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

KENNETH B. TAYLOR, STATE GEOLOGIST

NORTH CAROLINA GEOLOGICAL SURVEY
OPEN FILE REPORT 2018-13

Introduction

Location and Geologic Setting

... 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.

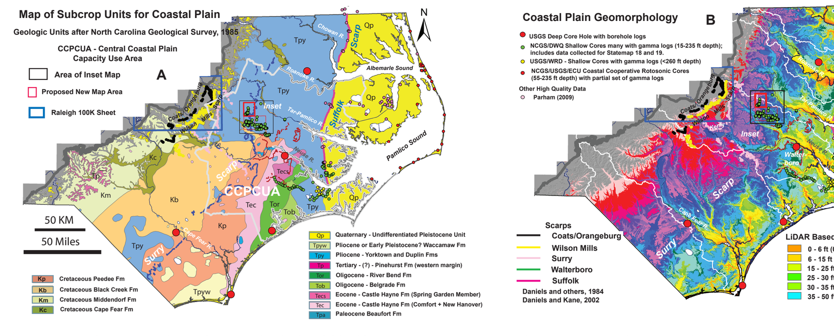


Figure 1. A. Geologic map for the Coastal Plain of NC (NCGS, 1985) shows the Yorktown Formation as principal surficial unit in STATEMAP FY16-16 study areas. B. LiDAR elevation model with color ramps emphasizing marine terraces and incised valleys; the locations of high quality core data (recently collected by NCGS and USGS, post 2008) are shown.

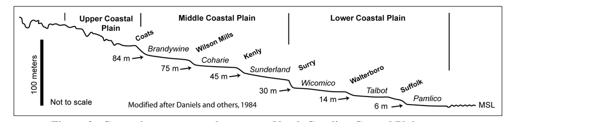


Figure 2. Coastwise terraces and scarps on North Carolina Coastal Plain.

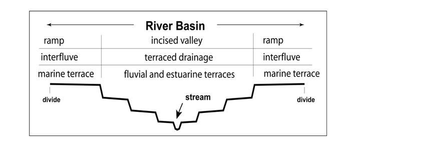


Figure 3. Stairstep topography bordering river basins and terminology.

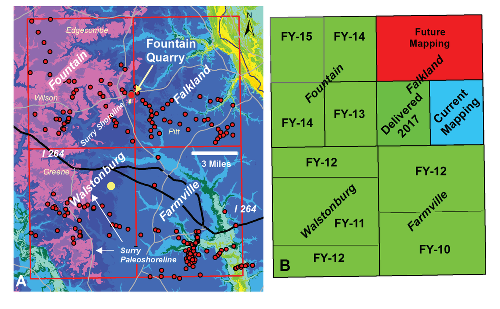


Fig. 4. Data distribution in the key 4 quad map area (Farmville, Walstonburg, Fountain and Falkland quads) that includes the Surry Pleistocene Surry Paleoshoreline complex on a LiDAR basemap. County boundaries and I264 transportation corridor are shown. B. Recent and newly proposed STATEMAP deliverables. Falkland quad (SE 1/4) is the new FY17 map area.

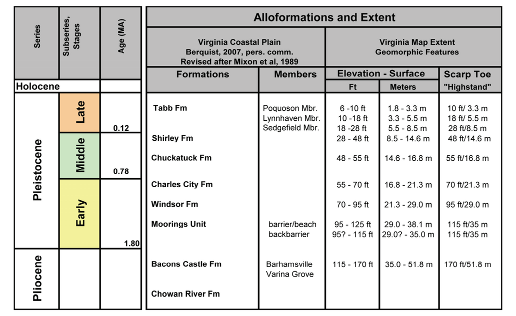


Figure 5. Chart showing relative ages and map units for Virginia's Coastal Plain Map (Mixon and others, 1989) This diagram does not incorporate revisions to the Pleistocene proposed by Gibbard and others (2010).

Table 1. Locations of cores collected in Southeast Quadrant of Falkland Quadrangle prior to the current fiscal year's data collection, collected for STATEMAP FY16 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
TUCKER-02	10/2/2016	K.Farrell, E.Thornton	Falkland	Pitt	211777.3330	741578.1420	35.650347	-77.542453	44.00	13.41	76.84	23.42	Geoprobe Discrete Sampling	D. Foyles
MONK-01	10/18/2016	K.Farrell, E.Thornton	Falkland	Pitt	211884.8940	741981.2400	35.651263	-77.537984	51.50	15.70	77.91	23.75	Geoprobe Discrete Sampling	D. Foyles
MONK-02	10/20/2016	K.Farrell, E.Thornton	Falkland	Pitt	211298.3890	742381.6690	35.645924	-77.533658	56.00	17.07	81.97	24.98	Geoprobe Discrete Sampling	D. Foyles
MONK-03	10/26/2016	K.Farrell, E.Thornton	Falkland	Pitt	210829.8980	743050.7810	35.641612	-77.526347	48.00	14.63	81.78	24.93	Geoprobe Discrete Sampling	D. Foyles
TUCKER-04	11/9/2016	K.Farrell, E.Thornton	Falkland	Pitt	210785.6230	739872.2280	35.641633	-77.561449	46.50	14.17	83.73	25.52	Geoprobe Discrete Sampling	D. Foyles
TUCKER-05	11/10/2016	K.Farrell, E.Thornton	Falkland	Pitt	211877.6290	740707.7610	35.651366	-77.552048	54.20	16.52	83.10	25.33	Geoprobe Discrete Sampling	D. Foyles
							Total Footage		300.20	91.50				

Table 2. Locations of new geoprobe cores collected during SM FY17. These are located in the Southeast Quadrant of Falkland Quadrangle.

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
MONK-04	10/13/2017	K.Farrell, E.Thornton	Falkland	Pitt	210188.1170	744641.7990	35.635620	-77.508888	55.60	16.95	79.27	24.16	Geoprobe Discrete Sampling	D. Foyles
MONK-05	10/18/2017	K.Farrell, E.Thornton	Falkland	Pitt	210437.6210	743940.1360	35.637964	-77.516594	54.50	16.61	83.46	25.44	Geoprobe Discrete Sampling	D. Foyles
MONK-06	10/19/2017	K.Farrell, E.Thornton	Falkland	Pitt	209408.1350	742758.5990	35.628844	-77.529807	64.00	19.51	80.81	24.63	Geoprobe Discrete Sampling	D. Foyles
MONK-07	10/20/2017	K.Farrell, E.Thornton	Falkland	Pitt	210053.8920	743242.9640	35.634599	-77.524354	48.00	14.63	83.99	25.60	Geoprobe Discrete Sampling	D. Foyles
MONK-08	11/30/2017	K.Farrell, E.Thornton	Falkland	Pitt	209797.0860	743023.0210	35.632314	-77.526824	55.70	16.98	82.71	25.21	Geoprobe Discrete Sampling	D. Foyles
MONK-09	12/1/2017	K.Farrell, E.Thornton	Falkland	Pitt	210194.1280	743607.2460	35.635814	-77.520309	48.00	14.63	83.17	25.35	Geoprobe Discrete Sampling	D. Foyles
MONK-10	12/6/2017	K.Farrell, E.Thornton	Falkland	Pitt	210502.4120	743308.1860	35.638633	-77.523560	45.30	13.81	80.71	24.60	Geoprobe Discrete Sampling	D. Foyles
MONK-11	12/7/2017	K.Farrell, E.Thornton	Falkland	Pitt	211288.2900	744577.7930	35.645545	-77.509413	49.90	15.21	79.36	24.19	Geoprobe Discrete Sampling	D. Foyles
MONK-12	12/19/2017	K.Farrell, E.Thornton	Falkland	Pitt	211000.6670	744063.5990	35.643022	-77.515138	60.00	18.29	81.53	24.85	Geoprobe Discrete Sampling	D. Foyles
TUCKER-06	1/24/2018	K.Farrell, E.Thornton	Falkland	Pitt	214002.8910	743047.8970	35.670217	-77.525860	56.00	17.07	80.77	24.62	Geoprobe Discrete Sampling	D. Foyles
TUCKER-07	1/25/2018	K.Farrell, E.Thornton	Falkland	Pitt	213931.3850	743328.4790	35.669535	-77.522773	42.50	12.95	69.72	21.25	Geoprobe Discrete Sampling	D. Foyles
TUCKER-08	2/1/2018	K.Farrell, E.Thornton	Falkland	Pitt	214305.5900	741098.3030	35.673204	-77.547345	51.65	15.74	81.43	24.82	Geoprobe Discrete Sampling	D. Foyles
TUCKER-09	2/14/2018	K.Farrell, E.Thornton	Falkland	Pitt	213792.4300	742221.8190	35.668430	-77.535019	50.65	15.44	81.99	24.99	Geoprobe Discrete Sampling	D. Foyles
TUCKER-10	2/21/2018	K.Farrell, E.Thornton	Falkland	Pitt	213380.1610	744638.3480	35.664390	-77.508397	63.00	19.20	69.65	21.23	Geoprobe Discrete Sampling	D. Foyles
TUCKER-11	3/28/2018	K.Farrell, E.Thornton	Falkland	Pitt	213651.5810	744227.1050	35.666892	-77.512894	55.00	16.76	70.70	21.55	Geoprobe Discrete Sampling	D. Foyles
TUCKER-12	4/26/2018	K.Farrell, E.Thornton	Falkland	Pitt	213334.1440	741174.7430	35.664439	-77.546657	53.80	16.40	81.43	24.82	Geoprobe Discrete Sampling	D. Foyles
TUCKER-13	5/2/2018	K.Farrell, E.Thornton	Falkland	Pitt	213748.6390	743523.8490	35.667862	-77.520645	30.25	9.22	46.88	14.29	Geoprobe Discrete Sampling	D. Foyles
TUCKER-14	5/2/2018	K.Farrell, E.Thornton	Falkland	Pitt	213845.4800	743658.7800	35.668716	-77.519139	24.00	7.32	44.49	13.56	Geoprobe Discrete Sampling	D. Foyles
TUCKER-15	5/3/2018	K.Farrell, E.Thornton	Falkland	Pitt	213367.5350	743094.4310	35.664484	-77.525451	28.20	8.60	48.56	14.80	Geoprobe Discrete Sampling	D. Foyles
TUCKER-16	5/3/2018	K.Farrell, E.Thornton	Falkland	Pitt	213376.6890	742959.7580	35.664585	-77.526937	28.00	8.53	62.07	18.92	Geoprobe Discrete Sampling	D. Foyles
TUCKER-17	5/10/2018	K.Farrell, E.Thornton	Falkland	Pitt	213158.3110	742658.7960	35.662657	-77.530296	33.20	10.12	51.74	15.77	Geoprobe Discrete Sampling	D. Foyles
TUCKER-18	5/10/2018	K.Farrell, E.Thornton	Falkland	Pitt	213360.5850	742774.6830	35.664465	-77.528983	40.00	12.19	75.95	23.15	Geoprobe Discrete Sampling	D. Foyles
TUCKER-19	5/14/2018	K.Farrell, E.Thornton	Falkland	Pitt	213557.4350	745192.8210	35.665913	-77.502244	59.00	17.98	82.38	25.11	Geoprobe Discrete Sampling	D. Foyles
TURNAGE-02	6/13/2018	K.Farrell, E.Thornton	Falkland	Pitt	210218.6820	740823.5920	35.636406	-77.551038	55.40	16.89	80.22	24.45	Geoprobe Discrete Sampling	D. Foyles
ALLEN-STOWE-01	6/20/2018	K.Farrell, E.Thornton	Falkland	Pitt	211979.3150	745406.8780	35.651660	-77.500143	40.00	12.19	77.62	23.66	Geoprobe Discrete Sampling	D. Foyles
							Total Footage		1191.65	363.21				

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

By
Kathleen M. Farrell and Erik D. Thornton

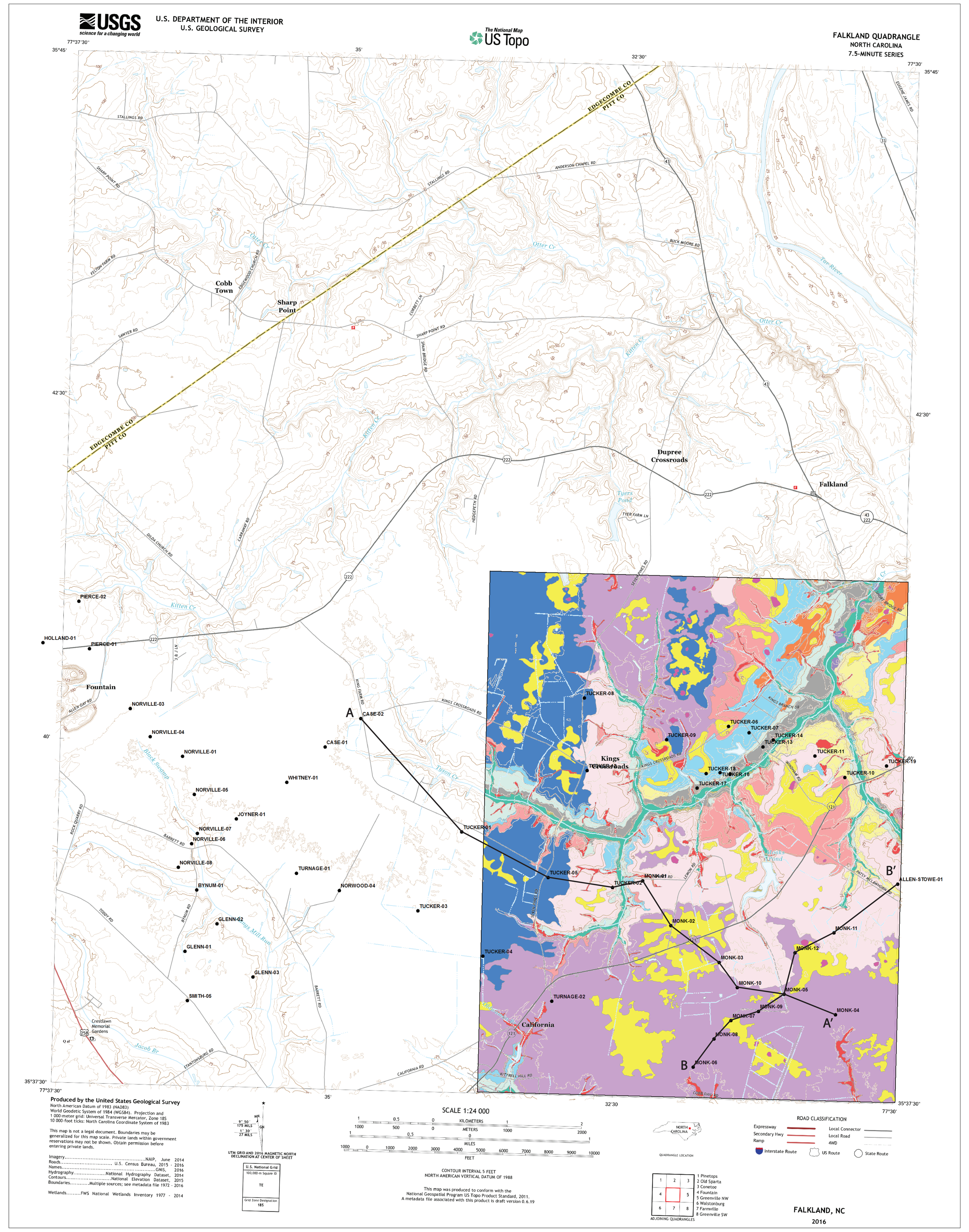
Geology mapped from July 2017 to June 2018. Landscape analysis, map preparation, digital cartography and editing by Kathleen M. Farrell.

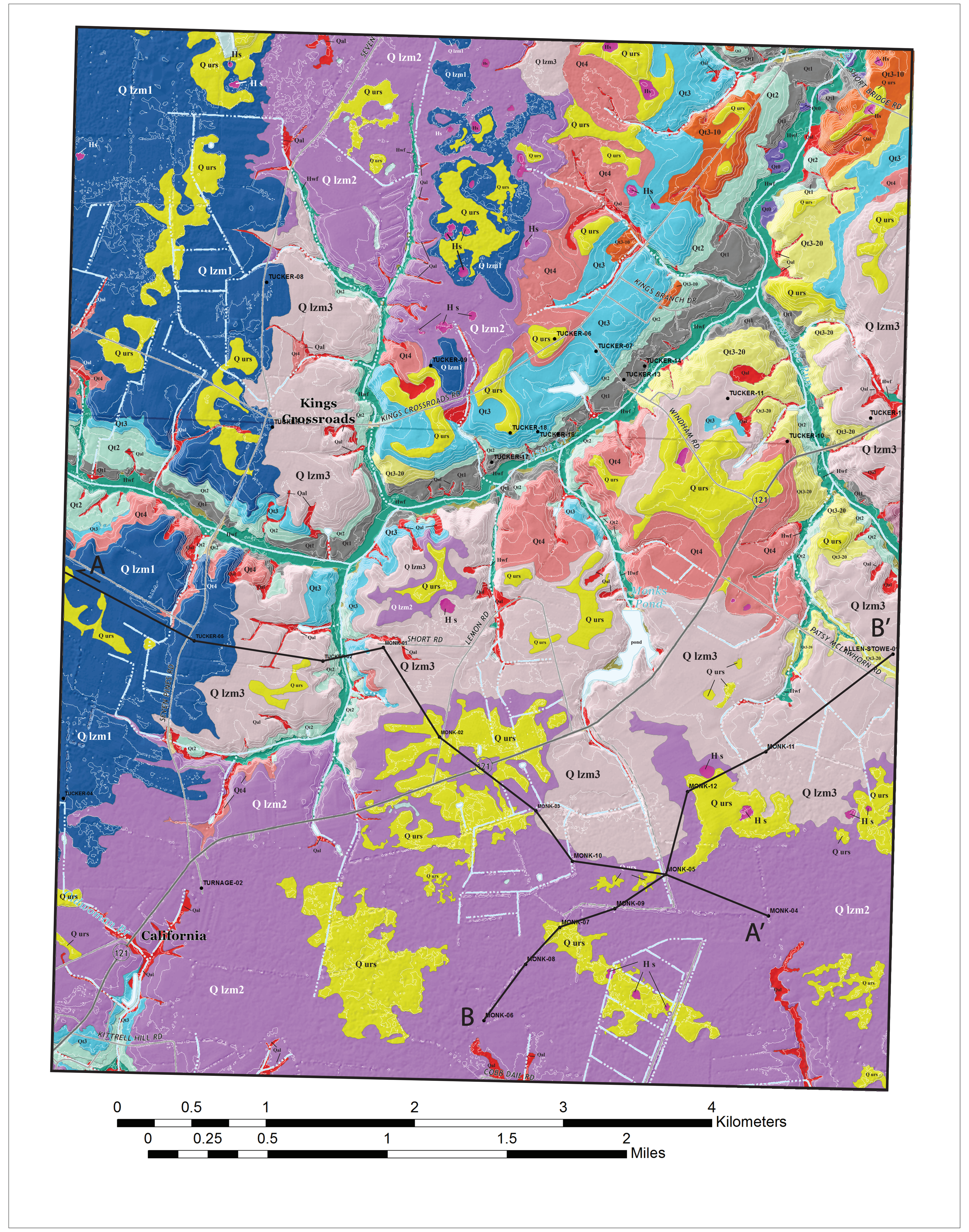
2018

Overview of Geomorphology and Stratigraphy in Falkland Quadrangle, Southeast Quadrant

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

- Geomorphic analysis reveals that the map area occurs east of the Plio-Pleistocene Surry Paleoshoreline complex (shore elevation ~30 m MSL) at elevations below 26 m. Interfluves range in elevation from ~26 m (northeast) to 24 m (southeast). Interfluves are separated by incised drainages which have a series of terraces that step down from 24 m to 5 m. The bottom of drainages includes a Holocene wetland flat 3 to 7 m thick, that gradually rises in elevation in an upstream direction, burying Pleistocene terraces.
- A significant shore parallel feature occurs at ~26 to 27 m, immediately west of the study area (see Farrell and Thornton, 2017). This elevation may correspond to a stratigraphic contact that separates a sand-rich shoreface unit (west) from falling-stage, finer-grained, highly variable deposits to the east. Tentatively this may be a "formation boundary", i.e. separating correlative Moorings from Windsor units. It may separate normal from forced regressive deposits.
- In the current quadrant, forced regressive deposits include a series of continuously-deposited, Early Pleistocene terrace-defined units that step down in elevation from 26 to 20 m, at intervals of 1 to 2 m. Geomorphic contacts between these 'marine terraces' are subtle; locally these transition into and cannot be separated from incised valley deposits. In these cases, the "incised valley" starts to lose its incised geomorphic character, becoming more depositional in character. This is especially characteristic at elevations of 25 to 22 m.
- The landscape in this area is very difficult to interpret geomorphically because of the existance of Carolina Bays. These bays likely formed as blow-outs of beach ridges. Map patterns for remobilized sands (from blowouts) indicate elongate, shoreline-parallel ridges, separated by deflation deflation surfaces, and lower-lying flats. Terrace boundaries are difficult to identify because of the blowouts. Sinkholes with springs or lakes occur within some of the blowout areas of the Carolina Bays.
- A separate problem with mapping terraces using high resolution Lidar is separating depositional terraces from erosional terraces. This is because the slope break is used to separate terraces. In many cases, a slope break may simply represent an erosional surface during sea level fall.
- The Quaternary section is ~ 40 to 64+ ft (12 – 20 m) thick. Refusal depth ranged from 28-64 ft (8.5 – 19.5 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 determining spacing for correlation purposes, specifically for correlating sands within the Pleistocene section (see cross sections A and B). Sand types include possible inlet, shoreface, fluvial(?), and indistributary bay mouth bar sands. A large parcel with a road network was available for drilling (Monk Property). Here cross sections were developed with cores spaced at intervals of 365 to 1319 meters. Optimal spacing for solid correlations is about 300-500 m, but about 1000 m should be the maximum spacing.
- Outstanding correlation issues are: 1) terminations of sands within the heterolithic sand/mud facies on the cross sections; 2) the relationship of very shallow stratigraphy with the remobilized sands derived from beach ridges; 3) terminations of possible shoreface and inlet fill sands. It may be that high resolution seismic reflection profiling or an alternative geophysical prospecting investigation is needed to resolve these types of correlation and stacking issues. The Monk Property changed ownership during this study and NCGS has not been able to get a response from the new landowner, to obtain several more cores along these profiles.





Legend for Geologic Map Units - Geomorphic Landscape Elements

Holocene

- Stream Channel
- Man-Made Excavation - Pond or Lagoon, Mining Operations.
- Man-Made Earthmoving 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 treeless or channelized 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 in the upstream direction it is replaced by Hwf2. Upstream, the flat narrows and is replaced by channel deposits of 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 associated 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.

Undifferentiated Quaternary Deposits:

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

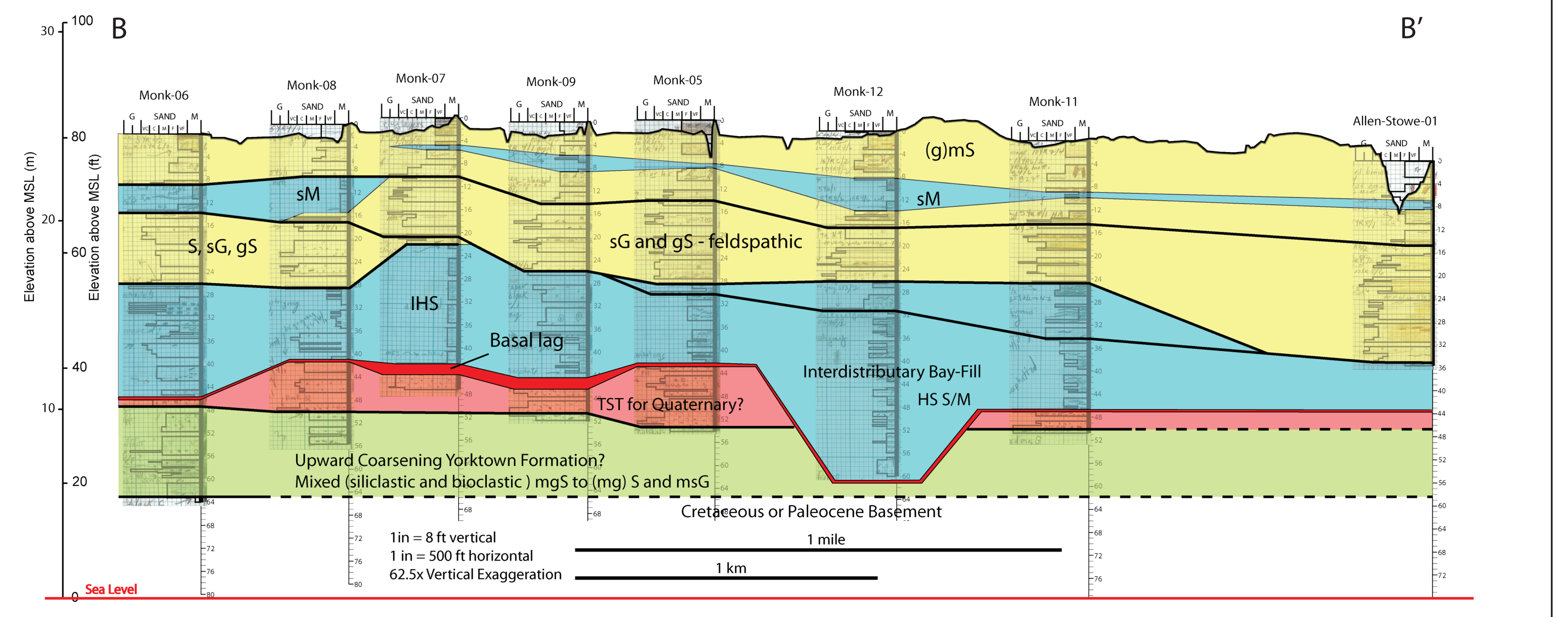
Undifferentiated Pleistocene Depositional Systems including Valley Fill and Falling Stage Deposits:

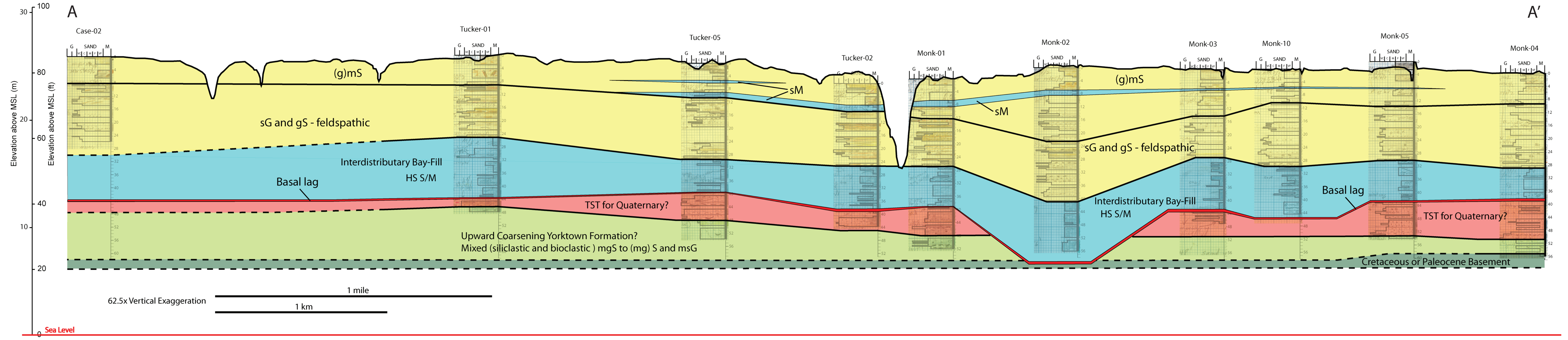
- **Qal** — Qal Undifferentiated Quaternary Alluvium - currently active landscape. Includes the Holocene material in side valleys and on alluvial fans and colluvium on side slopes.
- **Qt0** — Qt0 Pleistocene Stream Terrace @ 8-9 m on Falkland SE, not occurring upstream on Falkland SW.
- **Qt1** — Qt1 Pleistocene Stream Terrace @ 19-20 m on Falkland SW. Very distinct flat terrace mapped downstream to 11 m on Falkland SE. May be Middle Pleistocene.
- **Qt2** — Qt2 Pleistocene Stream Terrace @ 20-21 m on Falkland SW. Principally a colluvial deposit affiliated with Qt1. Mapped downstream to 13 m on Falkland SE. Locally widens into flat terrace.
- **Qt3-10** — Qt3-10 Pleistocene Stream Terrace @ 22-23 m on Falkland SW where it occurs as an upstream valley fill colluvial deposit. Downstream on Falkland SE, it broadens and flattens into a fully developed terrace at 20 m.
- **Qt3-20** — Qt3-20 Pleistocene Stream Terrace @ 19 m on Falkland SE where it occurs as an upstream valley fill colluvial deposit. Downstream on Falkland SE, it broadens and flattens into a fully developed terrace at 20 m.
- **Qt3** — Qt3 Pleistocene Stream Terrace @ 22-23 m on Falkland SW where it occurs as an upstream valley fill colluvial deposit. Downstream on Falkland SE, it broadens and flattens into a fully developed terrace at 20 m.
- **Qt4** — Qt4 Pleistocene Stream Terrace @ 23-24 m on Falkland SW where it occurs as upstream valley fill colluvium associated with falling stage. Downstream on Falkland SE, it forms broad flat areas at 21-23 m, and is associated with deflation surfaces of Carolina Bays.
- **Qt5** — Qt5 Pleistocene Stream Terrace @ 24-25 m on Falkland SW. This unit is similar to and may correlate with Q4, but is incised in updip areas. It was not identified in Falkland SE.
- **Qt6 vf** — Qt6 Pleistocene Valley Terrace @ 25-26.5 m; merges with marine terrace equivalent that is seaward (east) of ~26 m shoreline (Q lzm). Mapped upstream on Falkland SW; does not occur in downstream areas of Falkland SE.

Early Pleistocene Units - Marine Ramps on Interfluves:

Q lzm: Informal Lizzie Formation, downstepping, marine interfluve deposits; occur beneath marine flats east of 26 m shoreline, mapped downdip to 23 m.

- **Q lzm3** — Q lzm3: Marine terrace that occurs @ ~23-24 m.
- **Q lzm2** — Q lzm2: Marine terrace that occurs @ ~24-25 m, merging gradually (elevation-wise) with lzm1.
- **Q lzm1** — Q lzm1: Marine terrace that extends from 26.5 meters to 24.5 m. Boundary between lzm1 and lzm2/3 is ~24.5 m.





REFERENCES

Catuneanu, O., Abreu, V., Bhattacharya, J.P., Blum, M.D., Dalrymple, R.W., Eriksson, P.G., Fielding, C.R., Fisher, W.L., Galloway, W.E., Gibling, M.R., Giles, K.A., Holbrook, J.M., Jordan, R., Kendall, C.G. St.C., Macurda, B., Martinsen, O.J., Miall, A.D., Nearl, J.E., Nummedal, D., Pomar, L., Pasamentier, H.W., Pratt, B.R., Sarg, J.F., Shanley, K.W., Steel, R.J., Strasser, A., Tucker, M.E., and Winker, C., 2009. Towards the standardization of sequence stratigraphy. Earth-Science Reviews, v. 92, p. 1-33.

Daniels, R.B., Gamble, E.E., and Nettleton, W.D., 1966, The Surry Scarp from Fountain to Potters Hill, North Carolina, Southeastern Geology, v. 7, p. 41-50.

Daniels, R.B., and Kane, E.O., 2001, Coastal Plain Scarps of the Neuse River Basin, North Carolina, as delineated by R.B. Daniels: a new GIS coverage: Ground Water Circular No. 18, North Carolina, Department of Environment and Natural Resources, Division of Water Quality, Groundwater section, Raleigh, NC.

Daniels, R.B., Kleiss, H.J., Buol, S.W., Byrd, H.J., and Phillips, J.A., 1984, Soil systems in North Carolina, Bulletin 467, North Carolina Agricultural Research Service, North Carolina State University, Raleigh, NC.

Farrell, K.M., and Crane, C., 2013, Geologic Map of the Fountain 7.5 Minute Quadrangle, North Carolina, NCGS OFR-unnumbered.

Farrell, K.M. and Thornton, E.D, 2018, Geologic Map with Geomorphic Landscape Elements of the Falkland 7.5 Minute Quadrangle, Southwest Quadrant, North Carolina: North Carolina Geological Survey Open-file Report 2018, scale 1:24,000, in color.

Farrell, K.M., Harris, W.B., Mallinson, D.J., Culver, S.J., Riggs, S.R., Pierson, J., Self-Trail, J.M., Lautier, J., 2012, Standardizing texture and facies codes for a process-based classification of clastic rock and sediment, Journal of Sedimentary Research, v. 82, p. 364-378.

Farrell, K.M., Harris, W.B., Mallinson, D.J., Culver, S.J., Riggs, S.R., Wehmiller, J.F., Pierson, J., Self-Trail, J.M., Lautier, J., 2013, Graphic logging for interpreting process-generated stratigraphic sequences and aquifer/reservoir potential: with analog shelf to shoreface examples from the Atlantic Coastal Plain Province, U.S.A., Journal of Sedimentary Research, v. 83, p. 723-745.

Farrell, K.M., Mew, H.E., Jr., Keyworth, A.J., and Clark, T.W., 2003, Comprehensive landscape analysis, geomorphology, and sequence stratigraphy in eastern North Carolina's Little Contentnea Creek Watershed of the Neuse River Basin: methods for constructing reconnaissance-level geologic maps of a relict Plio-Pleistocene terrane. In Farrell, K.M. and Keyworth, A.J., editors, 2003, Surficial geology and shallow aquifer system of the Little Contentnea Creek Watershed, Neuse River Basin, North Carolina. Carolina Geological Society Annual Field Trip Guidebook.

Gibbard, P.L., Head, M.J., Walker, M.J.C., and the Subcommission on Quaternary Stratigraphy, 2010, Formal ratification of the Quaternary System/Period and the Pleistocene Series/Epoch with a base at 2.58 Ma, Journal of Quaternary Science, v. 25, p. 96-102.

Hughes, P.D., 2010, Geomorphology and Quaternary stratigraphy: the roles of morpho-, litho-, and allostratigraphy. Geomorphology, v123, p. 189-199.

Mixon, R.B., Berquist, C.R., Jr., Newell, W.L., Johnson, G.H., Powars, D.S., Schindler, J.S., and Rader, E.K., 1989, Geologic map and generalized cross sections of the coastal plain and adjacent parts of the Piedmont, Virginia: U.S. Geological Survey Miscellaneous Investigations Series Map I-2033.

Parham, P. R. 2009. The late Quaternary stratigraphy and geologic history of northeastern North Carolina and southeastern Virginia (PhD dissertation). Department of Geological Sciences, East Carolina University, Greenville, NC, 290 p.

Newell, W.L., and Dejong, B., 2010, Cold climate slope deposits and landscape modifications of the mid-Atlantic Coastal Plain of eastern USA. Geological Society of London Special Publication 443. In press.

North Carolina Geological Survey (NCGS), 1985, Geologic Map of North Carolina: North Carolina Department of Natural Resources and Community Development, Raleigh, NC, scale 1:500,000.

Oaks, R.Q., Jr., and J.R. Dubar, Eds., 1974, Post-Miocene Stratigraphy Central and Southern Atlantic Coastal Plain, Utah State University Press, Logan, Utah, 275 pp.

Tesoriero, A.J., Spruill, T.B., Mew, H.E., Jr., Farrell, K.M., and Harden, S.L., 2005, Nitrogen transport and transformation in a coastal plain watershed: Influence of geomorphology on flowpaths and residence times: Water Resources Research, v. 41, 15 pp.

Winker, C.D. and J.D. Howard, 1977, Correlation of tectonically deformed shorelines on the southern Atlantic coastal plain. Geology, v. 5, p. 123-127.

This geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program under StateMap award number G17AC00264, 2017.