

Location and Geologic Setting

Hughes, 2010), to define and map surficial geologic units. This method combines a geomorphic interpretation of the relict Quaternary landscape with targeted subsurface analysis along profiles that transect geomorphic features. It is useful because the NC Coastal Plain is notorious for its low relief, few outcrops, lack of defined units and type sections, recurring facies, colluvium on side slopes, and extensive wetlands cover, even on uplands: bedrock mapping methods do not apply. To produce the map, landforms were interpreted from the highest resolution Light Detecting and Ranging (LiDAR) elevation data (20 cm). LiDAR tiles, as floating on depths for final publishing of the complete quadrangle. point ASCI files were downloaded from the Floodplain Mapping Program's website (www.ncfloodmaps.com). These were transformed from ASCI files to raster grids, mosaiced into 10 X 10 rasters, and reprojected as State Plane Nad 1983 meters. Hillshade, slope, and contour lines (1.0, 0.5, and 0.25 meters) were constructed Falkland (1/4) Quadrangle: NW Quadrant Significant findings from the mapping include: from the raster grids. Orthoimagery (2012, 2010) from the NCONEMAP was used in conjunction with elevation grid color ramps, contour lines, hillshade and slope to interpret landforms. Farrell and others (2003) summarize the method of comprehensive landscape analysis. A series of landform elements was interpreted and • The map area is in the vicinity of the Plio-Pleistocene Surry Paleoshoreline complex (shore elevation ~ 30 m MSL) at elevations ranging from ~34 to 9 m. Interdigitized starting with the Holocene depositional system and working backward in time into older landscapes. Key transects cross cutting the Surry paleoshoreline fluves are separated by incised valleys which have a continuous series of terraces that step down from uous cores (discrete sampling method) collected in 4-foot increments. Cores were logged using the methods of Farrell and others (2012, 2013). High-resolution photos terraces. Numerous Holocene/Pleistocene side drainages cross cut the older landscape, feeding directly into the wetland flat or to older terrace sets.

Geomorphic and Stratigraphic Description of Four Quadrangle Region (Figure 4)

of the boundary between the "Sunderland Terrace" (see Fig. 2) and the "Wicomico Terrace". This geomorphically complex area includes a variety of relict coastal position of about 15.5 m (50 ft). In this map area, the terrace set rises or steps up to 18 and 19 m flats. landforms and associated facies along its length. Associated features include barrier islands, beach and shoreface, beach ridge accretion plains, longshore bars, spits,

• Upland areas (+24 m) are very difficult to interpret geomorphically because of the existence of Carolina Bays. These bays likely formed as blow-outs of beach embayed areas, lagoons, tidal channels, etc. (see Farrell et al., 2003). Near the Surry shoreline complex, four, surficial, early Pleistocene units occur beneath upland, ridges. Map patterns for remobilized sands (from blowouts) may indicate elongate, shoreline-parallel ridges, separated by deflation surfaces, and lower-lying flats. tions. All four units are Early Pleistocene in age (Mixon et al., 1989), becoming successively younger in age towards the east. These may be conformable as indicated lina Bays and elsewhere by stratigraphic details observable in core and outcrop. All four units potentially include similar, repeating facies. The current study includes marine interfluve units

In the current map area, the Quaternary section is ~ 6 to 52 ft (12 – 20 m) thick, depending on geomorphic position. Refusal depth ranged from 11 - 50 ft (3.7 – associated with correlatives of the Windsor and Charles City Formations, and a number of terraces in the local incised drainages. The map deliverable shows two units, tentatively called Q wm (Windsor Formation, marine) and Q lzm (Lizzie Formation, marine; terraces are numbered in sequence. The nomenclature utilized hole by thixotropic marine units, and cemented zones and large impenetrable shells.

phy indicate slightly higher sea levels (34-35 m) associated with the shoreline complex. Two units are associated with the shoreline complex itself (28-34+ m): the deposit; other facies are present as well. The unit was virtually impenetrable with the Geoprobe below the upper two runs or so. Recent discussions with Dr. W. Windsor Formation and the Moorings unit. The Moorings unit is locally associated with barrier island facies. The Windsor outcrops surfically, east of the 30 m

Burleigh Harris were unable to identify this unit's age or formation equivalent. It is likely that pollen may assist in identifying this unit. The bottom line, however, is contour. It is notched and overlain by the Lizzie Formation near the 26 m contour. This particular geomorphic boundary occurs in the current map area. The sea that the substrate is impermeable. level maximum associated with the flooding event that formed the Surry paleoshoreline complex was likely at about 34 – 35 m, with a shoreline complex and embayed • The shallow refusal depths prompted NCGS to have the Geoprobe completely serviced this fiscal year in Florida, at Geoprobe Systems, Inc. Two geologists took coast between 34 and 28 m. A second near-occupation of the same shoreline features at about 26 m in the current map area, the boundary two trips from NC to FL to drop off and pick up the rig in late May, early June 2020. The serviced rig (new hammer and hydraulic system overhaul) has not been tested between "Windsor" and "Lizzie" Formations. Valleys incised into the marine Windsor (Q wm) and Lizzie (Q lzm) units include a group of Pleistocene terraces that yet to determine if penetration depth is improved. step down from 26 to 8 m in Falkland quadrangle.

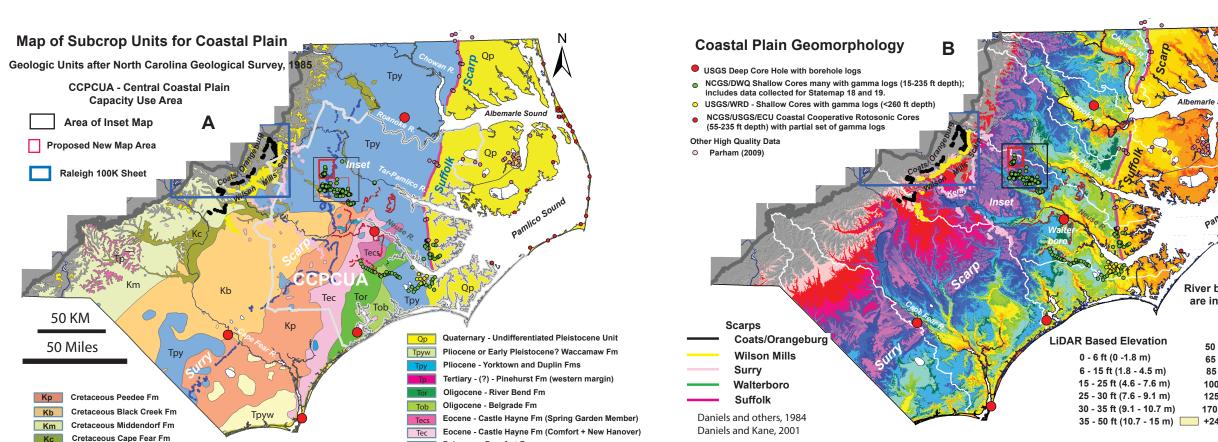
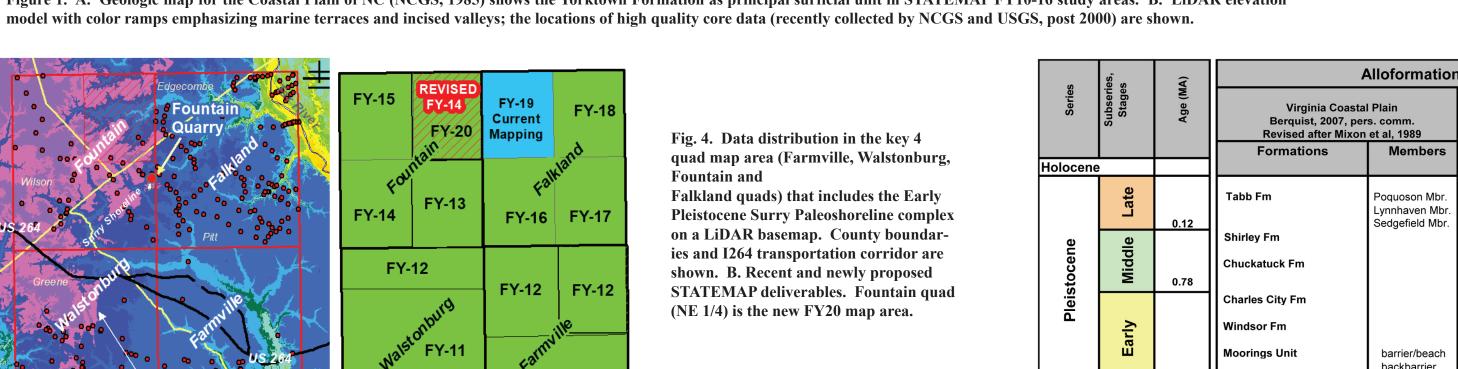
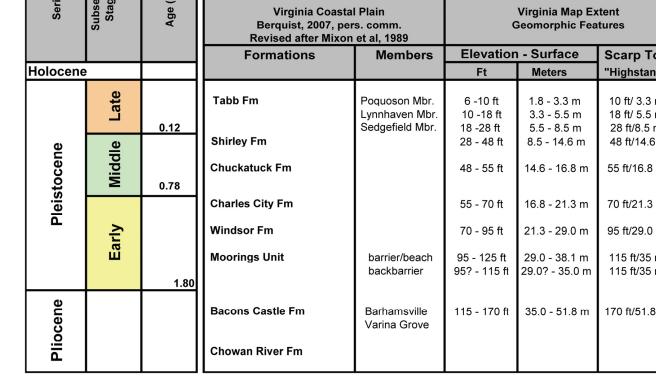


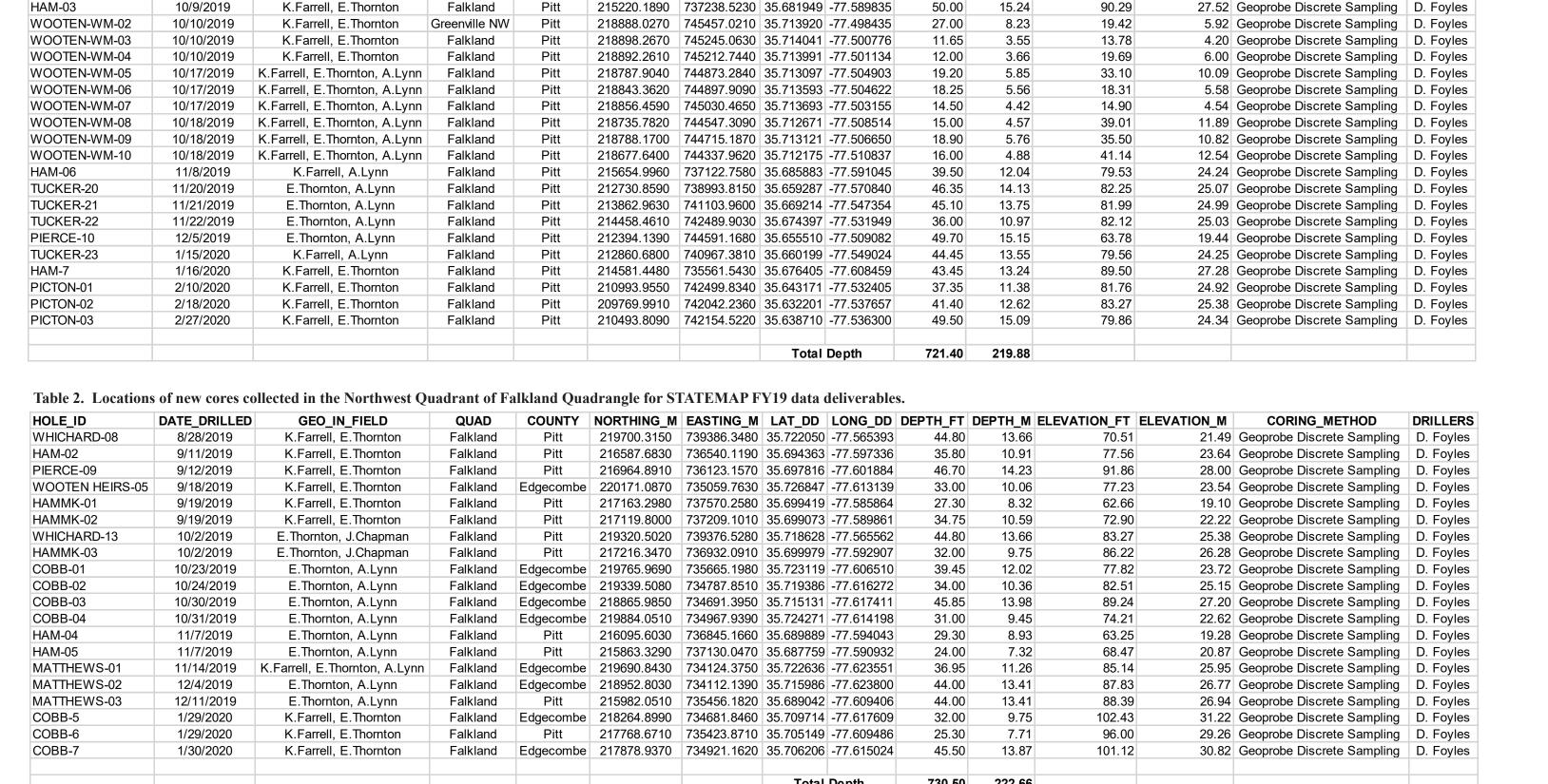
Table 1. Locations of new cores collected in the Southwest, Southeast, and Northeast Quadrants of Falkland Quadrangle for STATEMAP FY19 data deliverables.





00 Geoprobe Discrete Sampling D. Foyles

13.60 Geoprobe Discrete Sampling D. Foyles 21.47 Geoprobe Discrete Sampling D. F



Disclaimer: This Open-File Map is preliminary. It has been reviewed internally for conformity to this preliminary map may occur.

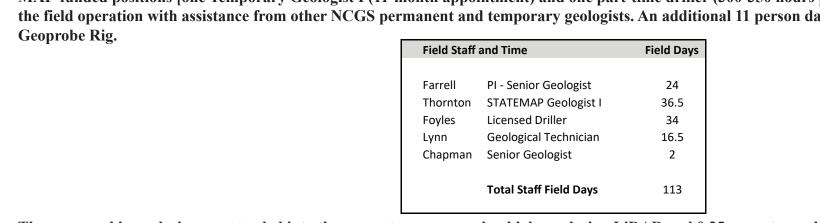
This geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program under StateMap award number G19AC00235, 2019. This map and explanatory information is submitted for publication with the understanding that the United States Government is authorized to reproduce and distribute reprints for governmental use. The views and

GEOLOGIC MAP WITH GEOMORPHIC LANDSCAPE ELEMENTS OF THE FALKLAND 7.5 MINUTE QUADRANGLE, NORTHWEST QUADRANT, NORTH CAROLINA

representing the official policies, either expressed or implied, of the U.S. Government.

Kathleen M. Farrell and Erik D. Thornton Geology mapped from July 2019 to June 2020. Landscape analysis, map preparation, digital cartography and editing by Kathleen M. Farrell.

New Geologic Mapping in the Coastal Plain, North Carolina The project deliverable is a PDF of the northwest quadrant of Falkland Quadrangle (1/4 quadrangle). This new map area is continuous with previous STATEMAP areas in Falkland, Fountain, Walstonburg and Farmville quadrangles (SM FY10-FY18). Both 1:24,000 and 1:12,000 scale maps are provided.



The Coastal Plain, a relict, Plio-Pleistocene landscape (Fig. 1B), consists of a series of progressively younger scarps, or paleoshorelines, and intervening terraces that

The geomorphic analysis was extended into the current map area using high resolution LiDAR and 0.25 m contours, hillshade and slope derived from bare earth, float-

Mapping was conducted in three or four person teams with 102 total staff field days. These included an NCGS staff Geologist (PI) and two temporary STATE-

Quadrangle		Stratigraphy			Geomorphology			
	Mapping Type		Coreholes		No. of Polygons	Linear Meters	% quad	Square miles
Falkland	Coastal Plain	44	44	1451.9	703	965.394	0.25	15

repeating facies, and fossils are rare. In Virginia (Mixon and others, 1989) these are the Moorings Unit and the Bacons Castle, Windsor, and Charles City Formations existing cross sections, and improving data density along existing cross sections. The deliverable includes one major (Fig. 5). In NC and VA, these correlative units occur within the shoreline complex, and both landward and seaward of it. These are not lithologically distinct bodies representative cross section that transections several geomorphic elements that range in elevation from about 102 ft to 60 ft. Additional cores were collected to provide of rock that are easily mappable; these are allo-units that are mapped by establishing bounding surfaces, their terminations, and the geologic facies above them. Our isopach and structure contour data for the Quaternary stratigraphy of the quadrangle. Signed permission forms were acquired from landowners prior to drilling. goal is to describe facies and establish units in a sequence stratigraphic context, and to determine the stratigraphy's relationship to surficial landforms. Sequence strategraphy's relationship to surficial landforms. access on hunt club lands that border the Tar River. Thirty-three (33) field days acquired 1451.9 ft core at forty-four (44) new borehole locations. Corehole depths ranged from 11 to 50 feet in depth. Recovery was greater than 85 percent. Deepest cores bottomed out in probable Paleogene or Cretaceous "basement". A total of 102

Geologic mapping in the NC Coastal Plain requires a non-traditional method, called three-dimensional (3D) subsurface mapping (see Newell and Dejong, 2010; and During drilling, cores were split, washed and described by using graphic (Farrell and others, 2012, 2013). Cores were photographed in the field with a cell phone; this As time permits, high-resolution graphic logs (1 inch = 1 foot) of core stratigraphy will be prepared in the lab; these logs are on par with methods of characterizing oil

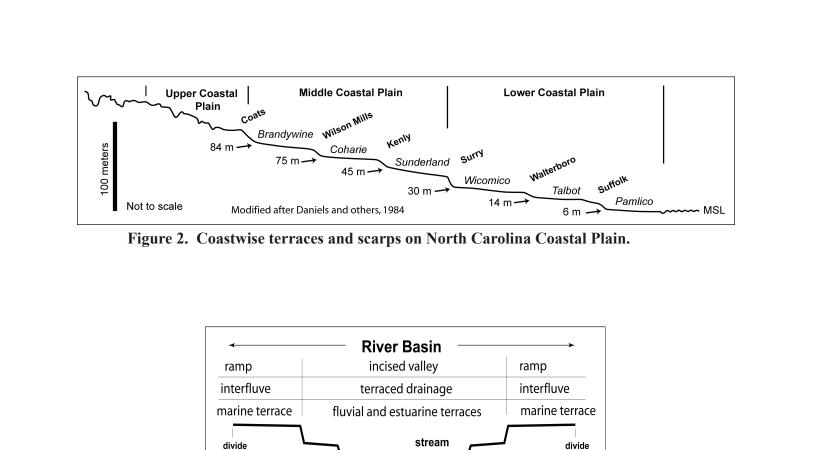
and gas reservoirs and permits direct correlation with gamma and resistivity logs; the field logs are adequate for this purpose as well, although will require a QA audit

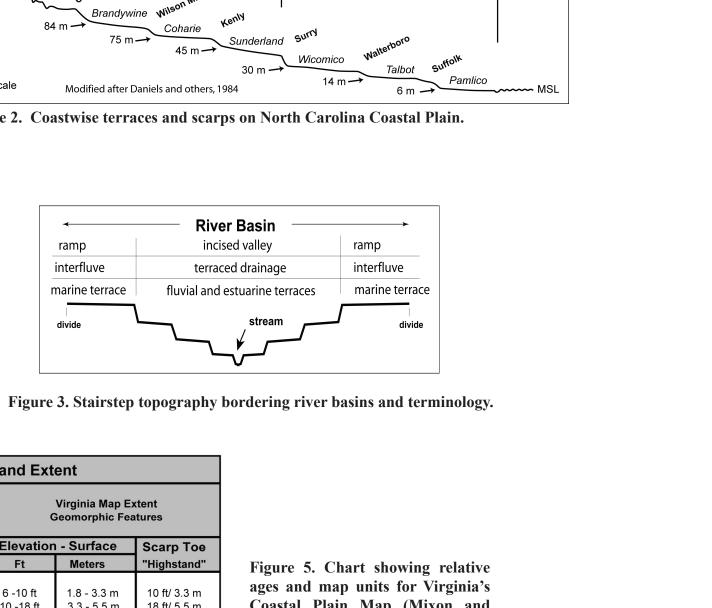
and other features were chosen for subsurface analysis. Geologic cores were acquired in plastic tubes with the Geoprobe drill rig. These are 1.5-inch diameter continof cores were compiled as photomosaics for archiving. Allostratigraphic units were defined on cross sections, and extrapolated regionally using geomorphic map. • The Early Pleistocene terrace-defined units step down in elevation from 30 to 20 m, at intervals of 1 to 2 m. Geomorphic contacts between these 'marine terrace-defined units step down in elevation from 30 to 20 m, at intervals of 1 to 2 m. Geomorphic contacts between these 'marine terrace-defined units step down in elevation from 30 to 20 m, at intervals of 1 to 2 m. Geomorphic contacts between these 'marine terrace-defined units step down in elevation from 30 to 20 m, at intervals of 1 to 2 m. Geomorphic contacts between these 'marine terrace-defined units step down in elevation from 30 to 20 m, at intervals of 1 to 2 m. Geomorphic contacts between these 'marine terrace-defined units step down in elevation from 30 to 20 m, at intervals of 1 to 2 m. Geomorphic contacts between these 'marine terrace-defined units step down in elevation from 30 to 20 m, at intervals of 1 to 2 m. Geomorphic contacts between these 'marine terrace-defined units step down in elevation from 30 to 20 m, at intervals of 1 to 2 m. Geomorphic contacts between these 'marine terrace-defined units step down in elevation from 30 to 20 m, at intervals of 1 to 2 m. Geomorphic contacts between these 'marine terrace-defined units step down in elevation from 30 to 20 m, at intervals of 1 to 2 m. Geomorphic contacts between these 'marine terrace-defined units step down in elevation from 30 to 20 m, at intervals of 1 to 2 m. Geomorphic contacts between these 'marine terrace-defined units step down in elevation from 30 to 20 m, at intervals of 1 to 2 m. Geomorphic contacts between the step down in elevation from 30 to 20 m, at intervals of 1 to 2 m. Geomorphic contacts between the step down in elevation from 30 to 20 m, at intervals of 1 to 2 m. Geomorphic contacts between the step down in elevation from 30 to 20 m. The step down in elevation from 30 to 20 m. The step down in elevation from are subtle with extensive colluvium commonly obscuring terrace borders; locally these transition into and cannot be separated from incised valley deposits. The "incised Terraces at less than 18 m in elevation are relatively easy to map geomorphically. A distinct set of terraces at ~14 m was mapped up the Otter Creek incised valley The southeast quadrant of Falkland is situated east of the Surry Palaeoshoreline Complex, mostly at elevations below 26 m, in a stratigraphically complex area east and other drainages into the current map area; this set of terraces morphs upstream into 16 m terraces. These may represent Middle Pleistocene deposits (highstand

predominantly marine flats: in adjacent Virginia, these are called the Bacons Castle Formation, Moorings Unit (informal), and the Windsor and Charles City Forma-

This year's drilling focused on characterizing major stratrigraphic contacts associated with geomorphic features, in particular, defining the incised Tar River Valley, and transitions from the upland terrace (30 m) down to the terraces at 6 m in elevation. The included cross section shows some of these relationships. In the four quad area, coastal landforms are preserved geomorphically between elevations of 26 and 34 meters. The toe of the Surry paleoshoreface is at about 28 m;

Coring the lower river terraces (5-10 meters) showed that the stratigraphy in the Tar River incised valley is very thin (2-5 m thick) and consists of Pleistocene. the main highstand elevation that explains most of the geomorphic features associated with the Surry Scarp is at about 30 m. Other landforms and surficial stratigra- gravelly sands. The sands are underlain by a very hard, consolidated, impermeable black or dark gray sandy mud with organic debris, that resembles a backswamp





others, 1989) This diagram does not incorporate revisions to the Pleisto-



Produced by the United States Geological Survey

..... U.S. Census Bureau, 2015 -

10 000-foot ticks: North Carolina Coordinate System of 1

Hydrography......National Hydrography Dat

Boundaries......Multiple sources; see metadata file 1972 -

Wetlands......FWS National Wetlands Inventory 1977 - 2014

conclusions contained in this document are those of the authors and should not be interpreted as necessarily

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1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

CONTOUR INTERVAL 5 FEET NORTH AMERICAN VERTICAL DATUM OF 1988

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Legend for Geologic Map Units - Geomorphic Landscape Elements

Man-Made Excavation - Pond or Lagoon, Mining Operations.

Man-Made Earthenware Structures - such as Spoil Piles from Mining and Dredging, Dams, Causeways through Wetlands. H wf--Wetland Flat (Holocene): Wetland flat at base of incised valleys; commonly with anastomosed channel network activated during flood stage, or a single main channel, which is commonly trenched and straightened by human activity; may exhibit lacustrine conditions. Basal quartz sand fines up into organic-rich sand and mud. Deposits are typically less than 3 m thick. Flat is typically flanked by colluvium, alluvial fan, and partly buried channel belts. It is partly incised into pre-exist-

ing deposits, and may be separated in stepwise fashion from other active wetland flats. Upstream, the flat narrows and is replaced by channel deposits or undifferentiated Quaternary alluvium. Typical facies include: muddy and sandy peat, gravelly sand and other facies. H wf2--Wetland Flat 2 (Holocene - reactivated Pleistocene flat): Wetland flat that merges with the Hwf in upstream reaches of incised valleys. In some cases, H wf2 is separated vertically by a step-like feature from H wf. An incised channel may connect the two wetland flats. In other cases, the two flats gradually merge in upstream reaches. H wf2 is dryer than H wf; it may be continuous with a set of valley fill terraces. Not systematically mapped on this quadrant yet.

H sc--Side valley colluvium, slightly higher Holocene facies, positioned marginal to wetland flat; may include side bars and lunate bars associcated with channels.

H s--Sinkhole (Holocene): Incipient ovate depression that is commonly incised into surrounding landscape; may occur in conjunction with depressions in centers

Untifferentiated Quaternary Deposits:

Q urs: Undifferentiated remobilized sands that usually on interfluve flats such as the 24-26 m marine terraces.

Untifferentiated Pleistocene Depositional Systems including Valley Fill and Falling Stage Deposits:

Qal Undifferentiated Quaternary Alluvium - currently active landscape. Includes the Holocene material in side valleys and on alluvial fans and colluvium on side slopes.

Qt0 Pleistocene Valley Fill Terrace @ 13-17 m on Falkland NW.

Qt1 Pleistocene Valley Fill Terrace @ 15-21 m on Falkland NW. Very distinct flat terrace mapped downstream to 11 m on Falkland SE. May be Middle Pleistocene.

Qt2 Pleistocene Valley FillTerrace @ 16-20 m on Falkland NW.

Qt3 Pleistocene Valley Fill Terrace @ 17-22 m on Falkland NW.

Qt4 Pleistocene Valley Fill Terrace @ 21-23.5 m on Falkland NW.

Qt5 Early Pleistocene Valley Fill Terrace @ 23-25 m on Falkland NW; merges downstream with marine terrace Q lzm2.

Qt6 Early Pleistocene Valley Terrace @ 25-26.5 m; merges with marine terrace equivalent Q lzm1.

Q lzm1 (Qt6): Early Pleistocene marine terrace that extends from 26.5 meters to 24.5 m.

Qt7 Early Pleistocene shoreline features @ 25.2-27.2 m; marks shoreline of Q lzm1 marine terrace.

Qt8 Early Pleistocene marine terrace @ 27-29 m.

Qt9 Early Pleistocene marine terrace @ 29-31 m.

Qt10 Early Pleistocene marine terrace - topographic lows to emphasize Carolina Bays.

