DRAYTON HALL THROUGH THE AGES

PREPARED FOR

SOUTH CAROLINA STUDIES

8th GRADE CURRICULUM SUPPLEMENT

Science – Week 5; Day 1

John R. Wagner, Clemson University – Project Director

January, 2005

SC MAPS Project Office
340 Brackett Hall
Clemson University
Clemson, SC 29634-0919

Funding for this project provided through a grant from the South Carolina Commission on Higher Education

DRAYTON HALL THROUGH THE AGES
(A hypothetical journey through time based on geologic evidence)

by
John R. Wagner – Professor of Geology – Clemson University

July 2003

The Drayton Hall site looks pretty much the same now as it did 100 years ago. But if we go back not hundreds of years, or even thousands of years, but millions of years, we probably wouldn't recognize the site at all. The problem isn't that Drayton Hall hadn't been built yet; that much should be obvious. But the very landscape and river frontage that makes the site special today looked very different in the distant past. The following account is not meant to be exact (we don't have enough geologic data to be precise), but represents a possible progression of landscapes and environments that shaped the site now occupied by Drayton Hall in ways that made it uniquely suited for the many uses put to it by the Drayton family.

> Drayton Hall is an authentic Plantation House (c.1738) situated on the Ashley River north of Charleston. It has been designated a "National Trust Historic Site" because of its unique architecture and offers tours and educational programs to school groups. Drayton Hall is located at 3380 Ashley River Road; Charleston SC 29414. For more information contact (843) 769-2600 or <http://www.draytonhall.org>.

PALEOZOIC ERA

Cambrian Period – The Drayton Hall site is part of the continent of Africa, far away from North America. Rivers (not the modern Ashley River, but ancient un-named rivers) flow across a coastal plain to an ancient sea called the Iapetus Ocean. The rivers are probably tidal and filled with mud, but there is no salt marsh. In fact, there is no plant life visible on land at all. During this time, there are no land plants anywhere on earth, with the possible exception of fungi (like mushrooms) and lichens. A variety of invertebrate animals exists in the ocean, but not many of these would inhabit the floodplain rivers. You might find some trilobites, some primitive echinoderms, and some wormlike creatures living in the mud where the rivers empty into the ocean.

Ordovician Period – Not much has changed for our site, except that sea level has risen and the shoreline is much closer. The exact position is unknown, so the Drayton Hall site could have even been underwater at this time. In fact, over 50% of all continental landmasses all over the world are under water. There is still no land vegetation, but the coastal areas are very low in elevation and very little sand or mud makes it to the ocean through river transport. The result is that limestone will probably form in the shallow ocean areas away from the shoreline. Likely invertebrate animals are trilobites, bryozoa, brachiopods, and primitive corals. The first primitive fish are swimming in the oceans and some of them may even swim up the rivers into the coastal area.

Silurian Period – The landscape has experienced a little bit of uplift and the streams now flow a little stronger and carry more sand and mud down to the ocean. Sea level is a bit lower now, and the shoreline is actually farther from the Drayton Hall site than it was. The rivers (still un-named) carry silt and mud which allow deltas to build up along the coast. The first primitive land plants (psilopsids) are probably visible over the wide expanse of the mud flats, but most would grow low to the ground. A few primitive snails and clams occupy freshwater areas, but most invertebrate life is in the sea. Away from the deltas, coral reefs are abundant and brachiopods and bryozoans dominate that habitat. Freshwater fish, although primitive, are becoming more common.

Devonian Period – Sea level changed drastically during the Devonian Period. In the early part of this period, sea level dropped exposing the sea floor to erosion and energizing streams flowing through the coastal floodplains that also eroded a lot of material. Later in the period, sea level rose again covering the eroded landscape with new deposits of sand and mud. The Drayton Hall site probably stayed above sea level, but was alternately eroded and built up again by the un-named rivers of the ancient coastal plain. Primitive trees became the first plants to reach up above the earth's surface to gather sunlight and ferns were abundant along the ground. The first amphibians crawled along the floodplain among the ferns, but never ventured far from the river and the moisture they needed to survive. Insects, such as cockroaches, were also abundant in the floodplain. Bony fish began to take over the seas, and the rivers. Swamplands were probably widespread.

Mississippian Period - The closing of two massive continents began to affect the Drayton Hall site through a variety of tectonic events. Volcanic eruptions and earthquakes were commonplace as the old Iapetus Ocean became narrower and narrower and ocean sediments were squeezed up onto the continental shelf. Volcanic mountains spewed lava and ash over the landscape and tectonic uplift created many more areas of high elevation. Erosion became the predominant force at the Drayton hall site. Layers of sediment that took millions of years to accumulate disappeared over a few hundred years. The eroded material spilled out of rivers into the ocean creating huge deltas and large areas of swampland and mudflats. The primitive trees (lycopsids, spenopsids, tree ferns) and the first gymnosperms (relatives of pine trees) piled up along the coast and were buried in deltaic sediment. After long years of burial, under high temperature and pressure conditions, these organic remnants would be converted to coal. More advanced amphibians roamed the swampland and the bony fish completed their takeover of freshwater habitats.

Pennsylvanian Period - The collision of Africa and North America reached its culmination during this period. The Drayton Hall site, along with most of the land for hundreds of miles in every direction was pushed up into a colossal mountain range, probably with ice-capped peaks and flowing glaciers. Rivers ran swiftly and strongly, but in totally different directions than before. The old Iapetus Ocean area was now the highest part of the mountain range and rivers had to run downhill away from this region. Freshwater fish and insects were abundant, as were the amphibians. For the first time, small, primitive reptiles appeared on the scene. Forests covered the slopes of the mountains, but only the primitive spore-bearing trees and gymnosperms. There were no flowering plants around at this time. The climate was probably dry and cold.

Permian Period – Even though the newly formed Appalachian Mountains continued to erode, the tectonic uplift continued to push most of this region well above sea level. Streams and rivers near the Drayton Hall site probably flowed eastward through Africa towards the Tethys Sea. After spending hundreds of millenia being pushed by the forces of continental drift, nearly all of the continents on earth had finally joined together to form the great supercontinent "Pangea". Gymnosperms were becoming more and more common on the mountain slopes, although the more primitive types of trees still survived. Reptiles coped much better than amphibians through the continually cooling and drying climate and soon became the dominant land vertebrate. The pelycosaurs (example Dimetrodon) and therapsids (mammal-like reptiles) were two such groups. Much of the swampland was gone and both plants and animals went through hard times. At the end of the period, a massive extinction took place and less than half of all biological families survived into the Mesozoic Era.

MESOZOIC ERA

Triassic Period – The Triassic Period heralded the beginning of the end for the supercontinent of Pangea. Slowly but surely, the same forces of continental drift that had pushed the continents together, now began to pull them apart. As the earth's crust was stretched, huge areas of land cracked and dropped down along large fractures creating a series of fault or rift basins that stretched across South Carolina and in fact along most of the eastern edge of the Appalachian Mountains. Several parallel bands of rift zones formed, but the actual break occurred along the rift zone south and east of the Drayton Hall site. The rift basins that cut through the midlands of South Carolina accumulated tremendous quantities of river sand, lake muds, and volcanic flows, but eventually became inactive and were covered by later sediments. The rest of the landscape remained fairly high and dry, with erosion being the main geologic process at work there. Stream systems were fragmented as rivers changed their courses to flow into the nearest rift valley. Forests and other vegetation didn't change much from previous periods, although coniferous trees called cycads started to cover the landscape. But the most important new arrival was the dinosaur. Still small and relatively non-threatening, these reptiles would grow in size and number to eventually dominate the entire Mesozoic Era.

Jurassic Period – The Jurassic Period marks the first opening of the new Atlantic Ocean. Because sea level was so low, the shoreline was located over a hundred miles east of the current Drayton Hall site. The high peaks of the Appalachian Mountains still dominated the landscape to the west and a vast erosional region known as the piedmont began to carry bits and pieces of the metamorphic and igneous rock foundation towards the new ocean. The rivers passing the Drayton site would have looked more like the Saluda or Catawba Rivers of the upstate look today. They would have been rocky and fast moving. Stretches of gravel and sand would fill in between the rocks. Invertebrates found today in upstate piedmont counties would have been abundant in the Drayton rivers. Forests of conifers would have covered the ground from the river banks to the hillsides. Dinosaurs ruled the animal kingdom. Allosaurus, Apatosaurus, and Stegosaurus were some of the big names that roamed the land. Flying reptiles soared through the air with the earliest birds, and strange reptiles like ichthyosaurs and pleisiosaurs ruled the seas. Primitive mammals, primarily insectivores, existed, but tended to stay low and out of the way to avoid being eaten.

Cretaceous Period – As the mighty Appalachian Mountains wore down further and further, and as rivers carried more and more sand and mud to the ocean, the coastal areas began to sink down under the weight and sea level began to rise, eventually covering at least half the modern state of South Carolina. For the first time in a long time, the Drayton Hall site was under the ocean. In fact, this site was actually deep under the ocean. The modern sandhills of the midlands region of South Carolina marked the shoreline during much of this time. These sand features represent either beach sand or dunes piled up by wind. In either case, the entire state, from Columbia southward was under water. Silt and other finer grained sediment wash out to sea further than sand and so these earliest ocean deposits mixed mud and sand with chemically precipitated calcite and glauconite (an iron mineral) to begin the building up of the modern coastal plain. The Cretaceous Period marks the first appearance of flowering plants and hardwood trees. Butterflies, bees, and ants were common insects. Birds and flying reptiles (pterodactyls) lost their teeth and developed beaks. But the dominant force was once again the dinosaur. Tyrannosaurus Rex and Velociraptor preyed on Iguanadon, Triceratops, and Ankylosaurus, as well as any small mammals they happened to find. But their rule came to an end very suddenly, at the end of the period. All the dinosaurs and many other kinds of plants and animals became extinct as the result of a huge asteroid impact that probably hit Mexico and proved disastrous for life in South Carolina.

CENOZOIC ERA

Tertiary Period

Paleocene Epoch – The seas continued to rise slowly at the beginning of the Cenozoic Era. The Drayton Hall site remained well under water, slowly accumulating fine grained sediment with occasional episodes of sand influx, perhaps as a result of storms such as hurricanes. Glauconite (iron mineral) and opaline claystone (sometimes known as Fuller's Earth) might have been common in some of these layers. Oysters and snails were common in the area. Modern fish and sharks would also were common. Primates, rodents, and early carnivores could be found on land.

Eocene Epoch – The Eocene marks the greatest advance of sea level in South Carolina history. The shoreline was almost certainly located in the upstate, perhaps even as far west as the Blue Ridge. Because the shoreline was so far away, land sediment eroded by rivers dropped out long before reaching the Drayton site. The absence of silt and mud allowed pure limestone to form over parts of the continental shelf of South Carolina. The most famous rock unit, the Santee Limestone, contains many fossils of both vertebrates and invertebrates. Bryozoa are common here, as are oysters and scallops. Sharks and whales frequented the area. The first horses appeared on land.

Oligocene Epoch – Sea level dropped somewhat, but still stayed fairly high. The closeness of the shoreline to the Drayton Hall site allowed silt and mud to mix with the chemically precipitated limestone to form the mixture known as marl. Occasionally, organic rich layers of mud would chemically alter into phosphate minerals. The Cooper Marl is the best known rock. It contains microfossils (foraminifera) and a fair number of scallops. On land, the dog and cat families diversified into many different genera and elephants and whales got larger and more specialized.

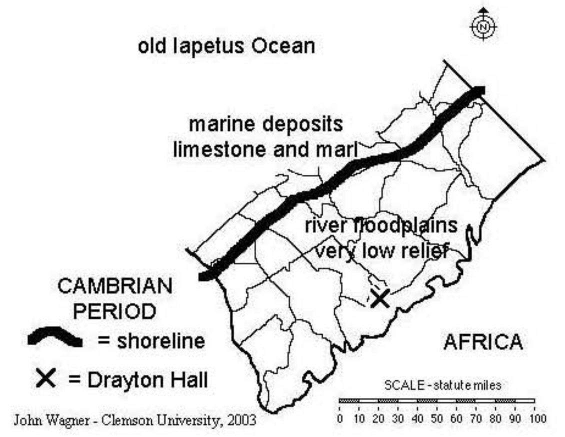
Miocene Epoch – The Appalachian Mountains experienced a renewed tectonic uplift which helped pull the western part of the South Carolina coastal plain out of the water. At the same time, the weight of accumulated sediment on the continental shelf caused the sea floor to subside, tilting the layers. At the Drayton site, a sandy phosphatic marl was deposited along with layers of mud. Today we call this unit the Hawthorn Formation. Many of the phosphate nodules were probably re-worked from earlier deposits. Fossils are few, but include oysters, scallops, and slipper clams. On land, the first grasslands appear along with grazing animals like bison and cows.

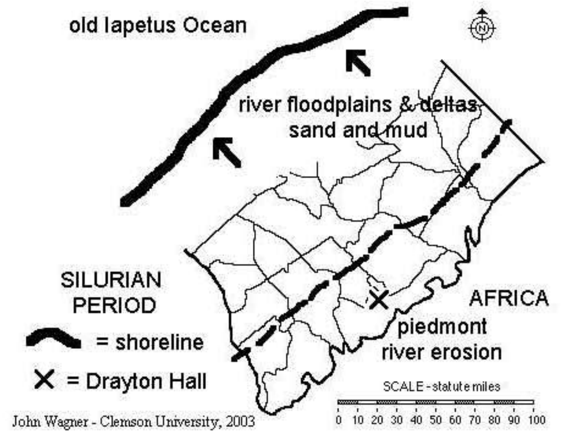
Pliocene Epoch – Sea level rose slightly putting the shoreline a little further away from the Drayton Hall site. The renewed uplift from the Miocene left streams flowing faster and bringing coarser material to the oceans. The deposits at Drayton are mostly sand with many mollusks including scallops, snails, sand dollars and clams. Land plants and animals are essentially modern.

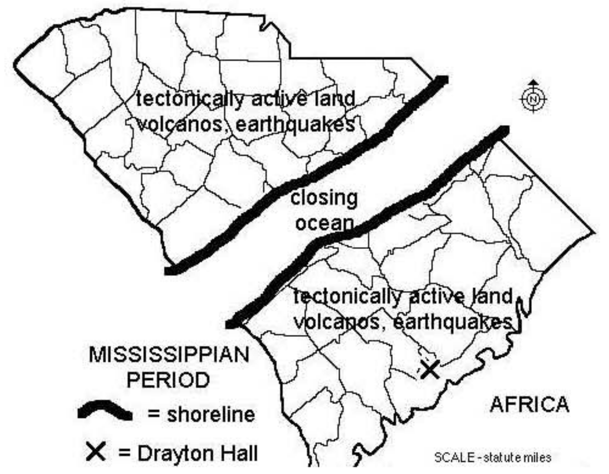
Quaternary Period

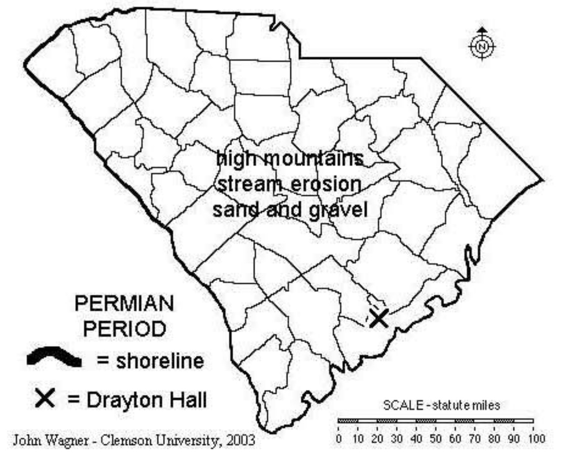
Pleistocene Epoch – Sea level fluctuated wildly during the Pleistocene as the great ice ages came and went. Although the ice never reached South Carolina, it pulled enough water out of the oceans to lower sea level by over 50 meters. So the Drayton Hall site was alternately drained and eroded, then flooded again when the ice melted. Most of the sediment deposited during the flooding was removed during the next erosion cycle. Each highstand of sea level left a beach ridge that is higher and drier than the rest of the landscape. Large terrestrial mammals like mastodonts, giant elk, giant beavers, and giant sloths wandered the area before becoming extinct at the end of the epoch.

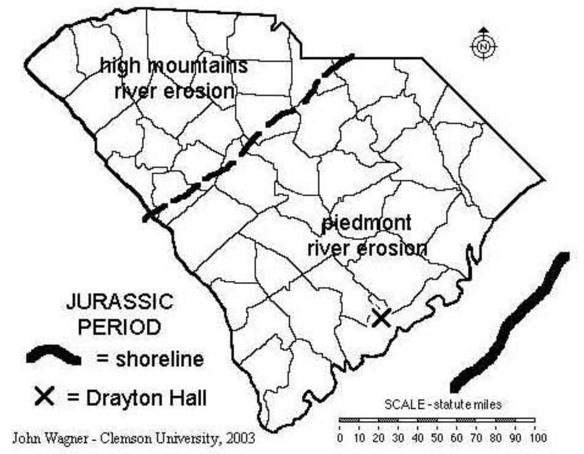
Recent Epoch – Sea level fell below the Drayton Hall elevation for the final time. Since then, the landscape has dried out, the Ashley River has begun to cut away at its banks, and human impact has left rice fields, roads, and of course, old buildings. Plants and animals are essentially modern.

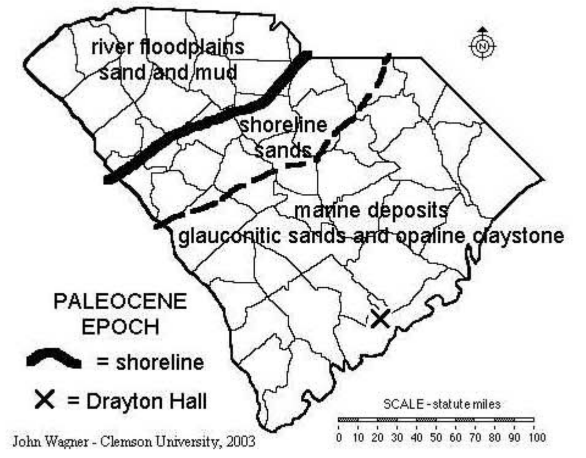


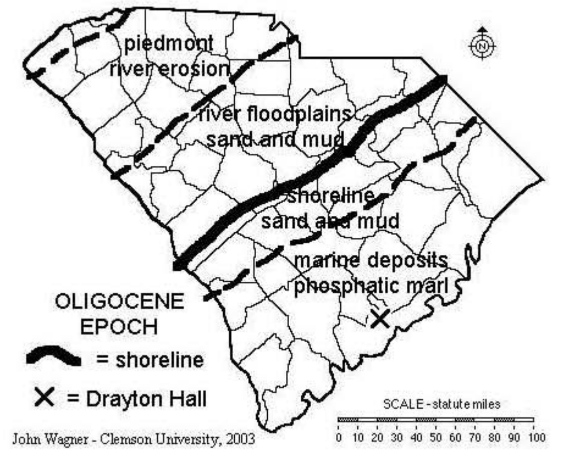


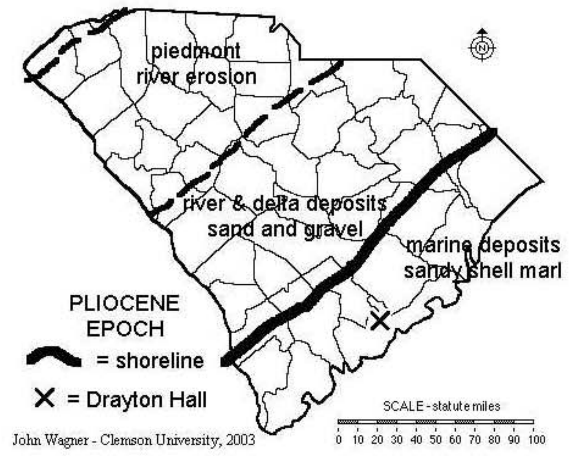


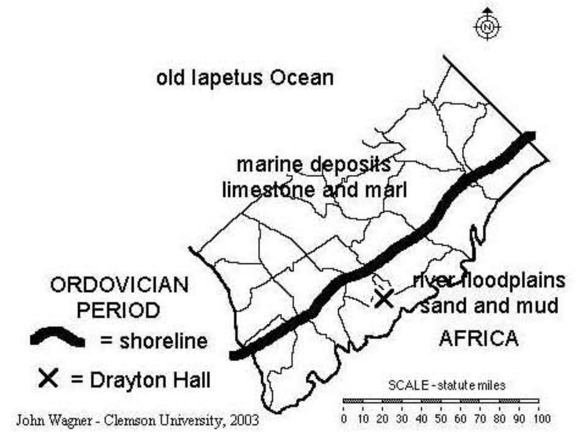


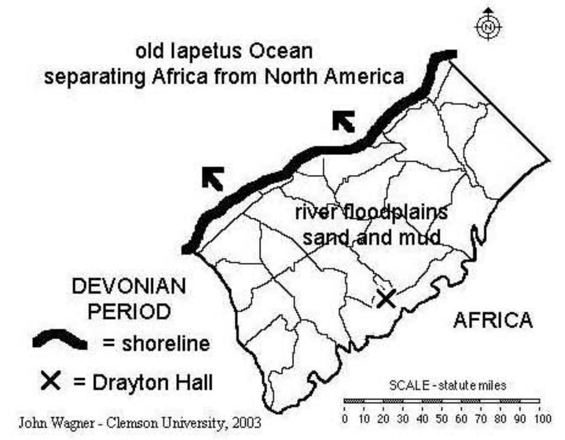


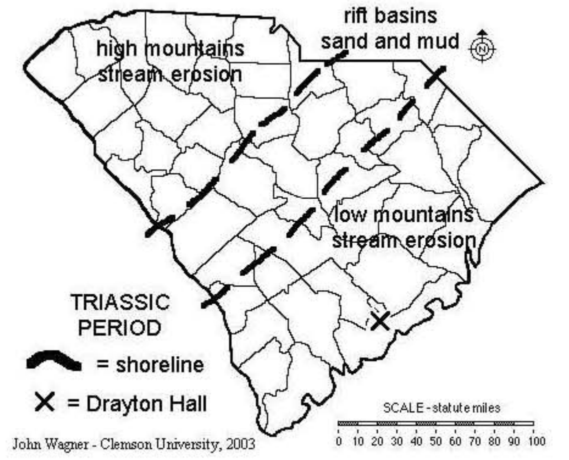


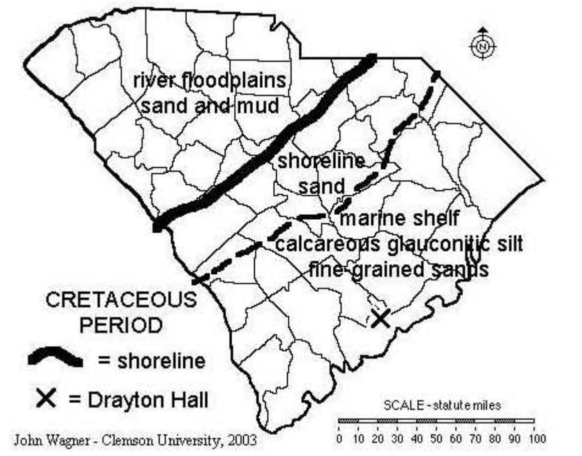


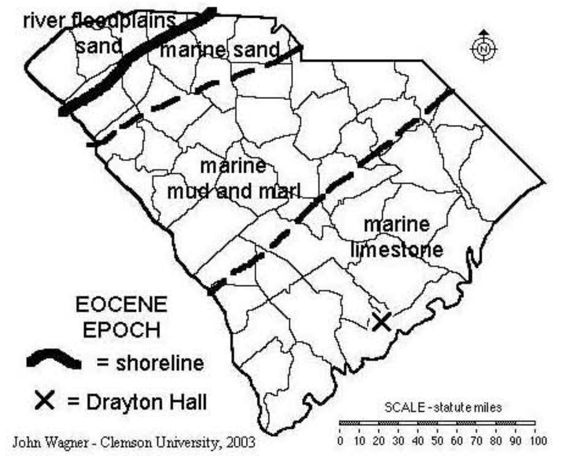


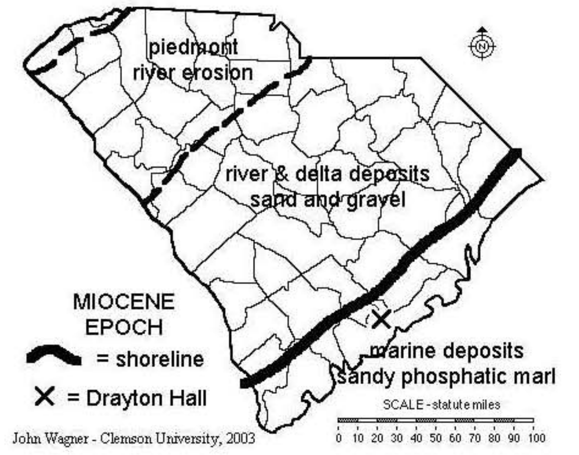


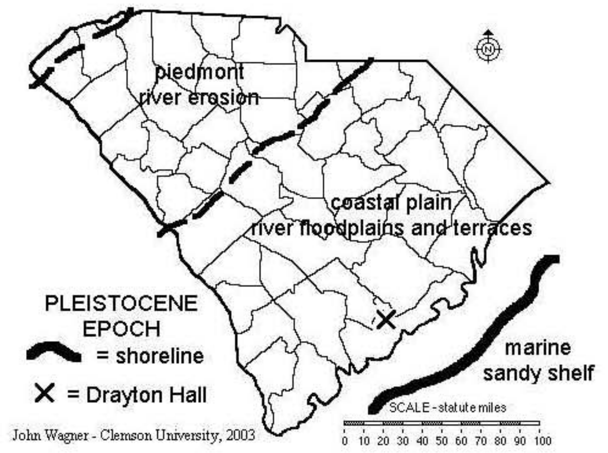


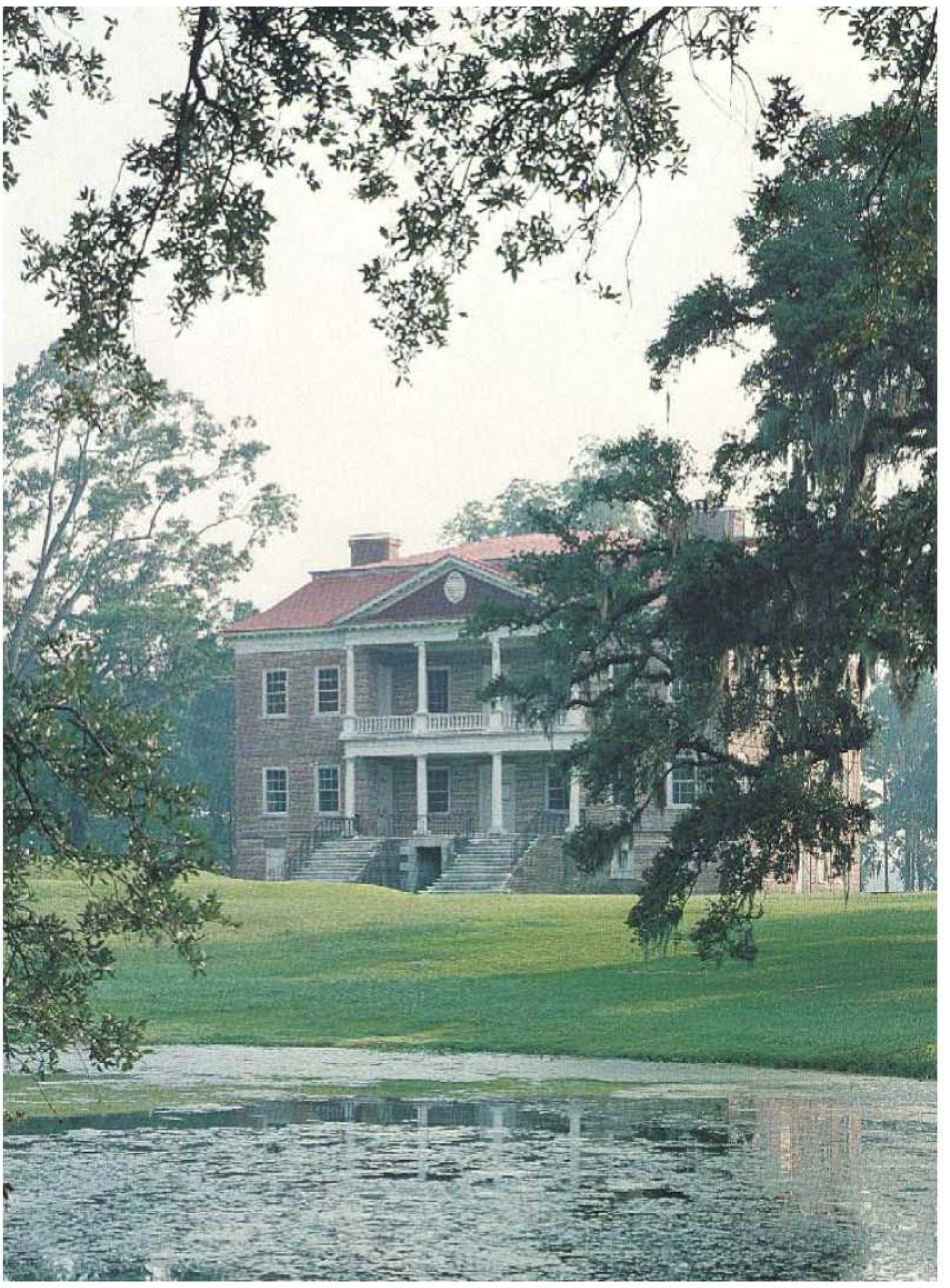


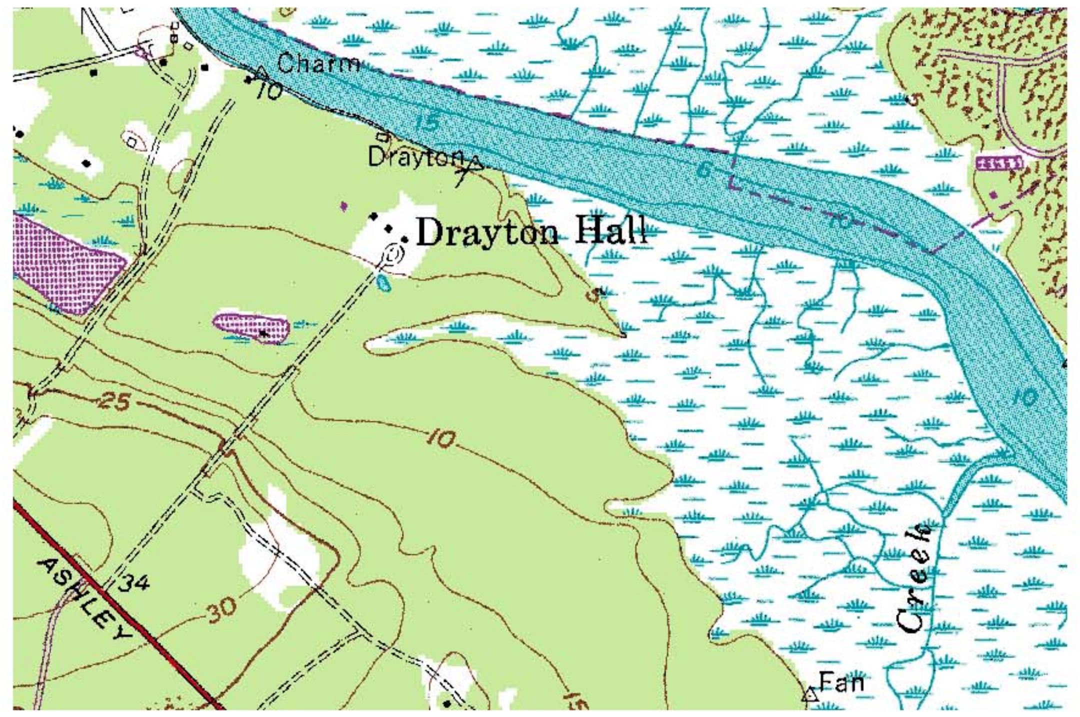












Drayton Hall – Geological Education Program

by Stephanie Jones and John Wagner
Department of Geological Sciences - Clemson University – 2003

Instructions for leader are in italics; ideas suitable for presentation are in regular type.

Assemble group for today's tour and go to the starting place.

Program Outline:

1. Start: *Intro information for site (a little about Drayton Hall in case students have not yet been on the house tour)*

2. Today you are here to learn about geology. *Can take place on main lawn*

Can anyone tell me what geology is? (scientific study of the earth and its processes – earth science)
What are some things that geologists study? (rocks, soil, fossils (dinosaurs included), rivers, lakes, oceans, water in the ground, earthquakes, volcanoes, mountains)
What does someone need to be a geologist? (graduate high school, go to college in geology; also be a good observer and have a good imagination.)

Imagination is very important to geologists because the things they study are usually too big, too small, or too far in the past to see with our eyes. Using the clues that have been left behind, geologists put together the story of what has happened to make the earth like it is today. Being a geologist is like being a detective for the earth.

Today we are going to become geologists for the day! We are going to look at some clues from the past to help us put together the story of Drayton Hall from a very long time ago.

***Travel from starting place to corner of house with earthquake damage. Touched up picture should be placed there beforehand.*

3. Earthquake crack on house
Have students look at a touched up photo of the house without the earthquake crack compared to the actual corner of the house with the crack.

First, we are going to test our observation skills. Look at the house, and look at this picture.
What is different between the picture and the house? (crack)
What could have caused the crack? (shaking or tremors from movement of the earth, specifically the 1886 earthquake)
How do earthquakes happen? (rocks break apart and rub together along faults (breaks in the rock); some faults are at the surface and can be seen, such as the San Andreas in California, but most are deep below the surface of the earth)

To illustrate how movement deep below the surface could affect the surface at all, use the wrist as an example. Have students hold an arm in front of them, parallel to the ground. Then have them rotate their wrists while observing the movement of their skin. They are moving something below the surface that alters the movement on the surface.

The earthquake that caused this damage happened only about 100 years ago due to rocks that formed *millions* of years ago.

Point out that the "Flanker Building" came down during the 1886 earthquake.

***Travel to large live oak trees in front of the house*

4. Live oaks in front of house
Discuss landscape when these trees sprouted.
How old are these trees? (350-400 years old)
What year was it when they sprouted? (1600-1650).
Who lived here? (Charleston was not founded until 1670, so only Native Americans)
What was the landscape like? (many more trees)

Close your eyes and imagine what this area looked like as a thick forest next to the Ashley River. (students can get clues from looking at trees around mined area)

What would be different about the ground? (it was unfarmed and unmined; students will probably not realize that mining was extensive in this area, and it can be mentioned at this point)

***Allow students to imagine the area pre-development for a moment, and then move on along the path towards the river for the next stop.*

5. Native American Artifact ***stop anywhere along path towards river***
If available, this is the time to discuss a Native American artifact. An older artifact would provide the best transition between 400 years ago and the next (calcium phosphate age) stop.

If desired, the provided maps and narrative of the Pleistocene and Pliocene Epochs can be used at this time to provide supplemental information about the appearance of the Drayton Hall site over the past 5 million years.

***Travel along the path towards the river for the next stop.*

6. Calcium phosphate nodules *along path near river*

Can anyone tell me what this is? (probably not)

Pass around nodule and ask students to describe it.

If possible locate a fossil collected from phosphate layer. If located, pass fossil around group and ask if anyone has ever seen anything like it. The fossil shells that I have seen closely resemble shells that are on the beach today.

The nodule is hard, lumpy, creamy colored, possibly has fossils in it.

What is a fossil? (very old evidence of life)

This fossil is about 25 million years old, but it looks like the same shells we can find on our beach today. How can this be possible? (the beach has moved, because this area was once underwater and near the beach)

The phosphate nodules are reworked portions of a rock unit known as the Cooper Marl, a view of which is the next activity of the program. This phosphate developed after the Cooper Marl had already been deposited, when water with high phosphate levels seeped through the sediment and replaced calcite crystals in the marl. This had to have occurred before the Miocene-age deposits immediately overlying the Cooper Marl were deposited. The Cooper Marl is between 23 and 33 million years old (Oligocene Epoch), while the overlying deposits are likely between 11 and 16 million years old (middle Miocene Epoch).

If we were stood here when this was deposited, what would we see if we looked around? (water – about 600 feet deep)

Where was the beach, if we were under 600 feet of water? (around the 600 ft contour, through the city of Greenwood [see state base map - contour map])

What types of animals were around? (on land: this is post-dinosaur, so ancestors of today's horses, elephants, cats and dogs; at sea: sharks, fish)

The provided map and description of South Carolina during the Miocene Epoch provide supplemental information for this age.

7. Marl in Ashley River *path along river bank*

The Cooper Marl is visible in the Ashley River at Drayton Hall during low tide. If the class visit will not be during a low tide, obtain a sample beforehand to show or ask students to imagine a thick, greenish-brown clay. The Cooper is Oligocene in age and has extensive exposures in the immediate area.

The greenish-brown mud in the river is called the Cooper Marl. Geologists give names to different types of rocks to identify them and classify them. **Marl** is the type of rock that is here, and **Cooper** is the name given to tell it apart from all the other marls in the area.

The provided map and description of South Carolina during the Oligocene Epoch provide supplemental information for this age.

8. Information Stop
This stop can be conducted anywhere that is convenient.

Using the provided maps of South Carolina during different time periods, tell the rest of the story about Drayton Hall. Remember that most evidence is either deeply buried or no longer present at all due to destructive geologic processes. Remember that the narrative proceeds from the past to the present, as that is how geology is normally represented. This walking guide, however, proceeds from the present to the past. Continue to present information in this order to students.

LEARNING GOALS: National Science Education Content Standards (pg. 160)
"Earth's History: The earth processes we see today, including erosion, movement of lithospheric plates, and changes in atmospheric compositioin, are similar to those that occurred in the past . . ."

GEOLOGIC SKILLS: Reading and interpreting paleogeographic maps

HIGHER ORDER THINKING SKILLS: Linking paleogeographic features to plate tectonics events occurring at that time

CONTEXT: Instructional level = 8th grade - focus on South Carolina Studies (interdisciplinary theme)
Prior skills required = ability to read a map and a legend
Place in course = an introduction to geologic time using a local example to extend historic time to prehistoric time. Can be used anytime after plate tectonics concepts have been introduced.

EVALUATION: This activity is part of a pilot project funded by the South Carolina Commission on Higher Education to promote the use of interdisciplinary case studies to learn about the geology, geography, human and natural history of South Carolina. Teacher Feedback forms and classroom observations by an external evaluator will help determine the effectiveness of the activity. After studying the geologic history of the local Drayton Hall site, students will be asked to construct a similar set of paleogeographic maps for their own school location or other well-known local site. Student success in the follow-up activity would provide evidence that the Drayton Hall activity provided a successful conceptual template for understanding geologic time.

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