Coastal Scarps, Islands
And High-Water Events:
Indian Village Location Models

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Directed Studies In Geology, Dr. David Mallinson
The Geomorphic Formations of Coastal North Carolina

Background

Coastal North Carolina and the Outer Banks have gone through many geologic formations. As a background, 4 billion years ago, the earth formed from accumulated dust particles. A progression of materials eventually became solid material called sediments, which eventually formed into large land masses.

Most of the North Carolina coastal makeup are from formations of sediments resulting from weathering and erosion, from the lands just to the west, and repeated inundations from rising water caused by melting of large glacial formations. [Parham 2009: 2] The newly flooded land was then transformed by the deposition of marine sediment from calcified animals and siliciclastic sands and mud. There have been dozens of these high-water events in the last million years and five have been documented in the last 125,000 years. (Parham, 2009: 1).

One of the defining features in the North Carolina Coastal Plain is the formation of escarpments. These formations have greatly helped in identifying the temporal sequencing for the Albemarle embayment. The Suffolk Scarp is the single largest feature left from these fluctuating sea-rises. The sequence of dating is accomplished by the serialization, or the scientific age dating of the remnants of life forms. These datings can be accomplished or sequenced with amino acid racemization (AAR utilizing fossil mollusk shells) (Parham, 2009: 7-9).

Dr. Stanley Riggs, of East Carolina University, utilizing seismic evidence, has counter-proposed that as many as 18 sea-level “high-stand deposits”, not the
above sited five, are preserved within the area of the Albemarle embayment, which includes from the Outer Banks westward to the Suffolk Scrape [The margins of the scarp runs approximately along RT. 32 in Washington and Beaufort counties].

Each high-water event stand results in a stacked, different, definable depositional sequence (i.e. the Suffolk Scarp, the Hickory Scarp and etc.). The above recurring cycles, land transformations and scarp development help in explaining the formation and evolution of the geological structures during the last 100 thousand years of the outer North Carolina Coastal Plain. (Riggs, 1974: 37; Riggs, 1992: 141-53; Riggs, 1984: 131-76). (This research will hopefully allow the research of the Indian highland village sites to be better comprehended and predicted in other locations in coastal North Carolina).

During the Paleocene Period (55-65 million years ago), the Coastal Plain was experiencing repeated weathering and erosion factors which carried deposits coastward. At the Eocene Period (34-55 million years ago), a very large geologic high-water event transformed coastal North Carolina, producing a sea depth of approximately 165 feet above the present sea level. This resulted in one of the more important sediment formations, called the Castle Hayne Formation. This formation is comprised of hundreds of species of marine bodies, resulting in a sediment formation (lithification) of these marine fossils, creating limestone deposits.

The Oligocene Period (25-34 million years ago) again saw the seas retreating, and the forces of erosion and weathering were at work again, whereupon some of the westward portion of the Castle Hayne Formation has been lost in sediments
tending east towards the coast. A smaller high-water sea event again occurred at about 30 million years ago, but the water only got as far inland as where New Bern is today, creating the River-Bend Formation. The sea levels were 23 to 130 feet deeper then present. During the Pliocene period (2.6-5 million years ago), an inundation effect again occurred, with sea depths ranged from 100 to 150 feet above present levels. The cycle repeated itself creating the Yorktown Formation, which is known throughout the world for the varieties of fossils found in it (Beyer, 1991: 76), such as the Megalodon shark with teeth the size of a human hand or larger.

During the Holocene Epoch (11,700 to present), the most recent retreat of ice sheets caused the oceans to advance, building barrier islands along North Carolina’s shoreline (Beyer, 1991: 159). The usage of foraminifera, sedimentological, seismic, geochemical, and geo-chronological data are presently being used to reconstruct the Holocene Paleo-environmental change on the current Continental Shelf, east of the Outer Banks barrier islands of North Carolina. Utilizing all of the above, it is suggested that a brackish estuarine system existed in this area, before sea-level rises deposited normal marine shelf sands that currently characterize this region. The above indicates that the initial flooding of the Albemarle/Pamlico River system started about 11,000 years ago (Stanton, 2008: 105-7).

_Supplemental Coastal Geological Analysis of the Outer Banks of North Carolina_
Present-day coastal morphology of the Outer Banks is dictated by long-shore currents, which are partially controlled by the north movement of the Gulf Stream, trapping the southern flowing Labrador Current against the beaches of the Outer Banks, the resulting event producing a collision of these two water courses at Cape Hatteras, North Carolina. Coastal sand transport systems have caused 12 inlets to be closed or relocated in the last 400 years on the Outer Banks of North Carolina (see John White map below p. 7, and the map on pg 6 by John Fisher 1962).

The southern-moving long shore current causes the north side of an inlet opening to extend southward into long narrow spits of sand, tending to close inlets in the North Carolina coastal locations. Of the 12 inlets documented in 1585, with John White's map, only Ocracoke Inlet remains open today (see John White Map on page 7 below and the chronology of the other inlets on Fishers map).

The Outer Banks of North Carolina constitute a geo-morphological feature that has been shown on maps for the last 400 years. As one of the first-mapped and studied areas in North America, it continues to be researched today. Understanding how the barrier land masses (The outer banks) reacts to weather and sea level rise has received much attention over the last fifty years as more of these beaches are being developed. The ocean currents, sand movements and the dynamics relating to this attenuated (Long and tapering) sand ribbon and its westward environs, including the Pamlico and Albemarle Sounds and relevant portions of the mainland, remain a major challenge to the people who are
attempting to live there and constitute geological topics of importance and interest today.

Map by John Fisher 1962

Port Ferdinando is the inlet depicted above, Sixth from the top.

Of special interest are the Outer Banks and the continually changing morphology of the inlets. Depicted below is the 1585 John White Map, which is the only existing map naming Port Ferdinando as the inlet used by all of the Roanoke Voyages: It is Ralph Lane, in 1585 who first writes of Port Ferdinando Inlet in his Letter of August 12, 1585:
“Ye Right honorable Sir Franscis Wallsyngham Knight. Thys other [inlet] called ye FerdyNandro hatheabarre also but at xij foote vpon the same sat hyghe water: and ye barre thys Porte at ye poynte of ye lande beying fortseyd with a skonse, yt ys not to be enterdde by all ye force yt Spayne canne make, wee hauynge ye fauure of God” (Quinn, 1955: 202).

John White Map Showing Port Ferdinando

This inlet closed over eight times during a 200-year period, and finally permanently closed in 1808. Oregon Inlet opened in 1846, 800 yards south of Port Ferdinando Inlet, and is still open today although it has migrated almost two miles to the south. (Fisher: 1962, See inlet map above Re Port Ferdinando)
The above Infrared Satellite Image is of the location of Port Ferdinando: north is to the bottom of the image. The above identifications were originally designated by John Fisher in 1962. The island to the right (see top circle) is the tell-tale feature of a past inlet. This feature is a flood tide delta. The ridge at the bottom of the image (see bottom circle) is the right-angled ridge system that forms on the north side of a south sand transport inlet system, both identified by Fisher and according to him some of the best example of all of the closed inlets on the Outer Banks. These features can be found on many of the relict inlets on the Outer
Banks today, of which hundreds have been documented (Fisher, 1962). The state of North Carolina has recently placed a historical marker just north of the Bodie Island Lighthouse, indicating the relict location of the Port Ferdinando Inlet used by all of the Roanoke Voyages (1584-1603) (Research by this author, See Roanoke Sagas: www.Lost-Colony.com).

The Port Ferdinando Site (Pea Island), Photo Taken 2001ECU Graduate Students William Moore and Ruth Wilson, Fred Willard Observing. The State of North Carolina placed this historic marking indicating the location of the relict inlet of Port Ferdinando.
Alligator River Flood Plain High Ridge Systems

The Suffolk Scarp that strikes through the North Carolina Coast northeast to southwest, but mostly north and south, is the defining geomorphic structure created by past inundations of high water. This feature became a major travel route, used first by the Native Americans and later by the English Colonists.

There were many visitors to these shores, but the first permanent settlement of colonies was by the English, under the banner of Sir Walter Raleigh and the Roanoke voyages (1584/1603). Of special interest to this author is the location of the inland Indian sites from the Outer Banks located east of the Suffolk Scarp and present at the contact period (1584/1603).

One of the most important criteria related to the location of these Indian villages is water access especially for large “War Canoes” (some of which are almost fifty feet long), and the need to be in a closed and protected water system that could provide a safe harbor located near a soil source of a mineral soil that would grow corn, peas and other food sources. (Dr. David Phelps Personal Communication: This author had the opportunity of working in the field with Dr. Phelps, Director of archaeology, East Carolina University, for ten years before his passing a few years ago). After working in the fields of archaeology, history, biology and using satellite imaging to confirm three
Figure 1-4. Shaded relief map of northeastern North Carolina and southeastern Virginia showing the location of the Suffolk Shoreline and geographic features referred to in this report. The study area is bounded to the west by the Suffolk Shoreline, to the north by the James River, to the south by the Neuse River, and to the east by the Atlantic Ocean.
Dillons Ridge is on the upper left and Buck ridge is just east of Gum Neck; these two ridges and the Dare County mainland (called Beechland and is the large area of land depicted on the right above) are all of important and of interest as many archaeological artifacts and indications of large Indian villages have been found there (Phelps: PC). The location of these sites seems like an easy scenario to predict, and one would think the coast would have an abundance of locations that would suffice, but that is not the case. See the above Lidar map produced by Parham: 2009. The bright yellow areas are locations that would support Indian villages if they had water access.
contact-period Indian sites (Croatan, Tramansqueocc (sic), and Occosqueocc (sic) have recently been discovered and confirmed. It has also been discovered that eighty to ninety percent of the geological formations near the large water courses are swampy, have underlying peat deposits or highly acidic soils, and will not grow enough corn for a community of Indian or English to survive. It is granted that just inland of the large water courses there is an abundance of good soil, but it has no access by large boats and most must be drained of surface water to produce high yields of corn. The coastal Indians are defined as “large boat people”, whereas the inland Tuscarora primarily used foot transport and dominated the inner coastal region, i.e. west of the Suffolk Scarp. The villages that have been found are all surrounded with millions of acres of swampland, have a high center ridge, and contain soils that yield hundreds of bushels of corn per acre and can only be accessed by boats even today because of the low swampy topography. (Dr. David Phelps Personnel communication and the studies of soil maps and research utilizing satellite imaging at Elizabeth State University, has confirmed Indian cites (with large quantities of both Indian and English artifacts) that indicate that large quantities of corn can be produced by the soils from these villages: The Elizabeth City State University research can be found @ Exploring the Migration of the Roanoke Colonists, http://www.lost-colony.com/currentresearch.html).

This paper will attempt to explain how these high ridges were formed, and how the Indians used them, producing large crops that would support Indian
populations in the thousands at the period of contact (estimated at about forty thousand when the colonists first arrived by Dr. Phelps; PC).

The shoreline coastal deposits and the sediments of marine based organisms have dominated the area in question and helped to temporally sequence the events that formed the Albemarle embayment (which can be defined as from the Norfolk Arch, near Currituck to Cape Lookout). The subsurface strata is overlain by eighty-five meters of Quaternary deposits that sit on three km of Mesozoic and Cenozoic structures, which is dipping slightly to the east (Parham, 1991: 7).

The dominant physiological events that have shaped this embayment have been stands of high water that were generated by deglaciation of the Polar Regions. This has been well documented by Dr. Stanley Riggs (East Carolina University, Emeritus) with seismic research, and with coring and geomorphic mapping by the Geology Department Of ECU. Each event (high and low stands of sea level) produces its own identifiable sediments which can be found in bore samples and borrow-pit samplings and are datable with sand grain analysis and marine identification of the organisms that are found in the sediments. Dr. Riggs has proffered that there were as many as eighteen sea-level high-stand events in the Albemarle embayment, and each belongs to a different depositional sequence. This sequencing event was discernable in the limited sampling done for this research in the Dillon’s Ridge depositional layers of marine sediments, that at twenty-six feet date back to fifty-six thousand years (Mallinson, 2009: working with this author with sand segments from the Dillon’s Ridge site [personal communication with
Dr. Riggs used fossil mollusk samples utilizing amino acid racemization (AAR) to date and separate the sequence of the high-water events and in addition Stephen J. Culver, Et El; The Sedimentary Record. Vol 5, No4, December 2007)

DR – 1 (Test Hole). Collecting sample from bottom of borrow pit, 26 feet below top of pit. Dillon’s Ridge

The most recent retreat of the ice sheets was about eighteen thousand years ago. When the seas started to rise, it formed barrier islands on the North Carolina coasts (Parham, 1991: 159). During the low-water periods, large amounts of sediments were washed eastward from the head-rivers and streams to the east and then to the coast, bringing nutrient rich soils. (Parham, 1991: 167). During one of the more recent high-water events (four to five thousand years ago), as documented above by Riggs and also by Greg L. Rudolph, 1999, and Culver ET el: 2007), Extensive breaching of the Outer Banks occurred, whereby a large
### Soil Screening from Dillon’s Ridge, 2009

The screening method and processes were supervised by Dr. David Mallinson, and he estimates the dating of the sand particles from 65 to 55 thousand years before present. The sand particles have inclusions of large quantities of marine deposition, producing a soil component that is rich and hence would grow large quantities of corn per acre. This particular ridge does not have direct-water access, so it would not be a good candidate for a permanent large Indian village location.

<table>
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<th>Sample ID</th>
<th>MEAN</th>
<th>SORTING</th>
<th>SKEWNESS</th>
<th>KURTOSIS</th>
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</table>
opening was created, allowing high rates of water exchange between the open sea and the embayment area. This event allowed for higher rates of sandy sediment depositions, becoming the dominate sediment throughout the area. This produced many inlets or one very large inlet 20 to 30 km wide. As sea levels continued to rise, new partial barrier islands formed, re-establishing semi-restricted conditions. The dominant sedimentological process during these events was controlled by the process of the creation of new coastal islands (Rudolph, 1999: 158, and Stephen J. Culver, Cadence A. Grand Pre', David J. Mallinson, Stanley Riggs, D. Reide Corbert, Jennifer Foley, Michael Hale, Lauren Metger, John Ricardo, Jeb Rosenberger, Christopher G. Smith, Curtis W. Smith, Scott W. Snyder, David Twamley (Department of Geological Sciences, East Carolina University, Greenville North Carolina 27858. Late Holocene barrier Island collapse: Outer Banks, North Carolina, USA. The Sedimentary Record. Vol 5, No4, December 2007).

A large section of the Outer Banks of North Carolina was not present for a protracted period of time just prior to the arrival of the English colonies of 1584/1560, according to new research completed recently that indicates that a seaborne form of planktonic foraminifera has been found with new vibracores method of studies. This indicates that a large portion of the southern Outer Banks underwent significant destruction as a result of hurricane activity that seemingly occurred approximately 1,100 cal. Yr. BP. (Sedimentary: 4). The lower area of the banks was subject to direct water access from water with high-salinity content,
which left a signature small sea organism that was not there before the exposure and is not there at the present.

The present Outer banks formed about 3,500 years BP, and indications are that many hurricanes hit the coast each century, but by the study of over 30 cores only one major collapse of the southern portion occurred, and that it lasted for several centuries. The effects of this inundation on the mainland Indian sites at the present time are not discernable, but any coastal Indian site in the affected area would have been destroyed. The ages of the Hickory Ridge, Roanoke Island, Powell’s Point and the Land of Promise Ridge systems overlap and range from 62-k to 41-k, and fall generally in line with our studies of the Dillion Ridge system and its components as discussed above. The Hickory structure is a re-curve spit morphology, indicating a South Transport sand system at the ocean’s edge. [David Mallinson, Kevin Burdette, Shannon Mahan and George Brook. Optically stimulated Luminescence age controls on Late Pleistocene and Holocene coastal lithosomes, North Carolina. Quarterly Research, Science Direct 2007]. and (www.elsvier.com/locate/yqres).
While working with Dr. Phelps, he indicated that there were no natural stones found on the coast that could be used for tool making except a small outcropping at the sea side near Nags head. This was very important to the Indians and was reported from the colonists from four hundred years ago. This author has confirmed
this out cropping and retrieved many jasper cobs from the site. Thousands of these same stone artifacts have been excavated, by this author, at the Croatan site in Buxton. The GPS coordinates for this valuable Indian commodity at Nags head are [N 35.54.362 and W 75.35.721].

**Conclusions**

It is the coastal islands as they are formed, similar to the coast of North Carolina today, that trap the inner sound water and form embayment’s. There are multiple ridges along the inner embayment that at one time were islands or scarps, when the coastline was far inland to the west. Dillon’s Ridge, along with possibly Buck Ridge, and Goshen Ridge were coastal islands and or scarps, and the low marsh lands that connect them today were just ribbons of sand (similar to the Outer Banks today).

A possible explanation for the ridge system formations on the west side of the Alligator River is that they are a construct of an escarpment that was formed about 65,000 years ago (+or -) [see area of Hickory Scarp (above) lying just west of the Alligator River (Gary B. Eames: Master’s Thesis, 1983: 11). The Hickory Scarp Detail shown above indicates that the ocean had risen and was located west of the Alligator River. The Beechland Ridge of today was a structured ribbon out island like the Outer Banks of today. This created rich nutrient marine deposits that become sediments for supporting Indian populations with corn and other sustainable farming when later exposed after the sea levels fell (See pages 3-5).
Depositional sequence two on page 19, 20 and 21 (Eames 1983) indicates Barrier Islands located at what is Beechland today, forming a high-mineral ridge system. The core samples from this location (Boring number 69 & 70 on page 24) produced data indicating that this near-shore facies (a group of stratified beds differing in lithological character or fossil context from the other beds around it) is an eastward fining, fossiliferous, with fine- to medium-grained quartz sand. The barrier facies is now the rich soil ridge called Beechland, and the main target area of our research concerning the Croatan, Hatteras and Mattamuskeet Indians (Fred Willard, Migration Patterns of Coastal N.C. Indians. http://www.lost-colony.com/migrationpatterns.html. Last reviewed: Summer 2010.

Each depositional sequence is a product of changes in sea level transgression and erosion. Each maximum sea-level stand is marked by the westward extent of a new set of barrier islands. Earlier barrier island systems tend to be discreet on the surfaces, or at least subdued from subsequent erosion by wind and water. The Hickory Scarp correlates with the Kempsville Formation of southeast Virginia. This event produced a minor water stand, which is represented by an additional 20 feet of water more than present. Although the dating sequences of this event have a wide variance, it is reasonable to project a period from 70 thousand to 40 thousand years ago, which fits nicely and confirms and supports the findings of our research at Dillon's Ridge. This would place the ocean front right at or just east of Dillon's Ridge within
Figure 54. Proposed shoreline position during the transgressive maximum of Depositional Sequence I. Facies I was deposited seaward of the shoreline in the nearshore marine environment.
The Barrier Island as depicted above coincides with one of our important research Indian location of the Hatteras Indians who occupied Buck Ridge and Beechland from 1690 to 1840 when an epidemic plague hit the area. This is the location of the Dare County Mainland today. The location of the Hickory scarp just west of the Alligator River corresponds with the ridge system being proffered with this research paper as Dillon’s, Levels Ridge, Buck Ridge, and Goshen Ridge. In addition the road beds of Gum Neck Road and North Carolina Rt. 94 also are located on or near the scarp. (Gary B Eames, Master’s Thesis, ECU 1983.)
our window of 68 thousand years before present (+ or -) (Eames, 1983: 119).

Core samples taken from Beechland, as cited in Eames’ theses

This represents fluvial and marine sediments from the high- and low-water events designated as the Hickory Scarp, which created an off-shore island with rich soils for the production of corn for the Native Americans living at Beechland during the contact period of English settlement (1584-1603).

A further analysis of high-water sequences from the research of Riggs indicates that, since the time of the event that developed the Hickory Scarp near Dillon’s Ridge, four more sequences have been identified. Each inundation that
causes the ocean front to move to the west constructs a barrier island system just to the east of it. During the transgression of the low event that happened about 40,000 years ago, the water levels fell by at least 50 meters (150 ft.) below present levels, which resulted in extensive erosion.

The newest sequence of high-tending water stands is happening now, and within a few hundred years (500?) all of the archaeological Indian sites we are seeking will be under water. This process, as it continues today, results in the present Outer Banks slowly migrating to the west (Eames, 1983: 130).

Dr. Stanly Riggs’ explanation of this event is succinct, and easy to understand:

Seven Coastal Plain depositional sequences were identified in late quaternary sequence. The Suffolk is the one most pronounced and is primarily the product of MIS 5a processes (a high- or low-water geological event; this scarp dates 60 to 80 thousand years before present; Parham, Abstract I). Each evolutionary stage, or low/high-water level sequence, produces its own geological formation. Four major processes produced this succession during the late Holocene: 1- the barrier islands migrated upward and landward by over-wash (as the high-water increased and tended westward), 2- flooding of the lands adjacent to the estuaries produced a vertical growth and accumulation of marsh and swamplands, 3- the estuaries maintained in size by active shoreline erosion, 4- sediments were derived from Piedmont streams and estuarine shoreline erosions were deposited as blanket sands and silts in the main flooded trunk of estuaries, while the suspended sediments were trapped and deposited both in the perimeter marshes and extensive clay wedges, which filled the embayed coastal plain tributaries. In addition, of the major trunk streams, deposits of fluvial (produced by river action) silt and sand from high-water events produced very rich marine sediments, usually surrounded by large areas of marsh (i.e. the Algonquian Indian word
“Pocosin”, which means a large swampy area with a high center, or an interfluvial body of water of the coastal plain of the southeast United States (Riggs, January 1975: p. 1247).

**Bibliography**


Cummings, William P. *The Southeast in Early Maps*. Chapel Hill, North Carolina: The University of North Carolina Press 1995/1998. [Twenty primary maps, found in Cummings, were utilized to reference Indian villages on the Zuniga map which were located to ascertain existing known locations today]


Mallinson, Dr. David. Personal Correspondence. 2009


December 2003.

Phelps, Dr. David. Personal Communication. This author worked with and was mentored by Dr. Phelps while working together for nine years at the Croatan site in Buxton North Carolina.


