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PHYSIOGRAPHY OF THE GULF COASTAL PLAINS

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The gulf plains are the western extension of the Atlantic coastal plains. They include a large area of land fringing the Gulf of Mexico, and are bounded by a line which forms the divide in Florida, and then extends north and west through Macon, Georgia, passing just north of Montgomery, a little south of Birmingham, just cutting the northeast corner of Mississippi, following the Tennessee River north to the Ohio, thence west to the Ozarks, southwest through Little Rock, crossing Red River at the southeast corner of Oklahoma and passing through Dallas, Austin and San Antonio to the Rio Grande. This irregular semicircle from Florida Bay to the Rio Grande by way of Cairo, Illinois, includes the Gulf Coastal Plains.

History and Topography.—The gulf plains occupy a part of the great central depression of North America, which, during the Paleozoic Era, was submerged by a great inland sea. Before this subsidence, there is strong reason for believing that the Appalachian Mountains extended across Mississippi and Louisiana, into Texas. At the close of the Jurassic Period, a great orographic change lowered the gulf plains and admitted the sea to southern Illinois. Consequently, the Silurian, Cambrian and Pre-Cambrian formations of Alabama plunge beneath the Cretaceous to the south and, in regions northwest of Austin, Texas, are known to dip eastward, and are in the same order. In each case the Carboniferous lies to the north, showing the drainage to have been in that direction before the subsidence. The drainage of Texas, Louisiana and Arkansas is now *against* the dip of the rocks, a condition which would result from a lowering of the Mississippi River valley. The overlying rocks, also, are thicker near the central portion where the depression was greatest.

The Gulf Plains are the uplifted bed of a former sea, lifted without disturbance. The highest portions are along the northern borders where

the altitude reaches 1,000 feet, and from which it slopes gently toward the present shore, much of the margin being but little above sea level.

The Gulf Plain in Florida slopes gently toward the gulf. Florida is a young region, lifted from the ocean floor by the continental force that is supposed to have lifted the Rocky Mountains from the Pacific Ocean. The surface of Florida is broken by a ridge, known as the "Trail Ridge," which extends from the northern border to the Everglades, and, in places, reaches a height of 230 feet. Much of the state is but little above sea-level. It being so low, the drainage is imperfect, the number of swamps and lakes being large. The solution of limestone often gives rise to lakes, ponds and sink holes.

Probably the most interesting topographic feature in the coastal plains of Alabama is the Cuesta. It is a ridge of resistant rock which borders the cretaceous lowlands on the north, and reaches an altitude of 250 feet above the adjacent surface. In eastern Alabama it is a watershed between the Alabama River on the north, and the Chattahoochee and the Gulf on the east and south. This ridge, known also as the Chunnenudda, is made of (1) hard limestone ledges, alternating with beds of indurated, silicious sandstone, becoming almost a quartzite, and of (2) the buhrstone formation. The country is rugged and hilly, and the soils sandy and very poor. The hard rocks which underlie the ridge have resisted the action of the weather, while the soft cretaceous formation to the north has suffered great erosion and its surface has been lowered by differential weathering from 100 to 200 feet below the summits of the ridge. To the north the slope of the Cuesta is steep and often precipitous, while to the south it is much more gentle.

During the Juratrias Period, southern Alabama was higher than at present, as is shown by the fact that none of its formations have been exposed. After Jurassic time a subsidence permitted an encroachment of the gulf until the shore lay as far north as the present northern boundary of the Gulf Plains. Erosion from the old lands brought materials into the gulf, the coarser being deposited near the shore in the strip of coarse sands and gravels, separating the Paleozoic from the Mesozoic formations, while the finer silts went into the deeper water and were incorporated in the Cretaceous and Tertiary strata. At the same time the land was rising, the shore line moving southwest, and exposing newer and newer beds lying in parallel belts in an east-west direction across the state.

The topography of Mississippi and Louisiana offers no striking features. The meanders of the Mississippi River have left bluffs of loess and loam, often 100 feet high, overlooking the valley. Even though Louisiana

is very low, portions are well dissected. The "Bayou Sara Quadrangle" shows elevations ranging from 20 to 320 feet above the sea. The region is characterized by steep slopes to creeks, and by a broken surface. North of Natchitoches in Louisiana are found Cretaceous outcrops. Other Cretaceous outcrops, known as the Five Islands, are in the southern part of the state, but are too small to be features in topography. The region through which the Red River passes abounds in small lakes and bayous. Many of these are caused by the Red River raft damming the mouths of tributary streams until their basins are converted into elongated lakes.

The surface of the Texas Coast Prairie* is low, the altitude of the inner border not exceeding 100 feet. The belt is broken only by drainage grooves which are fewer and fainter as the Rio Grande Gulf is approached. The drainage system is young. The country west of the Coastal Plains increases in altitude and has an older and better developed drainage system. Undulations and low, rolling hills appear as the Balcones Escarpment is approached. Some of the hills are capped with gravel brought by erosion from Edwards Plateau to the west.

The Timber Belt is a rolling country, 200 to 600 feet high, with occasional hills reaching 700 feet. These hills are wholly the work of erosion, there being no distortion of the earth's crust. Some of the highest points are capped with sandstone containing considerable iron. They are often called mountains. Mt. Salem and Gent Mountain in Cherokee County are examples. Occasionally the hills are broad, assuming the form of plateaus or broad mesas. In general, the Timber Belt is a beautiful upland country, well suited for the fruit industry in which it excels.

Surface Rocks and Soils.—The rocks of the gulf plains belong wholly to the Tertiary, Quaternary and Cretaceous systems. These formations dip toward the gulf, the Quaternary overlapping the Tertiary which, in turn, overlaps the Cretaceous. Many of the deposits of the Mississippi Embayment never hardened, or at least never became resistant, and are easily weathered and eroded. In general, the rocks are sandstones, limestones, shales and lignites. The soils offer great variety, being chiefly sands, clays, loams and alluviums, whose fertility ranges from unproductive sands to the richest of clays and loams.

The Mississippi Delta.—The great wedge-shaped area with its base southward and its apex extending northward to Illinois, constitutes the Mississippi Delta. The delta proper is three hundred miles long and has an area of twelve thousand three hundred square miles. The soils of the

*Divisions of the Texas Coastal Plains are defined in the discussion on "Surface Rocks and Soils."

delta are deep, rich alluvium brought down by the Mississippi River and its great tributaries. Along the Mississippi, on either side, southward from the Ohio, terrestrial deposits are found, while farther back the fossils are marine in character. From borings exposing these deposits, the extent of the delta has been determined. Much of the lower Mississippi is aggrading, and its overflows have deposited much material just outside of the banks, causing the land to slope gently away from the river. A cross-section of the river at Donaldsonville, Louisiana, illustrates this well. When floods occur sufficiently high to overflow, great sheets of shallow water are imprisoned back of these natural levees, where they contribute their loads of waste to the building up of alluvial plains. A large part of Louisiana and Arkansas, and considerable of Mississippi, have been deeply covered with alluvial deposits. From Cairo, Illinois, the river swings back and forth in a flood plain which extends from 15 to 20 miles on either side of its channels. Oxbow lakes are common, and terraces of alluvium and bluffs of loess often overlook the valley.

The history of the Mississippi River development seems to include a long period of subsidence and deposition, a short period of elevation and erosion, and a second period of subsidence which is still going on. At the beginning of the first period of subsidence, the land in northern Louisiana stood 250 feet higher than the present altitude, and at the close of the movement was 100 feet lower than it is to-day. Sand and gravels were deposited in the upper part of the valley, and fine silts in the lower part. During the period of elevation which followed this subsidence, the river cut out many deposits. The amount of excavation can now be judged by the heights of the Port Hudson bluffs and the Opelousas. In the Red River valley the excavation was 60 feet. Now a second subsidence is going on, evidenced by the drowned condition of the mouths of many coastal rivers; by the burial of Indian mounds, as at Belle Isle; by the almost stationary condition of the mouths of the Mississippi; by the formation of dune-shaped islands just off the coast; and by the investigations of Major Quinn, United States Engineer, who reported subsidence of one foot between 1875 and 1894. The river development shows in order: basal gravels, fluvial Port Hudson or old alluvium, and yellow loam-loess. The Port Hudson consists of swamp and marine clays and sands, which cover parts of Louisiana and Mississippi.

Loess and Loam.—The loess is a homogeneous, yellow, fine-grained, calcareous, silty and unstratified loam. It is found in hills bordering the river channels. Loess is also found skirting the east bank of the Mississippi at Vicksburg, and bordering the bluffs of the Yazoo River to the north.

The loess and loam in Mississippi are, essentially, flood-plain deposits of glacial *débris*. The melting of the Great Glacier, the southern margin of which corresponds roughly to the courses of the Ohio and Missouri rivers, furnished floods which carried the finer morainic materials southward into Mississippi and Louisiana. The loess is of great thickness, which shows that it could not be a disintegration from the underlying rocks. Its vertical extent sometimes reaches one thousand feet. It does not show stratification, a fact which distinguishes it from the "Orange Sands" on which it lies. The absence of lime distinguishes it from the bluff formations along the Mississippi River.

The loess is often deeper as rivers are approached, which shows that such channels were preëxistent. Increased thickness is observed near the Mississippi, Black and Tombigbee rivers. The erosion of loess surfaces now assists in the transfiguration of the country.

Loess and loam are continuous in Mississippi, though the former is absent in the bluffs. They pass each other by insensible gradations. They are said to be homotaxial and synchronous. The loess-loam was deposited while the region was at sea level and its position shows that no submergence has since occurred. As the great gulf into which the fine materials were deposited was not deep, the heavily loaded streams carried the fine sediments far outward. The later recession of water permitted winds to modify the position of the materials, hence both eolian and aqueous agencies have assisted in the formations. The yellow loam is unstratified as a result of sluggish, overloaded streams, or of subsequent modifications. No old shore lines are visible in these formations. The yellow loam is the latest deposit in northern Mississippi, extending fifty miles east of the Yazoo bluffs, and is described by Hilgard as the non-calcareous division of the loess. The loess proper is a fine, calcareous clay, containing a great variety of land and fresh-water shells.

The alluvium along the Mississippi River, and so largely forming the delta, is rich but low and swampy, and abounds in lakes and bayous so that much of it is uncultivable.

The Mississippi delta is that of a low-grade stream. The materials are fine and unassorted. It is an alluvial cone, but the slope is too gentle to be detected with the eye. It is a compound formation, the secondary deltas often uniting to form lakes, as in the case of Pontchartrain. The depth of the delta is, approximately, 1,000 feet.

In southern Alabama and Mississippi, and in the region southwest of the great bend of the Red River in Louisiana, there is a broad belt of "Orange Sands" generally considered coastal deposits of the Pliocene

Period. They are now known as the Lafayette formation. At the time of their deposition the coastal plains were submerged, a southward tilting stimulating river action, a result of which was the transportation of great volumes of sand and pebbles into the shallow waters of the gulf.

The Lafayette series consists of well-rounded, water-worn quartz grains and pebbles, iron-stained, and often cemented by the iron oxide into ferruginous sandstone. The soils of southern Mississippi, and especially of Alabama, have a consistency of 80 per cent. quartz sand deeply colored with iron (from which the name "Orange Sands" originated) and mixed with aluminous and clayey matter, forming a sandy loam of low fertility.

In Alabama a very interesting and clear illustration of belted coastal plain is found. The northern part of it is mountainous and belongs to the South Appalachians. This part of the state is older and abounds in iron, coal, limestone and marble. South of these "old lands" are the inner lowlands, a belt of rich, black, level soils about seventy-five miles in width, extending from Georgia westward across Alabama, and northward through Mississippi, into Tennessee. These soils are of Cretaceous origin and are highly productive. Owing to their fertility, and the long, warm, growing season, the cotton industry has been localized in this region.

South of these Inner Lowlands is a wide ridge of resistant rocks and unproductive sands, the Cuesta. The formations of this Cuesta are of Eocene Age and constitute the Claiborne group, the two subdivisions being the Claiborne proper and the Buhrstone. The Claiborne beds constitute the upper group. They are loose, incoherent, calcareous and ferruginous sands and glauconitic clays. The sands abound in fossils. The Buhrstone affords a marked contrast, being composed of hard, coarse and often glauconitic sandstone; hard, yellowish, silicious sandstone resembling quartzite; and flinty limestone. Owing to the great resistance of the rocks, the country is broken and rugged. The high, cherty hills of Buhrstone are called *mountains* in many localities. The soils are very poor, usually covered with long-leaf pine, the whole ridge being only sparsely settled. This belt offers a marked contrast to the Black Belt to the north, which is the great agricultural belt of Alabama.

In Texas the Coastal Plains include the Eastern and Southern Provinces. There are three well-defined types of country, the Coast Prairie, Timber Belt and Rio Grande embayment. These regions lie in belts parallel to the coast.

The Coast Prairie is a belt not over a hundred miles wide, bordering the gulf, in Texas and Louisiana. It is a structural plain, newly reclaimed

from the gulf. Lagoons fringe the coast, inside of which river sediments are collecting. The region is level, the interior margin not over 100 feet high. The surface is broken by deep grooves of streams constituting a young drainage system. The sea border is submerged and slopes gently. Along the Sabine River the Coast Prairie is fifty miles wide, but increases to one hundred miles at the Brazos. The monotony is broken only by strips of timber which follow the streams. The larger part of the Coast Prairie is included in the southern province. The soils are sandy, clayey and alluvial. Between the Brazos and Nueces rivers the soils are clayey, while both the eastern and western parts are sandy. Fine yields of farm products prove their great fertility. Cotton, sugar and fruits are extensively grown.

West of a line from San Antonio to Laredo there is a low, synclinal trough threaded by the Rio Grande, and known as the Rio Grande Embayment. The surface here slopes southeast, forming one side of the trough. In Texas the embayment consists of a low, broken plain butting against the Balcones Escarpment on the west. The Lafayette, or Fayette, Prairie occupies this region and stretches entirely across the state, having a width of from forty to one hundred miles. The soils are highly productive, their fertility being due to the lime which they contain. Usually they are of a black clayey or sandy character. The richness of these soils, together with their favorable location to secure rainfall, makes the Fayette Prairie region a rival of the black, waxy soils of central Texas.

These plains near Spofford and Del Rio are of the nature of gravel-covered flats resembling the llano. They are covered with storm-washed materials. In Uvalde and Kenney counties are localities in which necks, and monadnocks capped with igneous rocks, abound.

The Timber-Belt beds are north and east of the Fayette Prairie. The country here is rolling, broken and heavily timbered. Its altitude above the gulf is from two hundred to six hundred feet. Some hills are one hundred feet higher, and are due to erosion. No disturbance is anywhere seen. The hills are capped with iron sandstone of great hardness. The soils here are red clays, red sands and green-sand marls. The marls contain glauconite, a valuable fertilizer, and fossil shells, which make it especially productive. Beds of lignite are common.

The Balcones Escarpment is a series of steep faults running northeast and southwest along the west margin of the Coastal Plains. Just east of the Balcones the plains are older, higher and more dissected, and are known as the Black Prairie. The highest points here are 750 feet. The Austin

Quadrangle shows remnants of an old plateau, from 975 to 1,100 feet high, capped with limestone and forested with live and post oak.

Florida.—The entire state of Florida is underlaid with a soft, easily weathered limestone, often resembling chalk. This soluble material often gives rise to sink holes and lakes. St. John's River is a series of such lakes. The limestone nowhere shows disturbance, but is a solid, homogeneous mass. It is unstratified, and of Eocene Age. Resting upon it are scattered beds of phosphate rock, formed from the excrement of sea fowls. Rains have washed out the guano and soluble salts, leaving the insoluble phosphate of lime, now of great commercial value. It is shipped in large quantities to Europe.

Rivers and Drainage.—The Red River has its source in the llano, and drains a vast area of which 29,000 square miles are in Texas. Its length is 1,500 miles. It is navigable to Shreveport. It derives its name from the red clay which colors its waters. The river in the llano traverses an alluvial flood plain, and, as in the lower Mississippi River, the greatest elevations are along the river banks, the plain sloping away toward the hills which border the valley.

One of the points of interest in the Red River is the great raft which once filled the lower course for great distances. This raft is an accumulation of trees thrown into the river in times of flood. They pack closely and gather leaves and silt and so form an obstruction which causes the river to overflow, and to find its way into the back country where it follows the base of the hills until it again finds its way into the main channel below. This process repeats many times as the raft continues to grow. Since the timber along the river has been largely removed for agricultural purposes, the conditions for raft building are less favorable.

To the constructive work of the Red River and its bayou tributaries is due the presence of many lakes. These have been classified as: (1) cut-off lakes, (2) lakes of enclosure, (3) raft lakes, (4) delta lakes.

The extensions of secondary deltas often meet and so enclose sheets of water, thus forming delta lakes. Pontchartrain is an example.

Raft lakes are the result of an extension of the raft up-stream until the mouth of some tributary is dammed by the accumulation, and the tributary valley flooded. The size of the newly formed lake will then be determined by the height to which the dam is built (the quiet reach of water favoring the deposition of silts to considerable height), and the volume of water which is drained into the raft-dammed basin. The volume of water is often largely increased by the formation, above the dam, of an *outlet* bayou

or distributary, brought about by the flooded condition of the main stream, and which conveys large volumes of water into the lake.

Lakes of enclosure are common and owe their existence to natural levees. As the river rebounds from a hill or bluff it often makes large loops which become lake basins when the river has sufficiently built up its banks in the form of levees. The water is then confined between the bluff and the semicircular levee.

Cut-off lakes are common in the lower Red River valley, and are formed in the usual way, by a meandering stream that is aggrading its course.

The Brazos is one of the most important rivers of Texas. It drains 59,000 square miles and its length is 950 miles. It is navigable for light boats for 40 miles. East of the Brazos in Texas the rivers are clear and have swift currents, while west they are overloaded with silt and are sluggish.

The Trinity River enters Galveston Bay about forty miles from the city of Galveston. This river is 550 miles long and drains an area equal to that of Vermont and Massachusetts. The Colorado is the same type of stream, but is 900 miles long and drains a larger area.

The Rio Grande rises in Colorado and is 1,800 miles long. It drains only a small area in Texas, its basin being less than fifteen miles wide. It is subject to overflow and often causes great destruction. Much of its water is drawn into irrigation ditches.

The rivers of Texas are not valuable for commerce as their mouths are usually blocked with bars, and the volume of water which they carry fluctuates greatly.

The drainage system in Texas is well developed and lakes are rare. The numerous and extensive lagoons along the shore owe their existence to the building of barrier beaches.

The Alabama is the most important river in the state whose name it bears. It is formed by the confluence of the Coosa and Tallapoosa rivers, and cuts its way through the Cretaceous and Tertiary deposits, sometimes carving wide valleys and again flowing between high vertical walls of horizontal strata. From the point of its formation to its confluence with the Tombigbee, it is nearly 400 miles. Its depth is from three to seven feet. Its banks are forested with pine in the Cuesta, while the swamps along its lower course abound in cypress, or if less submerged, in extensive hardwood forests.

No adequate description of the Mississippi River will be attempted. A good description is given by Russell. No outcrop of hard rocks occurs for

nearly 1,000 miles from its mouths, the conspicuous bluffs, which mark the borders of the inner valley, being composed of loess. This valley is post-glacial, while the outer valley, carved from nearly horizontal beds of limestone, is pre-glacial.

Coastal Features and Harbors.—The land surface rises but little above the tide water of the Gulf of Mexico. In general, the features are those of a rising coast, though there is clear evidence of a slight submergence since the general uplift. Taking into consideration the shallows west of Florida, the delta formations of the Mississippi River, and the barrier beaches that fringe Texas, we should not expect many good harbors.

Considering the shore in detail, a broad fringe of shallows is noted, extending from Cape Sable to Cape Romano. The shore bordering these shallows is inaccessible to vessels, it being a tangle of swamps in which a salt vegetation encroaches upon the sea. There is no distinct demarcation of land and sea, islands being very numerous.

North of Cape Romano the coast is more characteristic. The streams end in enlargements formed by valley flooding due to a depression of the land. The most important flooded valleys are those of Hillsboro River, known as Charlotte Harbor, and Tampa Bay. Each of these embayments is fringed with mud banks. The west shore of Florida is destitute of coral formations as the Gulf Stream does not bathe this shore, in consequence of which the water temperature is unfavorable to the coral polyp. Barrier beaches at both ends of the harbors mentioned above, concentrate the tidal currents and maintain water of considerable depth. By extending the piers, good harbors for large vessels are secured. The importance of Tampa harbor is great as it is adjacent to the most extensive phosphate beds in the world. These beds extend back from the harbor for a distance of forty miles.

North of Tampa Bay the water is shallow and no good natural harbor is found for 200 miles, when St. Joseph Bay is reached. Occasional artificial harbors are maintained, as at Cedar Keys. Between Tampa Bay and Cape San Blas the shore is in the form of a broad-mouthed bay, 200 miles in width and 70 miles deep. Wave-borne sediments have partially filled this embayment and converted it into a shoal water region, characteristic parts of which are St. George's Sound, just west of Apalachee Bay, which is surrounded by barriers. Coastwise vessels only can enter this bay.

West of San Blas there is the deep-water area known as St. Joseph Bay. The water is from twenty-four to thirty-six feet deep, but so swampy

that the harbor is of little use. It is noted as being the deepest harbor on the Atlantic coast, formed by a land spit.

From San Blas to the Mississippi delta there is another broad embayment, not named. Reëntnants formed by gentle subsidence, and partially closed by barriers, characterize the region. There are also four submerged valley harbors which admit large vessels. They are St. Andrews, Choctawhatchee, Pensacola and Mobile. The first two have shoal entrances, but the rivers which enter Pensacola and Mobile bays maintain deep passages through the enclosing barriers. Before the uplift Mobile Bay extended much farther north, but a delta has filled the bay head so that deep water is now found at the mouth only. The opening into this bay, once twenty miles, is now but a little over two miles. Fifty miles east of Mobile is the cape of the Mississippi delta, having a front of 200 miles and extending 75 miles into the gulf.

Just after the glacial epoch the amount of sediments was greater and the delta built rapidly. The only entrance to the Mississippi River is through its main distributary on the southwest.

Westward from the mouth of the Mississippi are many reëntnants of shoal water admitting only coasting vessels.

The first harbor of importance on the Texas coast is at Galveston, a distance west of 300 miles. This reëntnant is flooded and barred from the sea by barriers. Shoal water two miles in width lies between the harbor and the sea, but government work keeps it open. This is the best harbor on the gulf coast. Behind the beaches the water is only nine feet in depth.

Along the shore southward to the Rio Grande reëntnants occur, but they are all shoal and admit only coasting vessels. The coast line is an almost continuous line of beaches enclosing lagoons, often connected. A barrier 110 miles long extends from Santiago to Corpus Christi, and is the longest barrier beach that faces any tidal sea. Many of the lagoons tend to assume a circular form owing to the action of wind, waves and eddies.