Rocks of the Coastal Plain

Region 3

The Southeast Coastal Plain region exposes Cretaceous, Tertiary and Quaternary rocks of the Atlantic and Gulf Coastal Plains, which sweep in a wide arc through Virginia, around the point of Florida, and up through the ***Mississippi Embayment*** and across Texas. The Atlantic Coastal Plain continues northward through New England, and the Gulf Coastal Plain wraps west around the Gulf of Mexico. Overlying the ancient bedrock of the Blue Ridge & Piedmont region, Coastal Plain sediment forms a wedge of gently dipping layers of sediment and sedimentary rock that thickens towards the Atlantic Ocean and Gulf of Mexico *(Figure 2.32)*. At its innermost edge (bordering the Piedmont), the wedge of sediments is very thin. Under the continental shelf out in the Atlantic Ocean, the wedge of sediment is as much as 4000 meters thick. On the Gulf Coast, the sediment is up to 12 kilometers thick.

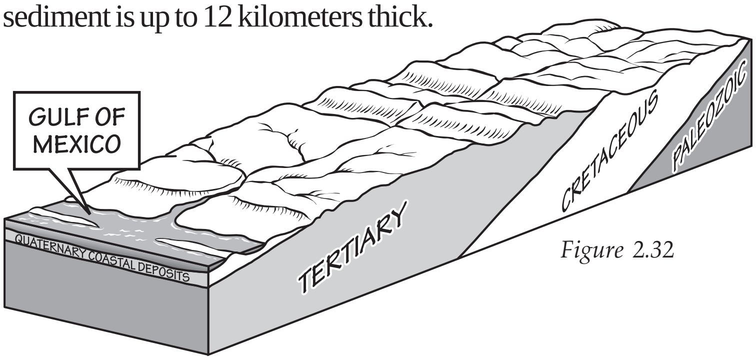


Figure 2.32

The sediment and rock of the Coastal Plain is geologically very young, ranging in age from Cretaceous (at the end of the "Dinosaur Age") to Quaternary. The sediment and rock include gravel, sand, silt, clay, marl, limestone, and uncommon layers of concentrated shell material called coquina. Much of the Coastal Plain "rock" is unconsolidated sediment that has not had time to be lithified, cemented or compacted enough to become hard. It may be tens or hundreds of millions of years before the unconsolidated layers of sediment are turned to rock, depending on the rates of cementation and compaction. Not all of the Coastal Plain rocks, however, are unconsolidated sediment. Some formations are more compacted or cemented than others, particuthe Quaternary Ice Age, also greatly contributed to coastal deposition and erosion. During the middle Mesozoic, when the Atlantic Ocean formed, a shallow sea connecting the Gulf of

The **Mississippi Embayment** *is considered part of the Coastal Plain region, and Tennessee, Kentucky, Arkansas, and even southern Illinois all have Coastal Plain rocks even though today they do not have any shoreline. But in the Cretaceous the ocean flooded the downwarped area of the embayment, giving these states prime ocean front property!*

DEF: EMBAYMENT

Tilted Rocks

Why are the Coastal Plain sediments exposed at the surface younger and younger as you move out toward the Atlantic Ocean or the Gulf of Mexico? As the Atlantic Ocean and Gulf of Mexico basins widened following the breakup of Pangea, new sediment was deposited in the basins. The weight of millions of years of sediment accumulation in the basins caused the coastal areas to subside, creating a gentle slope eastward toward the Atlantic and southward toward the Gulf of Mexico. The Mississippi River Valley also was subsiding during the Mesozoic and Cenozoic, causing a similar tilting of Coastal Plain sediment toward the Mississippi Embayment. This tilting, though slight, exposes the older Cretaceous units that would otherwise be buried by younger sediment. (Figure 2.32) (FIGURE: LACEFIELD CROSS-SECTION)

Mexico and the Atlantic Ocean covered the area that is now Florida. During the Cenozoic and Quaternary falling sea level exposed the Florida Peninsula. It was also during this time that the Mississippi Embayment was filled with sediment

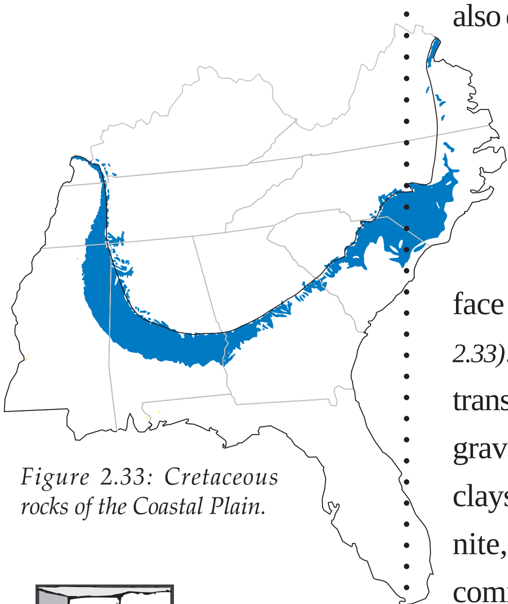
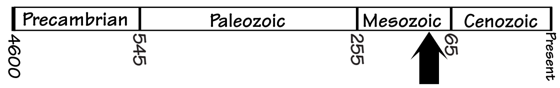


Figure 2.33: Cretaceous rocks of the Coastal Plain.

see Rocks, p.52, for more on **kaolinite.**

Cretaceous Rocks



Cretaceous deposits are the oldest sediment deposits exposed at the surface in the Coastal Plain and are found along the inner edge of the region *(Figure 2.33)*. The Cretaceous units record the erosion of the Appalachian Mountains and transportation of sediment by rivers to the coast, building up successive layers of gravel, sand, silt and clay that fanned out onto the continental shelf. A variety of clays are found in the Cretaceous rocks of the Southeast, including montmorillonite, which has been interpreted as a weathered ***volcanic ash*** that was perhaps coming from central Mississippi or the Rocky Mountains. Another kind of clay found in Alabama, Georgia and Florida is ***kaolinite***, a valuable economic resource that is mined in certain areas of the Southeast. Triassic and Jurassic rocks, exposed at the surface, exist in the subsurface of the Coastal Plain and are studied using drill cores.

Why would there be **volcanic ash** *in the Coastal Plain region? Two thousand nine hundred feet beneath Jackson, Mississippi, a set of igneous rocks and ash deposits attests to the volcanic past of the Southeast. During the Cretaceous, the Gulf of Mexico was widening as South America separated from North America. The divergence of plates caused significant volcanic activity in the area and volcanoes were located along the rim of the modern Gulf Coast. The volcanoes spewed ash that settled in layers at the surface. Far below the surface was magma that formed the cores of the volcanoes. The magma eventually cooled to form igneous rock. Though the igneous rocks are not seen at the surface, they are evidence of a now long-extinct volcano. Jackson, Mississippi is unique: no other US State capital or large city is situated on top of an extinct volcano! Also at this time in geologic history, the Rocky Mountains were being uplifted with much volcanic activity and ash that could have spread as far as the Southeast.*

Toward the end of the Cretaceous period, sea level was very high worldwide, allowing the deposition of marine sediment across much of the Coastal Plain. 'Greensand' was deposited in these marine settings during the Cretaceous and Tertiary. The greensand gets its color from the green mineral, glauconite. Since the mineral glauconite is associated with modern marine environments, its presence is a clue to geologists that sediment was deposited in a marine environment. Other clues to the marine origin of the late Cretaceous Southeast sediment include thick deposits of chalk. A soft variety of limestone, chalk forms from the build up of microscopic plates from one-celled algae. The plates, small as grains of clay, are called coccoliths. Chalk deposits are common in Cretaceous deposits worldwide and represent

deeper ocean waters in which the shells of tiny organisms settled to the bottom upon death and accumulated as layers of calcium carbonate. When clay particles are also settling to the bottom and are mixed with the layers of calcium carbonate, marl forms. While chalk deposits are white, marl deposits are gray to green because clay mud is mixed with the calcium carbonate mud. In the Southeast, thick chalk and marl layers are found in Alabama and Mississippi in a region known as the ***Black Belt.***

Although there are no Cretaceous rocks exposed at the surface in Florida, the carbonate sediment deposited during this period created the ***foundation*** of the modern Florida Platform. Following the breakup of Pangea in the Jurassic, a basin formed in the region of Florida where the continents separated and new ocean crust was forming. The basin was very gradually sinking, allowing reef communities to flourish and build on top of each other as sea level slowly rose (as the basin sank!). Sediment eroded from the Appalachian Mountains did not reach the carbonate platform because of the Gulf Trough in northern Florida. Currents moving through the trough swept away sediment coming from the north, thus protecting the corals and other organisms on the carbonate platform *(Figure 2.34)*. The skeletons of reef communities were composed of calcium carbonate, which formed the modern carbonate platform. Carbonate sediment continues to build up on parts of the Florida platform (such as the seaward side of the Florida

Cretaceous *is actually derived from the Latin word, "creta" or "chalk". The white (chalk) cliffs of Dover on the Southeast coast of England are a famous example of Cretaceous chalk deposits.*

The **Black Belt** *derives its name from the nearly black, rich topsoil that developed in the area over the Selma Chalk.*

The carbonate **foundation** *created during the Cretaceous was deposited on top of the ancient bedrock foundation of the Tallahassee-Suwannee-Wiggins terrane.*

see Geologic History, p. 7, for more on the **foundation of Florida.**

Depositional Environments

Sedimentary rock and sediment hold clues that lead geologists to recognize the environments that existed when the Earth materials formed. Geologists can recognize river or marine environments in deposits of gravel, sand and silt using evidence such as fossils, sedimentary structures, sediment size and other tools. For example, in some Cretaceous units paleosols are found. Paleosols are ancient soils. We can tell they are soils because they contain preserved mud cracks, root traces, and iron and manganese oxides, which indicate sediment exposed to the air and oxidized. The type of soil structures formed depends on climate and the amount of time the sediments were exposed. Paleosols can be compared to modern soils to determine ancient climates. In some areas, such as central Alabama and Northeast Mississippi, the paleosols have been heavily eroded and the colorful oxide layers look similar to the Badlands of South Dakota. Paleosols can also be found in older rocks of the Appalachian Plateau, and Valley and Ridge, and even in rock cores cut far below the surface in oil or gas wells.

Figure 2.34: The presence of the Gulf Trough contributed to Cretaceous carbonate deposits in Florida.

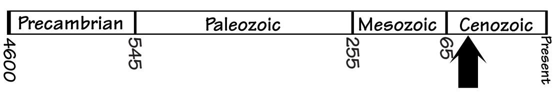
Keys) because similar conditions prevail today: warm, sub-tropical climate, and clear, shallow water that allow organisms with calcium carbonate skeletons to thrive and grow.

see *Geologic History*, p. 7 for more on the **Cretaceous-Tertiary Boundary**.

Cretaceous-Tertiary (K/T) Boundary

Within the Atlantic and Gulf Coastal Plain areas, the Cretaceous-Tertiary boundary is invariably marked by a distinct physical unconformity usually distinguished by a change in lithology. For example, at Moscow Landing along the Tombigbee River in Sumter County, west-central Alabama, and along the south valley wall of Lynn Creek in Noxubee County, east-central Mississippi, Tertiary sands or sandstones and dark gray marls and clays overlie white Cretaceous chalks. Another characteristic of the K/T boundary is the presence of a thin mm-scale layer of clay containing a number of rare earth elements, including iridium. Although present along the contact in many areas of the world, this boundary layer has as yet to be documented in either the Gulf or Atlantic Coastal Plain areas. Where present, this enriched boundary layer has led many scientists to believe the Cretaceous extinctions resulted from the impact of a large comet or asteroid.

Tertiary Rocks



The early Tertiary sediments of the Southeast Coastal Plain, particularly Alabama, are among the thickest and most interesting sections from this time period in the world. France, England and Alabama are the global standard for early Tertiary sediments and fossils. During the early part of the Tertiary, conditions like those of the Cretaceous period prevailed throughout the Southeast. Carbonate sediment deposits (forming mainly limestone) dominated the Southeast Coastal Plain as far north as North Carolina. During the late Tertiary, non-carbonate sediment deposits dominated, and no more carbonates were deposited over most of the Coastal Plain except in southernmost Florida *(Figure 2.35)*.

see *Fossil Fuel Resources*, p.154 for more on **lignite.**

(MARGIN: LIGNITE)

Lignite is commonly found in the Tertiary-age Coastal Plain deposits because coastal marshes and swampy areas near the shoreline accumulated large amounts of plant material. Sea level fluctuations throughout the Tertiary resulted in cycles of sand, silt, clay, lignite, and carbonate sediments.

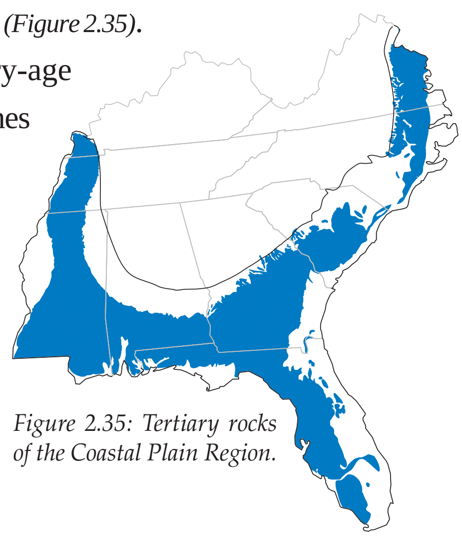


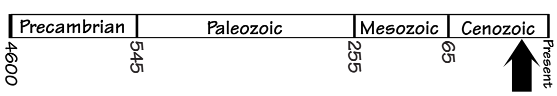
Figure 2.35: Tertiary rocks of the Coastal Plain Region.

Erosion of the Appalachian Mountains continued through the Tertiary, resulting in a thick band of Tertiary-age gravel, sand, silt and clay across the Coastal Plain. Tertiary sea level fluctuations continued, causing considerable back and forth shifting of the Southeast shoreline. The middle Tertiary sediment was deposited in a variety of environments, primarily near-shore marine environments when sea level was high, and river (fluvial) environments when sea level was lower. The Gulf Trough in northern Florida was gradually filled by the large amounts of sediment eroded from the Appalachians, allowing the Florida Platform (which up to this point was predominantly an area of carbonate deposition) to be blanketed with a layer of ***Appalachian-derived sediment***. As the sand, silt, and clay built up on the Florida Platform, the peninsula of Florida began to emerge above sea level. Deposition on the Florida platform from the middle Tertiary (~25 million years ago) to the present has consisted primarily of siliciclastic (non-carbonate) sediment (with the exception of the southern tip of the peninsula.) Sea level fluctuations affected Florida more dramatically than other parts of the Southeast because of the low relief of the area. Thus a range of environments may have existed in one place over time, from shallow lagoons and tidal flats to deep waters. In the late Tertiary, ***shell beds*** and fossiliferous sand and limestone were commonly deposited on the Florida Peninsula.

*The **Appalachian-derived sediment** is "siliciclastic", meaning it is made of gravel, sand, silt, and clay instead of carbonate material.*

*When cemented together, **shell beds** become a rock known as coquina. In rocks from the late Tertiary of Florida, these layers are quite common and are dominated by mollusk shells.*

Quaternary Rocks



The Quaternary period is recorded in the youngest sediment of the Coastal Plain *(Figure 2.36)*. The period is divided into two sub-divisions (epochs): the Pleistocene and the Holocene (in which we are currently living). The ice sheet that repeatedly advanced southward over North America during the ***Pleistocene*** never made it to the Southeast region. Despite not being directly affected by the glaciers, the glaciers indirectly left their mark on the area because when the climate cooled and the ice sheet began to advance, water locked up in continental glaciers caused sea level falls. Also, the cool climate caused dramatic shifts in plant

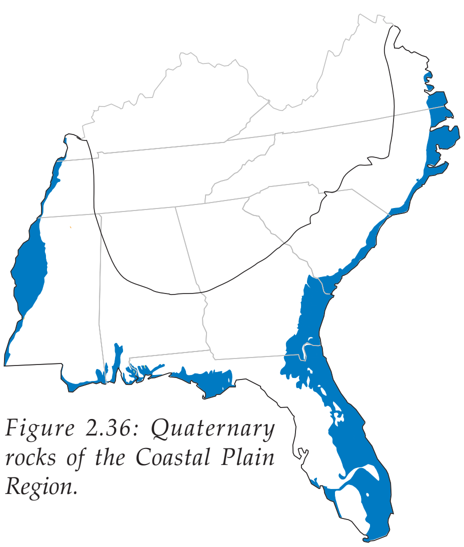


Figure 2.36: Quaternary rocks of the Coastal Plain Region.

*The **Pleistocene** was from 2 million years ago through 10,000 years ago.*

and animal communities. As glaciers to the North moved over the land like bulldozers, they scraped up the surface and pushed tons of sediment before them (and incorporated the sediment within the glacier!) When the climate warmed and ice sheets melted back (an interglacial period), sea level rose and melt water streaming off the retreating glaciers dumped gravel, sand, silt and clay into stream beds. The Ohio River valley, which forms the northern boundary of much of the Southeast region, was formed by the meltwaters of the last ice advance. Sediment from the melting ice was transported through the Ohio River in Kentucky, West Virginia and down the Mississippi River valley. The land area of the Southeast, and especially ***Florida***, increased when sea level was low and the ice sheet was advancing. Likewise, land areas were flooded when sea level rose, and marine sediment buried terrestrial sediment. The glacial changes in living communities are recorded in the Pleistocene fossil record, and also in the presence of remnant cold-climate species (such as hemlock trees in the Dismals Canyon, Alabama) in the warm south of today.

At the greatest extent of the last glacial maximum, the land area of ***Florida*** *was twice what it is today!*

Quaternary deposits make up much of the sediment you see immediately adjacent to modern ***estuaries, streams, floodplains*** and ***creek beds*** throughout the Southeast. The Chickasaw Bluffs, adjacent to the Mississippi River, formed from glacial sediment (including rock flour) that had filled up the Mississippi River Valley when the last ice sheet was melting back nearly 10,000 years ago. When the ***rock flour*** dried, it was easily picked up by the wind and storms, creating thick layers of ***loess*** on the banks of the Mississippi River. Loess is common elsewhere in the Southeast and not all of it is Quaternary in age. The erosion resistant loess layers form the bluffs at Vicksburg, Mississippi. The bluffs, up to 80 feet thick in places, made Vicksburg easily defended against capture by the Union gunboats that bombarded them from below. The extended siege at Vicksburg, the last Confederate stronghold along the lower Mississippi River, resulted from the strategic advantage of high ground overlooking the river.

Erratics

It is common in some of the Southeastern states to find boulders, cobbles, pebbles, gravel and sand that are not of the same composition as the local rock or sediment. For example, boulders of igneous and metamorphic rocks have been found in northern Kentucky and elsewhere, despite the fact that no igneous and metamorphic rocks outcrop in the vicinity. What accounts for the presence of these out-of-place "erratic" rocks? In many cases, glacial melt water brought these erratics much farther south than their origin.

The most recent deposits in the Southeast (from the Holocene epoch, in which we are currently living) from ***estuaries, streams, floodplains*** *and* ***creek beds*** *are not depicted on the geologic map used in this book. Such sediment is sometimes called "alluvium."*

Rock flour *is ground up sediment that has been pulverized to a very fine grain by glacial action.*

Loess *is a deposit of wind-blown silt and clay.*

Most of the surface sediment of the Florida Peninsula formed during the Pleistocene as sea level dramatically rose and fell. Over much of the peninsula, siliciclastic sediment dominates the surface sediment. (MARGIN: Siliciclastic sediment is non-carbonate sediment.) In southern Florida, however, carbonate sediment makes up most Pleistocene and recent deposits. In particular, the Miami Limestone underlies much of the southern peninsula. (MARGIN: The Miami Limestone is composed of ooids, spheroidal particles that form as concentric layers of calcium carbonate are precipitated around a bit of shell or other material. Ooids commonly form in warm shallow waters like those of Florida or the Bahamas.)

At the southern rim of the Florida Platform's escarpment lies a fringe of living and dead coral reefs *(Figure 2.37)*. The Florida Keys consist of fossil reefs and associated sediment. The living reefs are seaward of the Keys. During the ice age, colonies of coral flourished along the edge of the Florida platform. When sea level rose, the reefs grew upward, and when sea level dropped, parts of the reef were exposed and died. The dead reefs became foundations for new coral growth, forming the very thick (75-200 ft) Key Largo Limestone. The last sea level fall of the Pleistocene Epoch exposed the Key Largo Limestone, which is seen at the surface of the Florida Keys today. A bank of oolitic shoals formed the Lower Keys. Small, egg-shaped ooids are formed by a tiny fragment of shell or sand grain that is covered gradually by concentric rings of calcium carbonate. The shoals became exposed above sea level and eventually cemented together to form the surface of the Lower Keys.

Look Closely at the Sand!

If you travel around the Coastal Plain of the Southeast and closely examine the sand at different beaches, you will notice incredible differences! Parts of the Southeast are known for their pure white sand, such as the Gulf coast of Florida, Georgia, Alabama, and Mississippi. If you examine the white sand, you will see that it is made almost entirely of quartz grains. Other beaches may be pink (indicating a high concentration of the mineral feldspar) or have black specks (heavy minerals) or they may be white sands entirely made of calcium carbonate shell material! A surprising number of organisms can sometimes be identified by closely studying the tiny shell pieces. Look closely for parts of corals, bryozoans, echinoderms, shark teeth, clams, and snails, to name just a few.

Some of the differences will be noticeable only with a microscope. For example, grains of dune sand have been constantly moved around by the wind often have a polished, frosted surface. West Tennessee has "glass sand." Determining the types of organisms represented by the grains in carbonate sands is also easier with a microscope.

Why are there such differences in the types of sand? The answer lies in the origins of the sand. What rock was eroded to make up the sand? How long has the sand been eroded and weathered? How much of the sand is shell material that grew on or near the beach? Sand eroded from granite highlands may still have grains of granite left in it. If the sand is heavily weathered, the granite pieces will have broken down into their individual mineral components. Further erosion will entirely breakdown certain minerals such as feldspar into clays that are winnowed away leaving only the quartz and other resistant minerals that are comparatively rare.

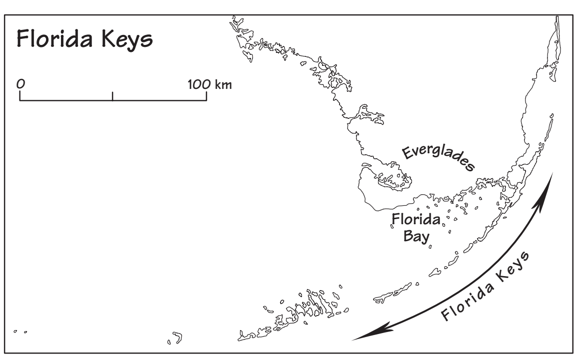


Figure 2.37: The FloridaKeys.