NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF ENERGY, MINERAL AND LAND RESOURCES

Dr. KENNETH B. TAYLOR PG, STATE GEOLOGIST

BRIAN WRENN, DIVISION DIRECTOR

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Introduction

The Atlantic Coastal Plain of eastern North Carolina (Fig. 1) is poorly understood from scientific, stratigraphic, and mapping perspectives. It is mantled primarily by Pliocene and Pleistocene deposits that have map extents, allostratigraphy, and relationships to global sea level cycles that are mostly undefined. Outcrops are rare, 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 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.

Location and Geologic Setting

The Coastal Plain, a relict, Plio-Pleistocene landscape (Fig. 1B), consists of a series of progressively younger scarps, or paleoshorelines, and intervening terraces that 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 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 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 (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 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 goal is to describe facies and establish units in a sequence stratigraphic context, and to determine the stratigraphy's relationship to surficial landforms. Sequence stratigraphy emphasizes facies relationships and stratal architecture within a chronological framework (Catuneanu and others, 2009).

Strategy for Performing the Investigation

Geologic mapping in the NC Coastal Plain requires a non-traditional method, called three-dimensional (3D) subsurface mapping (see Newell and Dejong, 2010; and 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 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 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 digitized starting with the Holocene depositional system and working backward in time into older landscapes. Key transects cross cutting the Surry paleoshoreline 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 continuous cores (discrete sampling method) collected in 4-foot increments. Cores were logged using the methods of Farrell and others (2012, 2013). High-resolution photos of cores were compiled as photomosaics for archiving. Allostratigraphic units were defined on cross sections, and extrapolated regionally using geomorphic map. Data locations were collected using GPS.

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

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 of the boundary between the "Sunderland Terrace" (see Fig. 2) and the "Wicomico Terrace". This geomorphically complex area includes a variety of relict coastal landforms and associated facies along its length. Associated features include barrier islands, beach and shoreface, beach ridge accretion plains, longshore bars, spits, embayed areas, lagoons, tidal channels, etc. (see Farrell et al., 2003). Near the Surry shoreline complex, four, surficial, early Pleistocene units occur beneath upland, predominantly marine flats: in adjacent Virginia, these are called the Bacons Castle Formation, Moorings Unit (informal), and the Windsor and Charles City Formations. 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 by stratigraphic details observable in core and outcrop. All four units potentially include similar, repeating facies. The current study includes marine interfluve units 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 here is considered draft only.

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; 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 stratigraphy 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 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 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 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 coast between 34 and 28 m. A second near-occupation of the same shoreline formed the shoreline features at about 26 m in the current map area, the boundary 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 step down from 26 to 8 m in Falkland quadrangle.

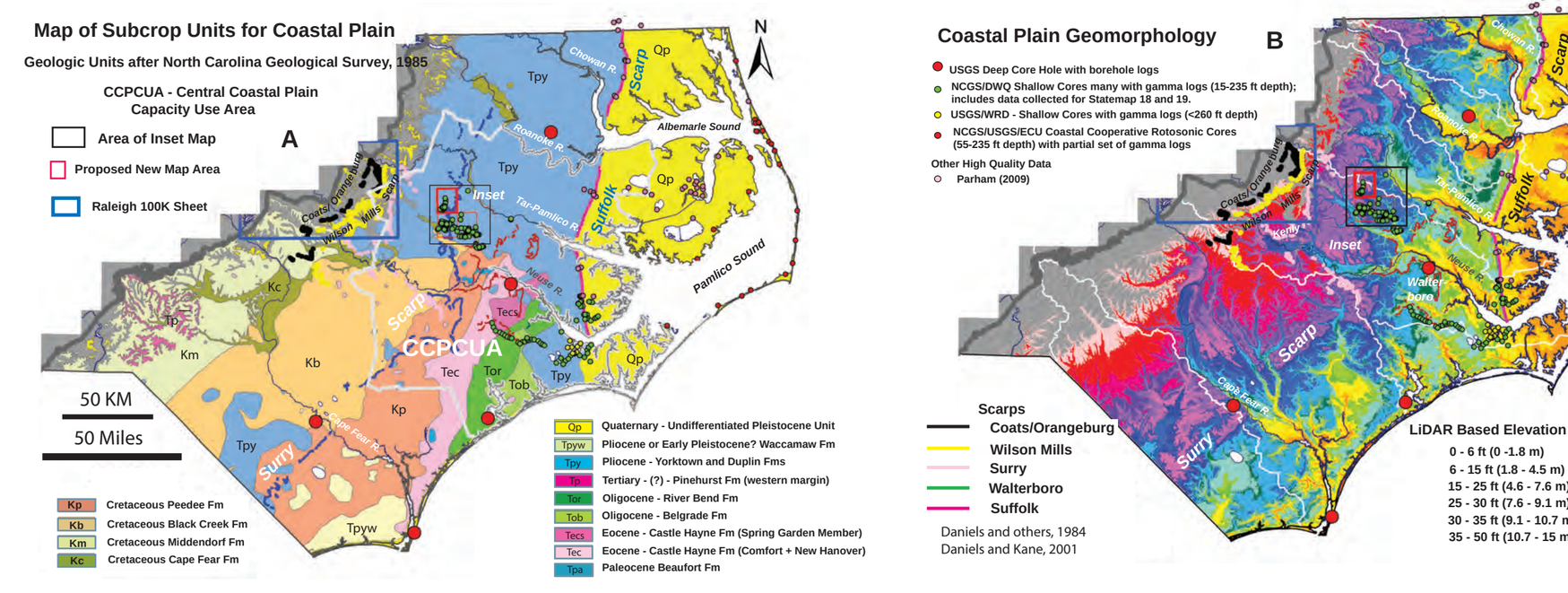


Figure 1. A. Geologic map for the Coastal Plain of NC (NCGS, 1985) shows the Yorktown Formation as principal surficial unit in STATEMAP FY10-16 study areas. B. LiDAR elevation model with color ramps emphasizing marine terraces and incised valleys; the locations of high quality core data (recently collected by NCGS and USGS, post 2000) are shown.

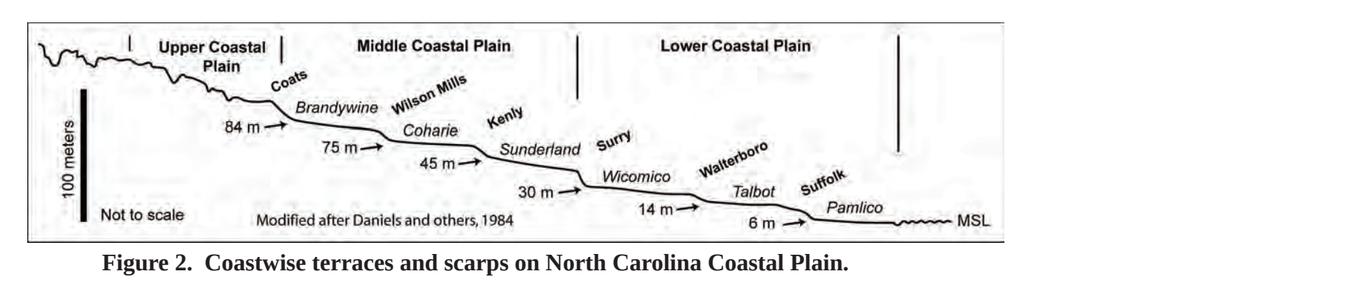


Figure 2. Coastwise terraces and scarps on North Carolina Coastal Plain.

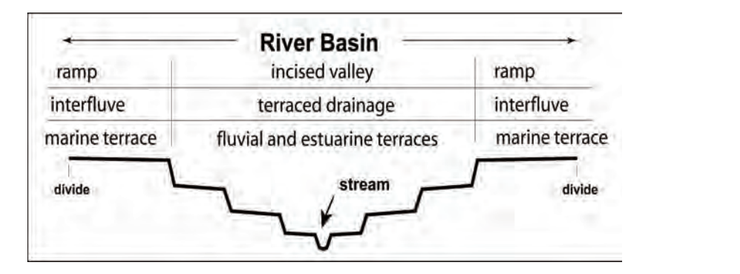


Figure 3. Stairstep topography bordering river basins and terminology.

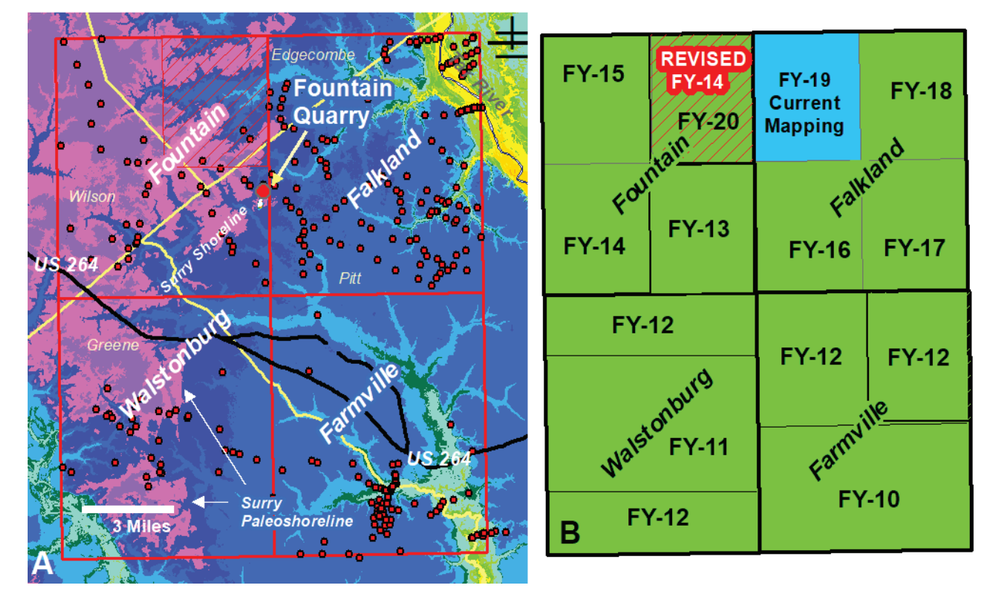


Fig. 4. Data distribution in the key 4 quad map area (Farmville, Walstonburg, Fountain and Falkland quads) that includes the Early Pleistocene Surry Paleoshoreline complex on a LiDAR basemap. County boundaries and I264 transportation corridor are shown. B. Recent and newly proposed STATEMAP deliverables. Fountain quad (NE 1/4) is the new FY20 map area.

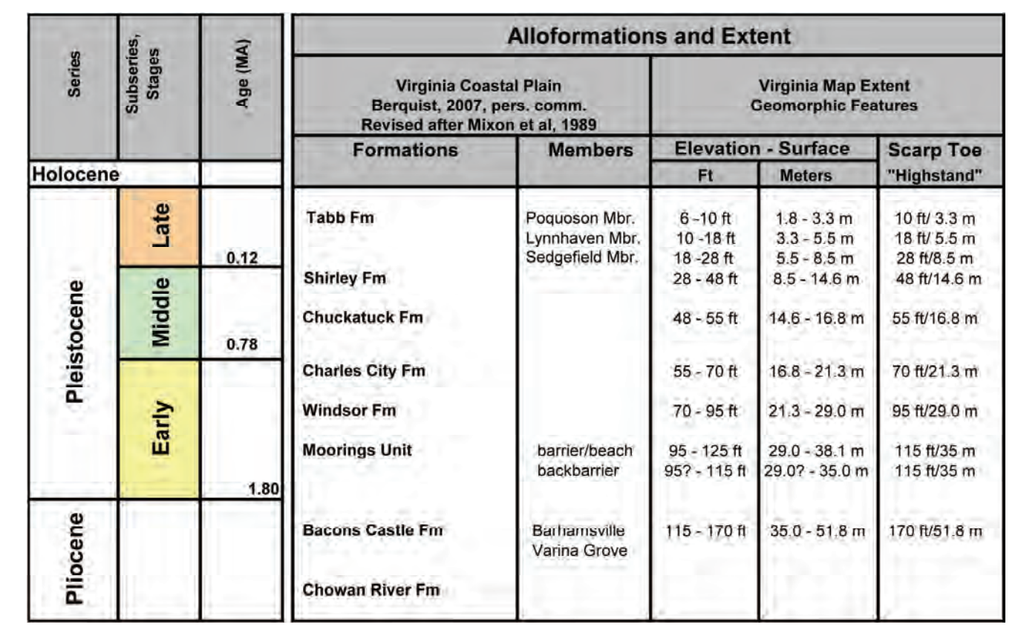


Figure 5. Chart showing relative ages and map units for Virginia's Coastal Plain Map (Mixon and others, 1989) This diagram does not incorporate revisions to the Pleistocene proposed by Gibbard and others (2010).

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

WHICHARD-09	8/29/2019	K.Farrell, E.Thornton	Falkland	Pitt	220224.5350	739881.1990	35.726710	-77.559840	18.50	5.64	46.75	14.25	Geoprobe Discrete Sampling	D. Foyles
WHICHARD-10	8/29/2019	K.Farrell, E.Thornton	Falkland	Pitt	220106.2660	739969.3060	35.725632	-77.558885	19.90	6.07	49.21	15.00	Geoprobe Discrete Sampling	D. Foyles
WHICHARD-11	9/4/2019	K.Farrell, E.Thornton	Falkland	Pitt	220159.4470	739938.3490	35.726116	-77.559219	15.20	4.63	44.62	13.60	Geoprobe Discrete Sampling	D. Foyles
WHICHARD-12	9/4/2019	K.Farrell, E.Thornton	Falkland	Pitt	219931.2440	739641.8830	35.724098	-77.562532	32.50	9.91	70.44	21.47	Geoprobe Discrete Sampling	D. Foyles
HAM-03	10/9/2019	K.Farrell, E.Thornton	Falkland	Pitt	215220.1890	737238.5230	35.681949	-77.589835	50.00	15.24	90.29	27.52	Geoprobe Discrete Sampling	D. Foyles
WOOTEN-WM-02	10/10/2019	K.Farrell, E.Thornton	Greenville NW	Pitt	218888.0270	745457.0210	35.713920	-77.498435	27.00	8.23	19.42	5.92	Geoprobe Discrete Sampling	D. Foyles
WOOTEN-WM-03	10/10/2019	K.Farrell, E.Thornton	Falkland	Pitt	218898.2670	745245.0630	35.714041	-77.500776	11.65	3.55	13.78	4.20	Geoprobe Discrete Sampling	D. Foyles
WOOTEN-WM-04	10/10/2019	K.Farrell, E.Thornton	Falkland	Pitt	218892.2610	745212.7440	35.713991	-77.501134	12.00	3.66	19.69	6.00	Geoprobe Discrete Sampling	D. Foyles
WOOTEN-WM-05	10/17/2019	K.Farrell, E.Thornton, A.Lynn	Falkland	Pitt	218787.9040	744873.2840	35.713097	-77.504903	19.20	5.85	33.10	10.09	Geoprobe Discrete Sampling	D. Foyles
WOOTEN-WM-06	10/17/2019	K.Farrell, E.Thornton, A.Lynn	Falkland	Pitt	218843.3620	744897.9090	35.713593	-77.504622	18.25	5.56	18.31	5.58	Geoprobe Discrete Sampling	D. Foyles
WOOTEN-WM-07	10/17/2019	K.Farrell, E.Thornton, A.Lynn	Falkland	Pitt	218856.4590	745030.4650	35.713693	-77.503155	14.50	4.42	14.90	4.54	Geoprobe Discrete Sampling	D. Foyles
WOOTEN-WM-08	10/18/2019	K.Farrell, E.Thornton, A.Lynn	Falkland	Pitt	218735.7820	744547.3090	35.712671	-77.508514	15.00	4.57	39.01	11.89	Geoprobe Discrete Sampling	D. Foyles
WOOTEN-WM-09	10/18/2019	K.Farrell, E.Thornton, A.Lynn	Falkland	Pitt	218788.1700	744715.1870	35.713121	-77.506650	18.90	5.76	35.50	10.82	Geoprobe Discrete Sampling	D. Foyles
WOOTEN-WM-10	10/18/2019	K.Farrell, E.Thornton, A.Lynn	Falkland	Pitt	218677.6400	744337.9620	35.712175	-77.510837	16.00	4.88	41.14	12.54	Geoprobe Discrete Sampling	D. Foyles
HAM-06	11/8/2019	K.Farrell, A.Lynn	Falkland	Pitt	215654.9960	737122.7580	35.685883	-77.591045	39.50	12.04	79.53	24.24	Geoprobe Discrete Sampling	D. Foyles
TUCKER-20	11/20/2019	E.Thornton, A.Lynn	Falkland	Pitt	212730.8590	738993.8150	35.659287	-77.570840	46.35	14.13	82.25	25.07	Geoprobe Discrete Sampling	D. Foyles
TUCKER-21	11/21/2019	E.Thornton, A.Lynn	Falkland	Pitt	213862.9630	741103.9600	35.669214	-77.547354	45.10	13.75	81.99	24.99	Geoprobe Discrete Sampling	D. Foyles
TUCKER-22	11/22/2019	E.Thornton, A.Lynn	Falkland	Pitt	214458.4610	742489.9030	35.674397	-77.531949	36.00	10.97	82.12	25.03	Geoprobe Discrete Sampling	D. Foyles
PIERCE-10	12/5/2019	E.Thornton, A.Lynn	Falkland	Pitt	212394.1390	744591.1680	35.655510	-77.509082	49.70	15.15	63.78	19.44	Geoprobe Discrete Sampling	D. Foyles
TUCKER-23	1/15/2020	K.Farrell, A.Lynn	Falkland	Pitt	212860.6800	740967.3810	35.660199	-77.549024	44.45	13.55	79.56	24.25	Geoprobe Discrete Sampling	D. Foyles
HAM-7	1/16/2020	K.Farrell, E.Thornton	Falkland	Pitt	214581.4480	735561.5430	35.676405	-77.608459	43.45	13.24	89.50	27.28	Geoprobe Discrete Sampling	D. Foyles
PICTON-01	2/10/2020	K.Farrell, E.Thornton	Falkland	Pitt	210993.9550	742499.8340	35.643171	-77.532405	37.35	11.38	81.76	24.92	Geoprobe Discrete Sampling	D. Foyles
PICTON-02	2/18/2020	K.Farrell, E.Thornton	Falkland	Pitt	209769.9910	742042.2360	35.632201	-77.537657	41.40	12.62	83.27	25.38	Geoprobe Discrete Sampling	D. Foyles
PICTON-03	2/27/2020	K.Farrell, E.Thornton	Falkland	Pitt	210493.8090	742154.5220	35.638710	-77.536300	49.50	15.09	79.86	24.34	Geoprobe Discrete Sampling	D. Foyles
							Total Depth		721.40	219.88				

Table 2. Locations of new cores collected in the Northwest Quadrant of Falkland Quadrangle for STATEMAP FY19 data deliverables.

HOLE_ID	DATE_DRILLED	GEO_IN_FIELD	QUAD	COUNTY	NORTHING_M	EASTING_M	LAT_DD	LONG_DD	DEPTH_FT	DEPTH_M	ELEVATION_FT	ELEVATION_M	CORING_METHOD	DRILLERS
WHICHARD-08	8/28/2019	K.Farrell, E.Thornton	Falkland	Pitt	219700.3150	739386.3480	35.722050	-77.565393	44.80	13.66	70.51	21.49	Geoprobe Discrete Sampling	D. Foyles
HAM-02	9/11/2019	K.Farrell, E.Thornton	Falkland	Pitt	216587.6830	736540.1190	35.694363	-77.597336	35.80	10.91	77.56	23.64	Geoprobe Discrete Sampling	D. Foyles
PIERCE-09	9/12/2019	K.Farrell, E.Thornton	Falkland	Pitt	216964.8910	736123.1570	35.697816	-77.601884	46.70	14.23	91.86	28.00	Geoprobe Discrete Sampling	D. Foyles
WOOTEN HEIRS-05	9/18/2019	K.Farrell, E.Thornton	Falkland	Edgecombe	220171.0870	735059.7630	35.726847	-77.613139	33.00	10.06	77.23	23.54	Geoprobe Discrete Sampling	D. Foyles
HAMMK-01	9/19/2019	K.Farrell, E.Thornton	Falkland	Pitt	217163.2980	737570.2580	35.699419	-77.585864	27.30	8.32	62.66	19.10	Geoprobe Discrete Sampling	D. Foyles
HAMMK-02	9/19/2019	K.Farrell, E.Thornton	Falkland	Pitt	217119.8000	737209.1010	35.699073	-77.589861	34.75	10.59	72.90	22.22	Geoprobe Discrete Sampling	D. Foyles
WHICHARD-13	10/2/2019	E.Thornton, J.Chapman	Falkland	Pitt	219320.5020	739376.5280	35.718628	-77.565562	44.80	13.66	83.27	25.38	Geoprobe Discrete Sampling	D. Foyles
HAMMK-03	10/2/2019	E.Thornton, J.Chapman	Falkland	Pitt	217216.3470	736932.0910	35.699979	-77.592907	32.00	9.75	86.22	26.28	Geoprobe Discrete Sampling	D. Foyles
COBB-01	10/23/2019	E.Thornton, A.Lynn	Falkland	Edgecombe	219765.9690	735665.1980	35.723119	-77.606510	39.45	12.02	77.82	23.72	Geoprobe Discrete Sampling	D. Foyles
COBB-02	10/24/2019	E.Thornton, A.Lynn	Falkland	Edgecombe	219339.5080	734787.8510	35.719386	-77.616272	34.00	10.36	82.51	25.15	Geoprobe Discrete Sampling	D. Foyles
COBB-03	10/30/2019	E.Thornton, A.Lynn	Falkland	Edgecombe	218865.9850	734691.3950	35.715131	-77.617411	45.85	13.98	89.24	27.20	Geoprobe Discrete Sampling	D. Foyles
COBB-04	10/31/2019	E.Thornton, A.Lynn	Falkland	Edgecombe	219884.0510	734967.9390	35.724271	-77.614198	31.00	9.45	74.21	22.62	Geoprobe Discrete Sampling	D. Foyles
HAM-04	11/7/2019	E.Thornton, A.Lynn	Falkland	Pitt	216095.6030	736845.1660	35.689889	-77.594043	29.30	8.93	63.25	19.28	Geoprobe Discrete Sampling	D. Foyles
HAM-05	11/7/2019	E.Thornton, A.Lynn	Falkland	Pitt	215863.3290	737130.0470	35.687759	-77.590932	24.00	7.32	68.47	20.87	Geoprobe Discrete Sampling	D. Foyles
MATTHEWS-01	11/14/2019	K.Farrell, E.Thornton, A.Lynn	Falkland	Edgecombe	219690.8430	734124.3750	35.722636	-77.623551	36.95	11.26	85.14	25.95	Geoprobe Discrete Sampling	D. Foyles
MATTHEWS-02	12/4/2019	E.Thornton, A.Lynn	Falkland	Edgecombe	218952.8030	734112.1390	35.715986	-77.623800	44.00	13.41	87.83	26.77	Geoprobe Discrete Sampling	D. Foyles
MATTHEWS-03	12/11/2019	E.Thornton, A.Lynn	Falkland	Pitt	215982.0510	735456.1820	35.689042	-77.609406	44.00	13.41	88.39	26.94	Geoprobe Discrete Sampling	D. Foyles
COBB-5	1/29/2020	K.Farrell, E.Thornton	Falkland	Edgecombe	218264.8990	734681.8460	35.709714	-77.617609	32.00	9.75	102.43	31.22	Geoprobe Discrete Sampling	D. Foyles
COBB-6	1/29/2020	K.Farrell, E.Thornton	Falkland	Pitt	217768.6710	735423.8710	35.705149	-77.609486	25.30	7.71	96.00	29.26	Geoprobe Discrete Sampling	D. Foyles
COBB-7	1/30/2020	K.Farrell, E.Thornton	Falkland	Edgecombe	217878.9370	734921.1620	35.706206	-77.615024	45.50	13.87	101.12	30.82	Geoprobe Discrete Sampling	D. Foyles
							Total Depth		730.50	222.66				

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.

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 STATEMAP-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 the field operation with assistance from other NCGS permanent and temporary geologists. An additional 11 person days were spent mobilizing and maintaining the Geoprobe Rig.

Field Staff and Time		Field Days
Farrell	PI - Senior Geologist	24
Thornton	STATEMAP Geologist I	36.5
Foyles	Licensed Driller	34
Lynn	Geological Technician	16.5
Chapman	Senior Geologist	2
	Total Staff Field Days	113

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, floating point data, using Spatial and 3D Analysis. About 703 polygons were mapped with a total linear circumference of about 965,394 m.

Quadrangle	Mapping Type	Stratigraphy Stations	Coreholes	Total Footage	Geomorphology No. of Polygons	Linear Meters	% quad	Square miles
Falkland	Coastal Plain	44	44	1451.9	703	965,394	0.25	15

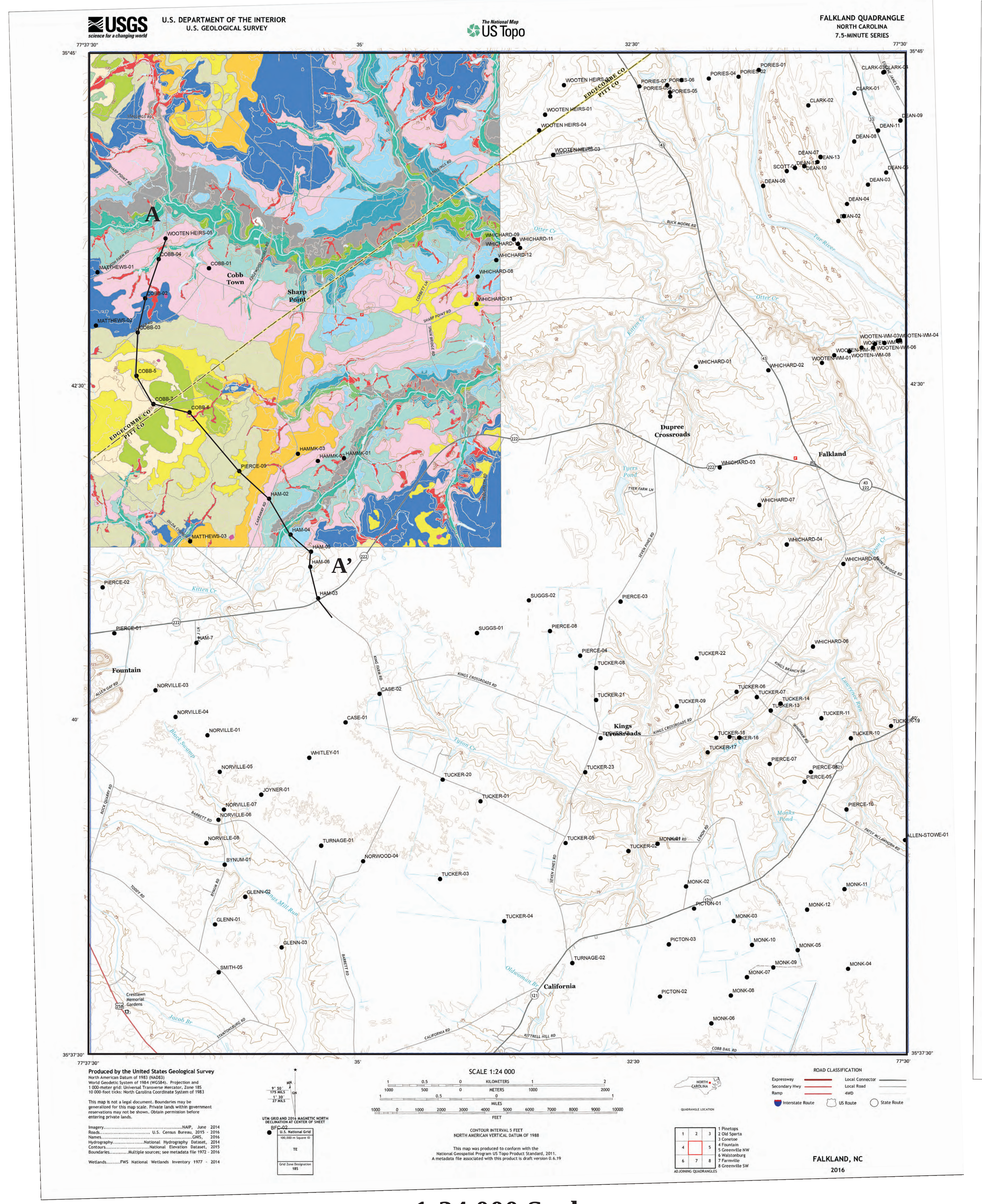
The geomorphic analysis provided a guideline for planning new core holes using the NCGS's Geoprobe Rig. The subsurface analysis of stratigraphy included extending existing cross sections from adjacent map areas, starting new cross sections, and improving data density along existing cross sections. The deliverable includes one major 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 isopach and structure contour data for the Quaternary stratigraphy of the quadrangle. Signed permission forms were acquired from landowners prior to drilling. Coring with the Geoprobe extended from September 2019 to February 2020. Rainfall and flooding were major obstacles to planning field work this fiscal year, as was 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 person days were spent in the field.

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 worked well as a first cut in core photography. Cross sections were constructed from the field logs in Adobe Illustrator.

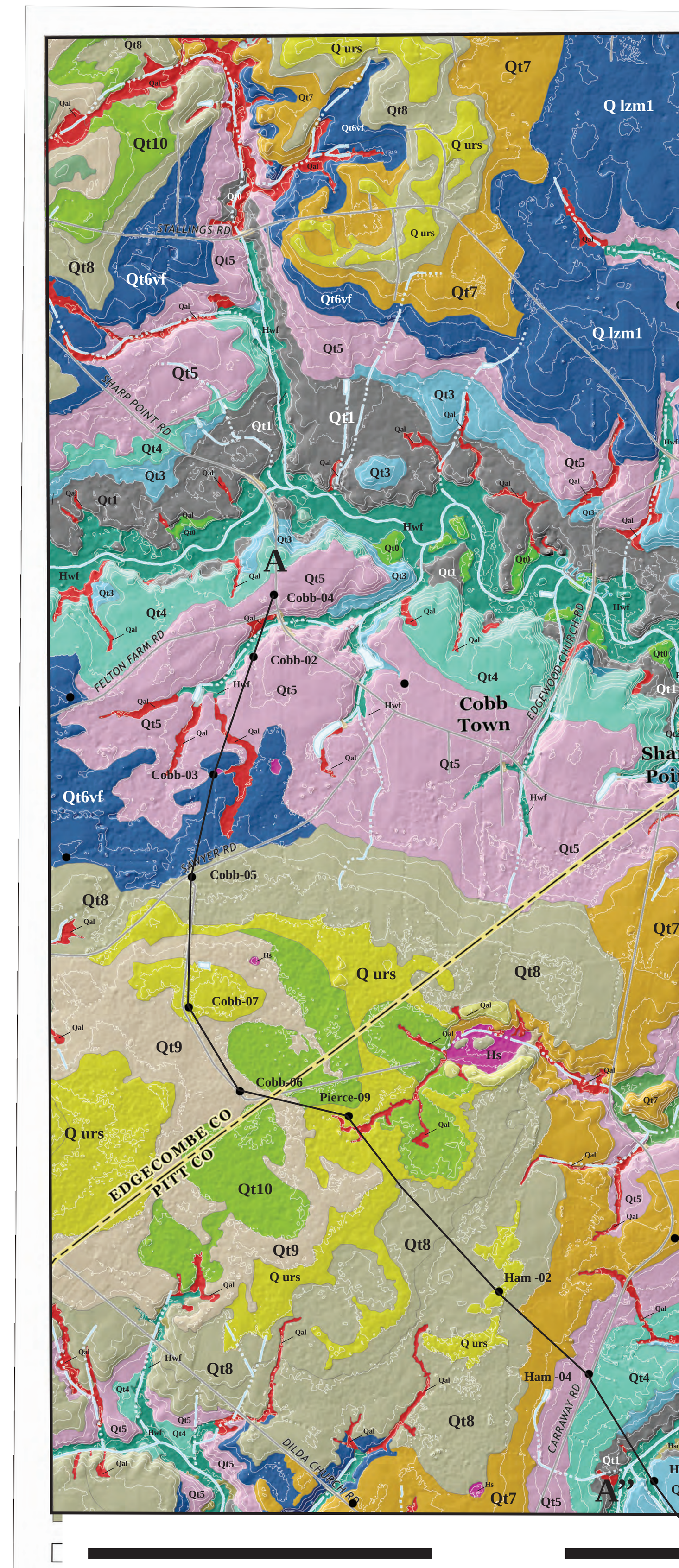
As time permits, high-resolution graphic logs (1 inch = 1 foot) of core stratigraphy will be prepared in the lab; these logs are on par with methods of characterizing oil and gas reservoirs and permits direct correlation with gamma and resistivity logs; the field logs are adequate for this purpose as well, although will require a QA audit on depths for final publishing of the complete quadrangle.

Falkland (1/4) Quadrangle: NW Quadrant Significant findings from the mapping include:

- 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. Interfluves range in elevation from ~ 34 m (northwest) to ~25 m. Interfluves are separated by incised valleys which have a continuous series of terraces that step down from ~30 m to ~ 12 m. The bottom of drainages includes a Holocene wetland flat at 10 to 18 m, that gradually rises in elevation in an upstream direction, burying Pleistocene terraces. Numerous Holocene/Pleistocene side drainages cross cut the older landscape, feeding directly into the wetland flat or to older terrace sets.
- 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 terraces' are subtle with extensive colluvium commonly obscuring terrace borders; locally these transition into and cannot be separated from incised valley deposits. The "incised valley" loses its incised geomorphic character as sea-level drops stepwise and subtly into the incipiently forming incised valley. This is especially characteristic at elevations of 26.5 to 22 m.
- 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 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 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.
- 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 ridges. Map patterns for remobilized sands (from blowouts) may indicate elongate, shoreline-parallel ridges, separated by deflation surfaces, and lower-lying flats. Terrace boundaries are difficult to identify because of multiple episodes of blowouts. Sinkholes with springs or lakes occur within some of the blowout areas of the Carolina Bays and elsewhere.
- 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 – 16.4 m). Refusal was caused by encountering semi-consolidated substrate (Paleogene or Cretaceous), collapse of loose shells, sands and gravels into corehole, closing of hole by thixotropic marine units, and cemented zones and large impenetrable shells.
- 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.
- 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 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 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. 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 that the substrate is impermeable.
- The shallow refusal depths prompted NCGS to have the Geoprobe completely serviced this fiscal year in Florida, at Geoprobe Systems, Inc. Two geologists took 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 yet to determine if penetration depth is improved.



1:24,000 Scale



1 Mile

2 Kilometers

1:12,000 Scale

CONTOUR INTERVAL = 1 METER

Legend for Geologic Map Units - Geomorphic Landscape Elements

Holocene

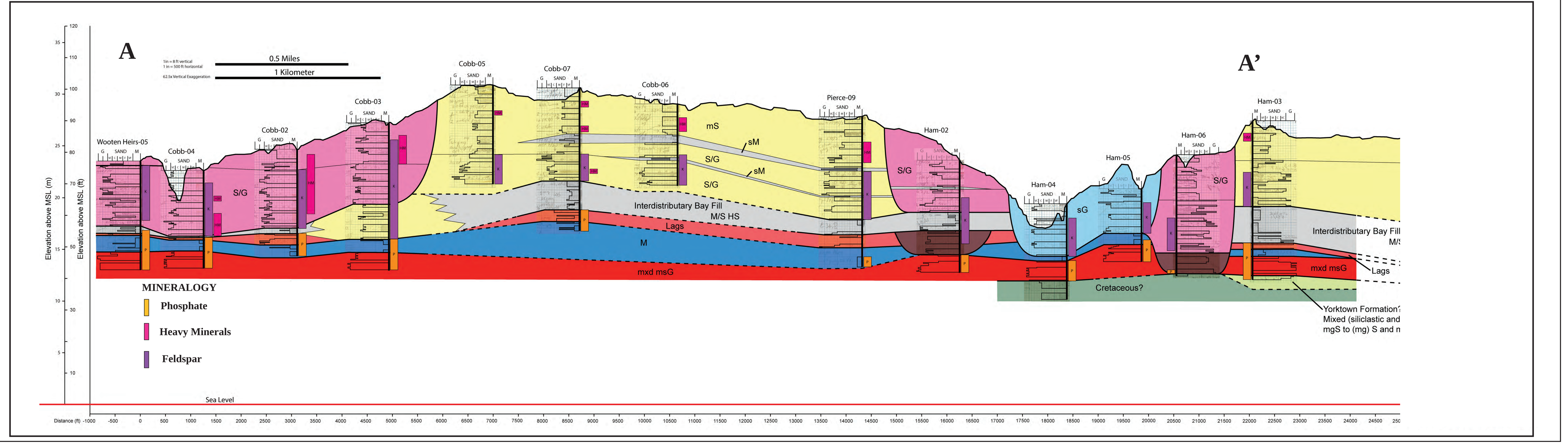
Unit	Description
	Stream Channel
	Man-Made Excavation - Pond or Lagoon, Mining Operations.
	Man-Made Earthenware Structures - such as Spoil Piles from Mining and Dredging, Dams, Causeways through Wetlands.
H wf	H wf--Wetland Flat (Holocene): Wetland flat at base of incised valleys; commonly with anastomosed 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-existing 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	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	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	H s--Sinkhole (Holocene): Incipient ovate depression that is commonly incised into surrounding landscape; may occur in conjunction with depressions in centers of Carolina Bays.

Untifferentiated Quaternary Deposits:

Unit	Description
Q urs	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:

Unit	Description
Qal	Qal Undifferentiated Quaternary Alluvium - currently active landscape. Includes the Holocene material in side valleys and on alluvial fans and colluvium on side slopes.
Qt0	Qt0 Pleistocene Valley Fill Terrace @ 13-17 m on Falkland NW.
Qt1	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	Qt2 Pleistocene Valley FillTerrace @ 16-20 m on Falkland NW.
Qt3	Qt3 Pleistocene Valley Fill Terrace @ 17-22 m on Falkland NW.
Qt4	Qt4 Pleistocene Valley Fill Terrace @ 21-23.5 m on Falkland NW.
Qt5	Qt5 Early Pleistocene Valley Fill Terrace @ 23-25 m on Falkland NW; merges downstream with marine terrace Q lzm2.
Qt6 vf	Qt6 Early Pleistocene Valley Terrace @ 25-26.5 m; merges with marine terrace equivalent Q lzm1.
Q lzm1	Q lzm1 (Qt6): Early Pleistocene marine terrace that extends from 26.5 meters to 24.5 m.
Qt7	Qt7 Early Pleistocene shoreline features @ 25.2-27.2 m; marks shoreline of Q lzm1 marine terrace.
Qt8	Qt8 Early Pleistocene marine terrace @ 27-29 m.
Qt9	Qt9 Early Pleistocene marine terrace @ 29-31 m.
Qt10	Qt10 Early Pleistocene marine terrace - topographic lows to emphasize Carolina Bays.



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

By
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.

2020