MISSISSIPPI
STATE GEOLOGICAL SURVEY

WILLIAM CLIFFORD MORSE, Ph.D.

Director

BULLETIN 63

LEE COUNTY MINERAL RESOURCES

GEOLOGY

by

FRANKLIN EARL VESTAL, M. S.

UNIVERSITY, MISSISSIPPI

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MISSISSIPPI GEOLOGICAL SURVEY

COMMISSION

STAFF

LETTER OF TRANSMITTAL

Office of the Mississippi Geological Survey
University, Mississippi
April 18, 1946

To His Excellency,
Governor Thomas L. Bailey, Chairman, and
Members of the Geological Commission
Gentlemen:

Herewith is Bulletin 63, Lee County Mineral Resources, by Franklin Earl Vestal, M. S., Geologist. It represents the final efforts of a study begun in 1941 at the instance of Mr. V. S. Whitesides, President of the Peoples Bank and Trust Company, Mr. Noel Monaghan, Attorney, and other Tupelo business and professional men, who personally raised $600.00 as Lee County's share of the cooperative undertaking rather than accept Federal aid.

To these men and other good citizens of Tupelo and Lee County, the Mississippi Geological Survey wishes to express its appreciation, not only of financial cooperation, but of moral support as well.

The survey was begun by Harlan R. Bergquist, Ph.D., but was soon interrupted by his Federal assignment to a foreign investigation. It was much later taken up by F. E. Vestal after his completion of other assignments. In the meantime T. E. McCutcheon, B. S., Cer. Engr., performed the laboratory research on Rock Wool and B. F. Mandlebaum, B. S. E., and Herbert S. Emigh, M. S., made the chemical analyses.

The survey disclosed the Plantersville structure (Press notice, October 6, 1943), which the State Geological Survey still hopes is the final compression of a much older fold in the Paleozoic rocks—a fold that would constitute a trap to catch some of the oil which escaped in Tishomingo County and adjoining Alabama when the streams cut open these saturated oil reservoirs.

The survey also demonstrated the fitness of the Selma chalk near Tupelo, perhaps at many other places, for the manufacture of excellent insulating rock wool—a product that can be made from 8 to 20 feet of pit run rock without the addition of any other material.

The survey further shows a belt of Selma chalk in mid-western Lee County 15 to 30 feet in thickness from pit run material of which Portland cement can be made without the addition of any other material whatsoever.

Very sincerely and respectfully,

William Clifford Morse,
State Geologist and Director

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GEOLOGY

FRANKLIN EARL VESTAL, M. S.

INTRODUCTION

Lee County is in northeastern Mississippi (Figure 1) about 35 miles south of Tennessee and 19.5 to 21.5 miles west of Alabama. It is a roughly rectangular area of 455 square miles[1] extending south-north 30 miles through 25 minutes of latitude (34° 05′ to 34° 30′ N.), and east-west 16 miles through 17 minutes of longitude (88° 32′ to 88° 49′ W.). It does not have a true rectangular shape, not only because of the slight convergence northward of its eastern and western boundaries, but because of offsets of all its boundary-lines. The main irregularities of this kind are a 2-mile offset on the northwest, a 1-mile offset on the northern boundary and one of the same magnitude on the south; a minor offset breaks the eastern and western boundary-lines a little north of the middle (Plate 1). The county is bounded on the north by Prentiss and Union Counties, on the east by Prentiss and Itawamba, on the south by Monroe and Chickasaw, and on the west by Pontotoc and Union (Plate 1).

The population of Lee County numbered 38,838 in 1940, this figure representing an increase of 10 percent over the 1930 population, and more than 31 percent over the 1920 population. The 1940 census classes 8,212 as urban; it shows also that the percentage of increase of the urban population during the decade 1930-40 was 29.1, whereas the percentage of increase of the rural population during the same period was only 5.8. The percentage of the 1940 population classed as urban was 21.1, against 18.0 of the 1930 number.[1] The U. S. Census Bureau states: "The urban population of Mississippi comprises all persons living in incorporated places of 2,500 or more, the remainder of the population being classified as rural."[1] So far as Lee County is concerned, "urban," in the sense specified in the Census Bureau's definition, applies to Tupelo only, because, of the seven incorporated places[1] in the county listed by the same authority, Tupelo only has a population of 2,500 or more.

Despite the greater increase of the urban population, as defined above, almost four-fifths of the people of the county are classed as rural, and of these probably five-sixths live on the 5,000 or more farms,[2] the remainder in the several villages and hamlets. Moreover,

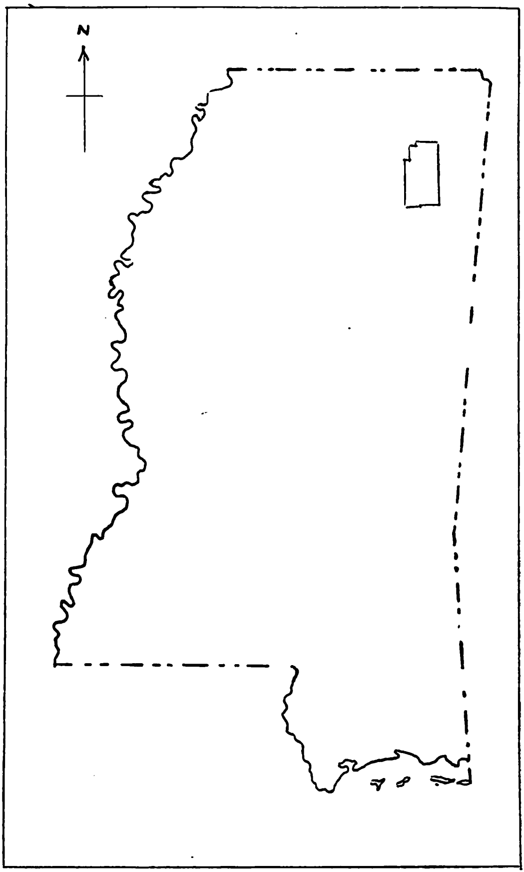


Figure 1.—Location of Lee County.

a very considerable proportion of the inhabitants of the villages, and a notable number of the people of Tupelo are land owners or are interested in farming in some way. The leading occupation of the people, then, is agriculture. The distribution of the population and of the roads and railroads and other cultural features reflects this, but the cultural pattern is affected also by the natural surface features, which are what they are largely because the climate and the geology are what they are. A glance at a map of the county (Plate 1) will reveal that the public road pattern is near to uniform over the area except in certain places where public roads are fewer or not present at all. These places are sparsely populated, because they are the areas where conditions are not favorable for farming. Viewed as a whole, the land surface of the county includes slopes, which may be rugged hill or rolling prairie, and flats, which may be terrace top or flood plain. Cultivation of the land is carried on to some extent in every part of the area, but in the more rugged hill sections, largely in the northeastern quarter, it makes use of the flat or gently sloping valley floors, and to a lesser extent of the gentler slopes of the hills. In the prairie region a much larger percentage of the land is under cultivation, because there the relief is less and few slopes are too steep for the use of farm machinery; besides, in general the soil of the prairies is more fertile. The surface area which is valley floor or terrace top is topographically most favorable of all for farming, due to its flatness; however, much of it is subject to shortlived floods, and some of it is permanent swamp, too wet for cultivation, even if it were cleared of the dense vegetation.

"All the uplands in Lee County originally supported an open forest of hardwoods, while the creek bottoms were mostly swamps, heavily forested and with much undergrowth of tall cane."[3] A large part of Lee County is still wooded, and other considerable tracts are occupied by a dense growth of shrubs, vines, and grasses. The forested regions are hill tops and slopes, or patches of bottom and terrace land, particularly strips bordering the stream channels. Some large timber remains, but most of it has been cut, and the forest growth now standing is for the most part small or of medium size. Both hardwoods and softwoods are represented in the forests, the pines as a rule being most numerous in the sand territory, and occupying the summits and upper slopes of the hills, whereas the hardwoods (oak, hickory, poplar, ash, sycamore, gum, etc.) grow almost anywhere with reference to the topography, but more commonly on the lower slopes and in the valleys. Cedars are many in the chalk territory, southern and western parts of the county, and are thinly scattered over the sand hills district, also. The lumber business is still of some importance in the county, even though, as stated, most of the best timber has been cut.

Cotton is the leading cash crop: The Tupelo compress has handled an average of 65,000 bales annually for the last 20 years. The county has a corn production, also, of approximately a million bushels a year, and hay is grown extensively.[2] The alluvial valley lands are particularly favorable for good yields of cotton, corn, hay, alfalfa, oats, and pasture crops. Truck crops are grown on a relatively small scale, chiefly for local consumption; fruits are given a small acreage, and sorghum and other cane, as well as peanuts and several other legumes, are common. The raising of live stock has increased very much during the last few years, and dairying has become the leading pursuit in the trend towards diversification of agriculture.[2] Cattle can forage all the year in northeast Mississippi, although they should have shelter in winter, and beef and dairy products have become more important as marketing facilities have improved. The people of Lee County have cooperated fully with the Federal Government agricultural program, and with Mississippi State College and other authorized agencies; they have shown a keen interest in plans and methods designed to aid conservation and care of the soil, and improve tillage and producing capacity. Probably their interest and willingness to co-operate had something to do with the choice of the county as one of three localities in the United States for the testing of a recent new large-scale soil conservation program.

Tupelo, the county seat (population 8,212, in 1940),[1] is the only city of Lee County and the largest industrial center in the northeastern part of the state. It is a busy and enterprising little city which has had a steady growth (29 percent in population during the decade 1930-40)[1] in spite of misfortunes, including one of the worst tornadoes in weather history.[4] The more prominent of its industries are: A milk-processing plant; an ice-cream plant; a meat-packing plant; a fertilizer factory; a frozen foods plant; a cotton oil mill and a cotton gin; and four garment factories.[2] In addition are a number of smaller industries and numerous business establishments, among which L. P. McCarty & Son, Reed Brothers, and Clift & Hyde are three of the largest. Still other features of Tupelo and nearby territory are worthy of special mention: The fine new schools; the community hospital; churches of several denominations; the hotels; the numerous attractive dwellings; the broad streets; the excellent water, sewerage, and telephone systems;[2] the two daily newspapers—in fact, facilities and improvements too numerous to itemize, of which any municipality should be proud. Points of interest near the city are the Tupelo Country Club buildings and grounds, the Government subsistence homestead project[2] houses and grounds, and the American Legion park, including a beautiful 40-acre lake. Tombigbee State Park, containing a narrow 105-acre lake (Lake Lee) bordered by steep wooded slopes, is some 5 to 6 miles southeast of Tupelo, among rugged picturesque hills[2] (Figure 2).[5]

Seven centers of population are classed by the Census Bureau as towns: Baldwyn, Guntown, Saltillo, East Tupelo, Verona, Nettleton, and Shannon.[1] Baldwyn is on the Lee County-Prentiss County line, and 610 of its 1,279 inhabitants (1940 census) are residents of Lee County. Nettleton stands on the Lee County-Monroe County line, and 334 of its 861 people reside in Lee County.[1] All the towns named are centers of farming sections, and rely on the farms for

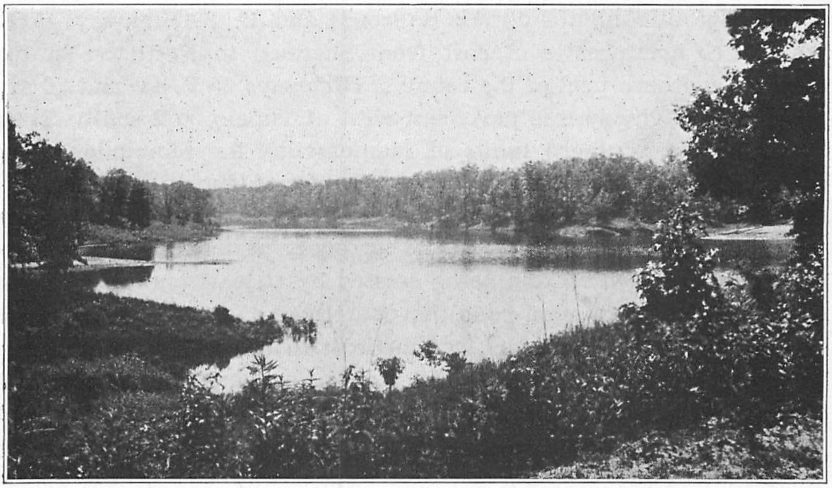


Figure 2.—Lake Lee, looking eastward up the valley that had reached early maturity in its development before the lake waters filled it, Tombigbee State Park. Photo by W. C. Morse, June 5, 1936.

their support: The buying, processing, shipping, and selling of farm products and the supplying of farm requirements maintain the small businesses. Other groupings of population in addition to the one city and seven towns, are the village of Plantersville,[1] and communities such as Bissell, Belden, Mooreville, Corrona, Eggville, and Bethany. Commonly these community centers grow at road intersections or along main highways, and consist of church, school, general store, and a few dwellings.

Lee County is served by two railroads, the Gulf, Mobile & Ohio, and the St. Louis & San Francisco (Frisco)[2] (Plate 1). The Gulf, Mobile & Ohio extends south-north across the county via Shannon, Verona, Tupelo, Saltillo, Guntown, and Baldwyn; the Frisco trends northwest-southeast, southwest of the center, by way of Tupelo, Plantersville, and Nettleton. Four trunk highways are the main routes of travel: U. S. Highway 45, which crosses the county north-south roughly parallel to the Gulf, Mobile & Ohio Railroad, and through the same towns; U. S. 78, known also as the Bankhead Highway, which traverses the western part of the county northwest-southeast to Tupelo, thence almost east to the county line; Mississippi State Highway 6, which extends from the western boundary of the county in a direction north of east to Tupelo, thence east to East Tupelo, from where it trends irregularly southeast to Nettleton, via Plantersville, roughly paralleling the Frisco Railroad; and U. S. Highway 45 E, which lies northwest-southeast from Shannon to Nettleton in the extreme southern part of the county. Highways 45 E, 45, and 78 are pavement; Highway 6 is pavement west of Tupelo, and southeast of Tupelo to the southern limits of Plantersville, the remainder being graveled. The pavement of Highway 6 west of Tupelo and of Highway 78 east of Tupelo is rough. An extensive secondary road system provides access to market facilities for every part of the county, almost every section of land being crossed by at least one road. Most of the roads are in good condition, but those that are not metaled, especially in the chalk area, are difficult to travel in wet weather. Some small areas, commonly flood plain or rugged hills, have few if any public roads; examples of such are in the northeastern corner of the county; a strip just east of U. S. Highway 45 north of Tupelo, and two or three sections south of Tupelo. Certain of the roads, aside from the main highways already mentioned, may be called highways. In this class are: Old Highway 45; the unnumbered highway leading south from U. S. Highway 78 at Mooreville, to Amory; the Mooreville-Mantachie road; the East Tupelo-Eggville road; roads leading west and northwest from Shannon; the Guntown-Bethany road; and some others (Plate 1). Except for old 45, which has a narrow, very rough pavement, all these secondary highways are graveled.

Electric power for all purposes is provided by the Tennessee Valley Authority, largely through the Tombigbee Electric Power Association. In fact, Tupelo was the first Mississippi town to use T. V. A. power. The pattern of the power-lines of the county is an irregular web centering at Tupelo. The T. V. A. transmission lines include: Tupelo to Booneville, 44 Kv., along the Gulf, Mobile & Ohio Railroad; Tupelo to Pickwick, 110 Kv., through the northeastern corner of the county; Tupelo to Holly Springs, 44 Kv., along U. S. Highway 78; Tupelo to Sardis Dam, 44 Kv., built for 110 Kv. construction,

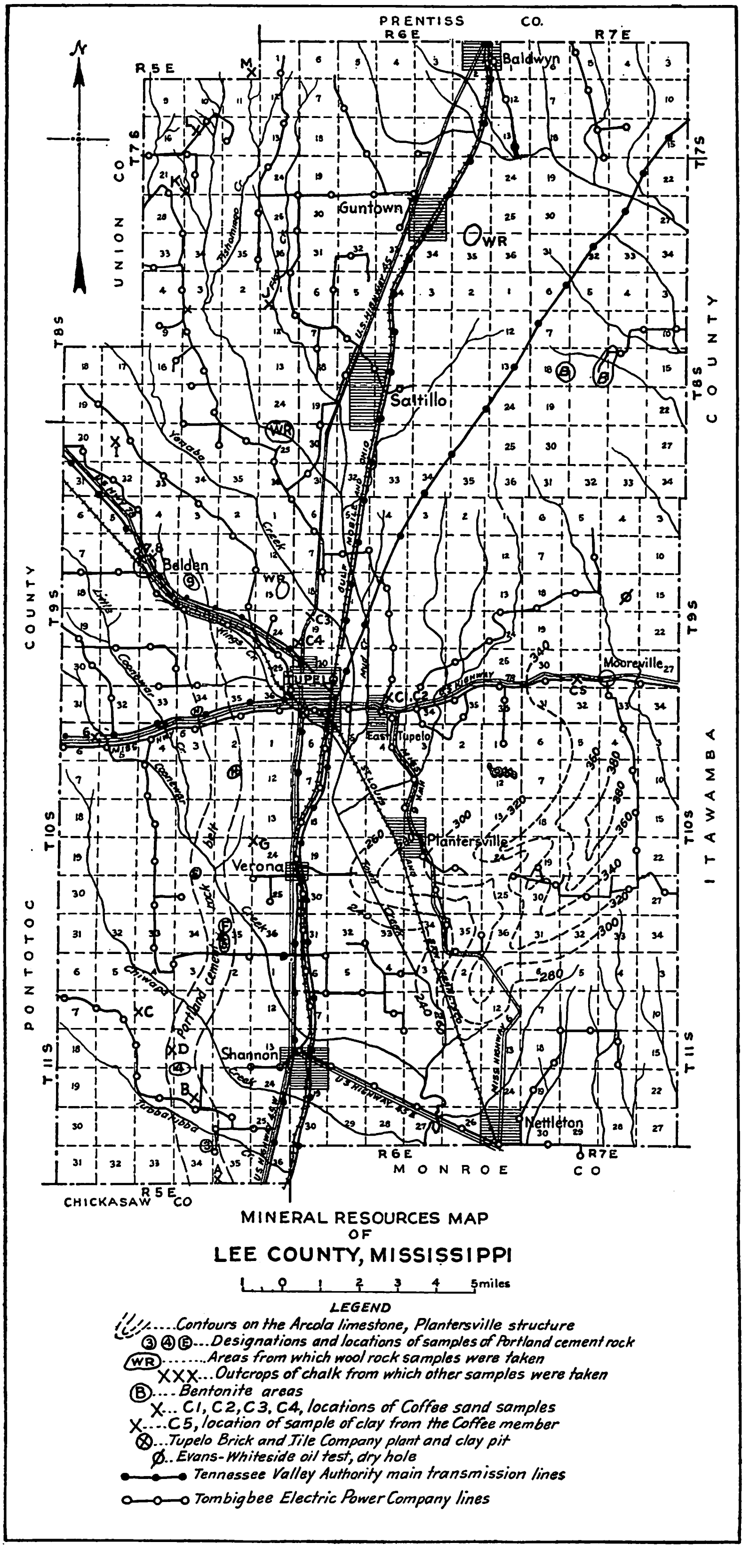


Figure 3.—Mineral resources map of Lee County showing relative locations of mineral deposits and railroads, highways, and power lines.

via Pontotoc; Tupelo to West Point, 44 Kv., along the Gulf, Mobile & Ohio; and Tupelo to West Point, 110 Kv., along U. S. Highway 45. Local power lines branch from the main lines in all directions, but are most numerous in the northwest quarter of the county (Figure 3).

Natural gas is brought into the county from the Monroe and Richland, Louisiana, gas fields, through a pipe-line; any desired pressure is available.[2]

CLIMATE

Lee County has the humid sub-tropical type of climate, which is characterized by rather long hot summers and comparatively short mild winters, but not by extremes of temperature. Relative humidity is high, hence sensible temperature is high in summer and low in winter; mean annual precipitation is heavy, most of it coming in winter and early spring; the prevailing winds are light southwesterlies, but cyclonic, anticyclonic, and monsoon-type winds dominate the atmospheric circulation. Thunderstorms are frequent in the summer months and may occur at any time of the year; tornadoes visit the region now and then. Tabulated data relating to the climate follow. The figures are for Pontotoc County, but are essentially accurate for Lee.

Mean annual temperature, 61.7 degrees Fahrenheit
Mean winter temperature, 44.2 degrees Fahrenheit
Mean summer temperature, 78.1 degrees Fahrenheit
Average date of first killing frost in the fall, October 28
Average date of last killing frost in the spring, March 28
Average annual precipitation, 47.95 inches
Average monthly precipitation, January, 4.88 inches; February, 4.47; March, 6.01; April, 3.70; May, 3.57; June, 4.12; July, 4.86; August, 3.64; September, 3.07; October, 1.58; November, 3.44; December, 4.61

The highest temperature recorded was 105 degrees Fahrenheit, in July, and the lowest, -11 degrees Fahrenheit, in February, but extremes that even approach these are very rare. The average length of the growing season is about seven months.[2, 5]

PHYSIOGRAPHY

PROVINCES, TOPOGRAPHY, RELIEF

Lee County consists of a little of the western part of the Tombigbee River Hills and the eastern and central parts of the Black Prairie.[6] The Tombigbee River Hills province as a whole is characterized by hills which range from low and smoothly rounded, separated by broad flat-bottomed valleys, to ridges and hills of 200 feet relief having steep slopes and narrow crests, and separated by narrow valleys.[7] The relief may average 100 feet over much of the county, especially in the central and eastern districts.[8] In the northeastern corner the uplands appear to merge into high undulating terraces along Twentymile Creek.[3,7] In general the Lee County part of this physiographic province is a succession of southeastward-trending and southward-trending valleys and ridges. An interesting and striking feature is that in every case the northeastward-facing or eastward-facing (up-dip) slope of the ridge is short, rough, and relatively steep, in contrast to the opposite slope of the same ridge, which commonly is long and relatively low.[3] In places the northeastward-facing bluff of Twentymile Creek Valley reaches, within a quarter of a mile, a height of 100 feet or more above the flat; for example, a mile or so northeast of Chapelville.[8] This distinctive topographic peculiarity is still more conspicuous in the western part of the county, as described below.

The Tombigbee River Hills region of the county is underlain by sand and subordinate clay and shale belonging in part to the Coffee sand, and in very small part to the Tombigbee member of the Eutaw formation.

The Black Prairie belt is represented by the southern and western parts of the county, which are underlain by chalk belonging to the Selma formation.[6,7] Its "rolling" topography is characterized in general by low rounded hills or ridges (cuestas), from the crests of which the surface slopes gently westwards to southwestwards (down dip), and steeply to the stream flats in the opposite direction. These cuestas are separated by wide, alluvium-filled bottomlands (inner lowlands). Terraces are conspicuous along many of the stream valleys, notably in the southern part of the county; commonly the terrace borders the valley on the east or northeast, at the foot of the back slope or "outer lowland" of the cuesta. That is, the larger valleys are bounded by bluffs along their west or southwest margins for a small fraction of a mile from the flats, and along their east or northeast margins by low slopes which seem to merge with the rolling to level dividing belts, or, more commonly, with wide terraces.[3] Also, in places short, steep slopes have been developed near the heads of valleys and along gorge-like stream channels.

The boundary between the Tombigbee River Hills province and the Black Prairie province, which is in general the surface trace of the contact between the Coffee sand member below and the Selma chalk above, trends roughly southwest and west from the Itawamba County line, describing a ragged-edged tongue, to a point as far south as Plantersville and as far west as Tupelo, thence north and east of north to the Prentiss County line, although of course it is very irregular in detail (Plate 1).

The Black Prairie belt has a local relief probably not greater than 40 to 50 feet,[7] but its altitude within the county ranges from 414 feet at Baldwyn, on the northern boundary, to 252 feet at Nettleton, on the southern. The greatest altitude in the county is 522 feet, at the junction of local roads about a quarter of a mile southeast of Hebron Church (near the center, Sec. 29, T.8 S., R.7 E.). Several other points in the vicinity reach an altitude of 500 feet or more, and sizeable areas are well over 400.[8] The lowest point in the county is little, if at all, above 200 feet, on the southern boundary at the bottom of the valley of Old Town Creek (West Fork of Tombigbee River). Thus the maximum relief of the county as a whole is at least 300 feet.

DRAINAGE

Lee County is almost at the sources of the headwaters of the Tombigbee River system; in fact, the Tombigbee-Tallahatchie and the Tombigbee-Yalobusha divide—which is to say the Tombigbee-Mississippi divide—is only a few miles west of Lee County; the Tombigbee-Tuscumbia divide only a short distance north, and the Tombigbee-Tennessee divide less than the width of the county northeast.

That the surface of the county slopes southwards and southeastwards is evident from the direction of flow of the streams, all which belong to the Tombigbee River system. The degree of regional slope north-south is roughly indicated by the altitudes of stations along the railroads:[9] Baldwyn, 374 feet above mean sea-level; Guntown, 381; Saltillo, 312; Tupelo, 270; Verona, 301; Shannon, 243; Plantersville, 252; Nettleton, 252. Guntown stands at the northwest end of the divide between the Old Town Creek and Twentymile Creek systems, the highest belt of land within the boundaries of the county; Verona, on the crest of the divide between the valleys of Old Town and Coonewah Creeks; and Tupelo, only slightly above the flat of Old Town Creek.

The main stream, Old Town Creek or West Fork of Tombigbee River, is formed northwest of Tupelo by the confluence of Busfaloba and Yonaba Creeks and flows southeast, south, and east of south, leaving the county a mile or more west of Nettleton. Its chief tributaries are Kings, Coonewah, Chiwapa, and Tubbalubba Creeks from the northwest, and Mud and Tulip Creeks from the north and northeast. Of these tributaries, Mud Creek, rising in the northwestern corner of the county, is the largest which is wholly within the county. Each of these streams has numerous branches, of which some of the larger have names: For examples, Flat, Euclautubba, and Sand Creeks are chief branches of the Mud Creek system, and West, Middle, and South Tulip Creeks contribute most of the volume of Tulip Creek. Several small streams enter Old Town Creek south of Tulip Creek: Garrett, Smith, Carmichael, Leeper, and Smith. The Old Town Creek, or West Fork of Tombigbee, system drains at least two-thirds of the county, but northeast and east of a divide extending from Bethany in the northwest corner southeast through Guntown, thence southeast and south almost to the southeastern corner of the county, the drainage is southeast to East Fork of Tombigbee River, chiefly via Twentymile, Mantachie, Puncheon, Boguefala, and Boguegaba Creeks, which have numerous short tributaries. Several of the larger streams —Old Town, Mud, Yonaba, Coonewah, Chiwapa, and Twentymile Creeks—have been canalized through greater or lesser distances, to provide better drainage for their wide valleys. The larger stream channels carry water at all times, but most of the smaller have streams only during rainy weather.

The dendritic or tree-like drainage pattern characteristic of a region of horizontal or low-dipping strata has been traced by the streams of Lee County. In this case a rough outline of a Lombardy poplar has been made, Old Town Creek simulating the trunk, and its tributaries the tree branches. This special type of dendritic pattern, featured by angles of 30 to 45 degrees or lower between the main and its tributaries, is likely to be described by headwater branches of a drainage system.

The average annual precipitation of the region is about 48 inches, of which nearly 20 inches normally fall in December, January, February, and March. October is the driest month and March the wettest, on the average.[2, 3] Such a distribution of rainfall, the heaviest coming in winter and early spring, is very favorable for maximum run-off and hence maximum erosion, because at that time plants are dormant and much of the ground is essentially unprotected by natural vegetation; furthermore, violent downpours are as common in this climate as are gentle, slow, prolonged rains. The canalization of the main streams, too, although unquestionably promoting drainage, also promotes removal of soil, because it steepens the gradients not only of the streams which have their channels thus deepened, but also of their tributaries; steepening of gradient leads to increase of the velocity of the running water, which in turn results in enormously increased impact and erosive and transporting capacity. The transporting capacity of running water varies as the sixth power of the velocity; more specifically, if the velocity be doubled, the transporting capacity of the water becomes 64 times as great. Thus any drainage project which involves material steepening of gradient or considerable increase of the volume of water in any one channel is sure to lead to more severe erosion. Of course Nature herself tends to counter this disturbance of the balance by loading the stream to its utmost capacity with suspended sediment, which lessens the velocity; also, accumulation of sediment and debris, and the growth of plants in the stream channel, tend to slow the water, and will eventually choke the stream unless successive floods or additional ditching operations keep it open.

Inasmuch as the sand region of the county absorbs more rain than the chalk territory absorbs, springs are more numerous in the sand, and the deeper stream courses are more likely to contain running water at all seasons, because the sands feed their absorbed water into the valleys.[7] The thin clay beds and the indurated sand beds in the great body of the sand may serve to localize the springs. However, owing to their greater porosity, the sandy soil and the underlying sand to varying depths in the sand terrane lose water more rapidly through both evaporation and subsurface drainage than the clay soils and the underlying clayey lime rock of the chalk region lose it. The soils of the sand part of the county, then, dry out more rapidly than do the soils of the chalk areas.

STRATIGRAPHY

GENERALIZED SECTION[7]

The following summary indicates the names, geologic classification, relative ages, lithologic and structural characteristics, and approximate thicknesses of the rock units which crop out in Lee County:

	Feet
Psychozoic group	
Holocene system	
Recent series	
Recent formation	

	Feet
Mantle rock, consisting of residual soil, subsoil, and coarser rock debris; colluvium; alluvium, comprising flood-plain and channel deposits; all rock waste in situ or in transit. Maximum, estimated	30
Great unconformity	
Cenozoic group	
Pleistocene and Pliocene (?) systems	
? series	
Terrace deposits	
Gravel, sand, clay, silt, flood-plain deposits probably all of Pleistocene or more recent age, now left as terraces by deepening of stream valleys during and subsequent to Pleistocene time. The oldest of these deposits may be of Pliocene age, now appearing as the highest terraces, but no definite criteria can be applied for distinguishing Pliocene material, if present, from Pleistocene. Up to	25
Great unconformity	
Mesozoic group	
Cretaceous system	
Gulf series	
Selma formation	
Chalk, marl, soft limestone, bluish to gray to white, containing clay, sand, and silt in proportions which vary from place to place, greater in lower part; locally very fossiliferous; structure typically massive, but in places beds and laminae; lower part tongues into the Coffee sand member, the chief tongue being the Mooreville, which consists of sandy and silty chalky clay and clayey chalk; the Arcola member, hard buff to white fossiliferous limestone 1 foot or more thick, is about in the middle of the formation; the upper 250 to 280 feet of somewhat purer chalk has been designated the Demopolis member. The Coffee member is dark greenish-gray sand which weathers light-gray or tan to yellow, light brown, and red-brown; glauconitic, fine-grained to medium-grained, micaceous, fossiliferous; cross-bedded or laminated in most places, but the Tupelo tongue is massive almost everywhere; includes discontinuous and broken layers of calcareous sandstone, and, locally, laminae or beds of gray to blue or black silty clay. Correlative in Lee County with the lower 200 feet more or less of the chalk farther south, into which it merges by tonguing. Plus or minus	450
Unconformity	
Eutaw formation, Tombigbee member	
Sand, fine to medium, greenish-gray to very dark gray to black, glauconitic, massive, locally fossiliferous; contains layers or indurated beds of sandstone or hard nodular masses of calcareous sandstone. Plus or minus	100

EUTAW FORMATION, TOMBIGBEE MEMBER[7a]

The oldest formation represented at the surface in Lee County is the Eutaw. A little of the upper part of the Tombigbee member of the Eutaw immediately underlies Recent mantle rock and possibly some Pleistocene and Recent terrace material in the extreme southeastern part of the county. Small exposures can be seen low in the valleys of Boguefala, Boguegaba, Shoaf, Wolf, and Cowpenna Creeks and their tributaries. The Tombigbee is in general a massive, glauconitic, somewhat calcareous micaceous fine sand, containing indurated layers and concretionary masses, especially in the upper part. Weathering changes the color of the sand from greenish-gray to various shades of brown, near red, and yellow, by oxidation of the iron of the glauconite and of other minerals. The upper thicknesses of the Tombigbee sand contain in places many fossils of marine invertebrates and vertebrates, but a large part of the member as a whole is not fossiliferous. The glauconite and the fossils seem to indicate deposition in deeper marine waters at some distance from shore. The thickness of the entire Tombigbee sand averages 100 feet or less, and in view of the fact that the uppermost part of the formation is exposed in Lee County, 100 feet probably is about the correct figure to express the thickness there. The J. P. Evans et al Whiteside No. 1 well (Center, Sec. 16, T9. S., R.7E.), about two miles north of Mooreville and the same distance west of the Tombigbee sand outcrop belt, passed through the entire Eutaw formation, including both Tombigbee sand and Lower Eutaw, according to the log. Of the total thickness, 254 feet, at least the uppermost two intervals, "Green sand, water-bearing, 50 feet," and "Gray sand, 20 feet," could most certainly be assigned to the Tombigbee, and probably several feet of the next lower interval, "Green 'creek' sand," are part of the Tombigbee, also, although the log does not distinguish the Tombigbee member from the remainder of the Eutaw.

So far as can be determined from the few outcrops referred to above, the Lee County Eutaw does not differ from the Tombigbee part of the formation as a whole: "It consists of massive ferruginous, glauconitic fine sand where weathered, and of soft calcareous sand in fresher exposures." The Eutaw is a source of artesian water throughout the Cretaceous belt, and wells drilled through the Selma chalk, which is a good cap rock for the Eutaw aquifer, penetrate the Eutaw (Tombigbee) sand at a depth of about 200 feet in the eastern areas of Lee County and approximately 600 feet in the western.

The Tombigbee sand responds to the action of the agents of erosion in a different way than does the lime farther west. Being more porous, it absorbs more water and retards the run-off, thus it is lowered less rapidly and retains vertical faces and relatively steep slopes for a longer time. The sand is cut into ridges and hills which have a fairly high ratio of steep to low slopes and an altitude notably greater than the altitude of the contiguous lime region. These ridges and hills developed by erosion of the Tombigbee sand are part of the Tombigbee River Hills, one of the main physiographic regions of Mississippi. The massive sand gives rise to steep-sided, more or less conical peaks, among which are the highest topographic features of the state. Resistance to erosion is stiffened by the presence of hard sandstone at various levels in the sand, sandstone formed by cementation of the loose sand by iron and silica and other substances precipitated on and between the sand grains from solution in percolating underground water. Almost every considerable hill contains masses of this sandstone, much of which is ferruginous.

THE SELMA FORMATION[7b]

The Selma formation as a whole is a flattish body of chalk, marl, limestone, sand, sandstone, clay, clay shale, and minor components which lies unconformably on the Eutaw formation from eastern Alabama to southern Tennessee. Having a low regional dip ranging from south at its southeastern extremity to northwest at its northern limit, it shows at the surface as a roughly crescentic belt which borders the Eutaw belt of outcrop on the Gulfward side, and tapers towards the ends. This Selma outcrop belt has a width of about 24 miles at the Alabama-Mississippi line, but narrows irregularly northwards. The formation is commonly called "Selma chalk," because by far the largest part of it is chalk; but it ranges lithologically from chalky clays and sands to facies containing 85 percent or more of calcium carbonate. In general the chalk of northern Mississippi is more sandy and clayey than the typical chalk farther south. The "chalk" is, as a matter of fact, a fine relatively soft more or less argillaceous and sandy limestone having a chalky texture. In fresh exposures it is dark-gray to bluish-gray, but dries to light-gray and white, and appears as "bald spots" on the slopes, or as conspicuously white bluffs bordering the stream valleys (Figure 7).

Probably the chief minor constituents of the Selma formation are iron sulphide and lime phosphate. The iron sulphide is in the form of concretionary nodules of marcasite of various shapes and sizes, but chiefly almost spherical and not more than 1 to 1 1/4 inches in diameter. Although scattered somewhat widely through the chalk, these marcasite concretions are more numerous in certain intervals. The phosphate may be disseminated through certain layers of the chalk or segregated in nodules or in molds of mollusks. Three phosphatic bands have been recognized: The lowermost from the base of the chalk to a few feet above it; the uppermost, 30 to 35 feet thick, from the top of the chalk downwards; and the middle layer, thinner than either of the others, just above the Arcola limestone member.

The typical chalk is massive of structure (Figures 6, 7, 8, 11), but weathering brings out stratification lines even in the purest facies, and the more clayey and sandy parts show distinct bedding-planes.

The Selma chalk just west of where it is crossed by the Alabama-Mississippi line is about 900 feet thick, but the chalk part of the formation thins towards the north to 250 feet at the Mississippi-Tennessee line, where only the middle part of the southern chalk is represented. The Selma exposed at the surface at the Alabama-Mississippi line is entirely chalk or limestone of varying degrees of purity; but northward the lower and upper parts merge laterally into non-chalky equivalents, whereas the intervening middle portion remains chalk. The non-chalky equivalent in Mississippi of the upper part of the Alabama Selma is the Ripley formation, a body of sand and clay chiefly, which, from northwestern Noxubee County to and beyond the Mississippi-Tennessee line overlies the restricted chalk. The non-chalky equivalent of the lower 250 feet or more of the Alabama Selma is the Coffee member, a body of sand and subordinate clay which extends from south-central Lee County northwards into Tennessee. The middle chalky body of the southern Selma is mapped as the northward continuation of the Selma chalk; it is the equivalent of the Demopolis chalk of Smith's Alabama classification, which includes all the Selma chalk above the Arcola limestone member.

The Arcola member of the Selma is, as a whole, a persistent unit consisting of one layer or more of almost pure hard limestone traceable from Warrior River in Alabama to somewhere near the mid-latitude of Lee County, Mississippi. Everywhere it is thin, the thickness ranging from a foot to at least 4 feet, but in few places in Mississippi is it more than a foot. The color is white or light-yellow. Other features of this rock are: In most outcrops its surface is very irregular from differential weathering, the irregularities commonly taking the form of borings; the bed has a tendency to break into roughly cubical blocks, which break down further to smaller blocks and finally to bowlders, cobbles, and pebbles of limestone; the topographic expression of the bed is a rocky ridge. The Arcola does not maintain a fixed stratigraphic position, but in Mississippi ranges from 265 feet above the base of the Selma farthest south, to about 200 feet near Mooreville, Lee County. Stratigraphically, in Lee County it is near the top of the Mooreville tongue of the chalk. In fact, south of Mooreville the Arcola member is only about 10 feet below the base of the Tupelo tongue of the Coffee sand, and it appears to end in Lee County in the upper part of the Mooreville.

Except for the small irregular areas of the Tombigbee sand outcrop belt, described in foregoing paragraphs, the entire width of Lee County south of the latitude of Verona is in the outcrop area of the Selma chalk; also north of that latitude all the county west of an irregular contact line following roughly the Tupelo meridian is Selma chalk territory. This somewhat unusual pattern of areal geology is due to the northward merging and intertonguing of the lower half of the chalky Selma into non-chalky sand to which the name Coffee sand has been given. Thus about the northeastern third of the county is in the area of outcrop of the Coffee sand (Plate 1).

In the southeastern part of the county the Selma formation lies unconformably on the Tombigbee sand member of the Eutaw. The contact is not sharp, but the lowermost few feet of the Selma include much more sand than is present higher up; locally this same lowermost thickness contains numerous phosphatic molds of fossils, a few phosphatic nodules,[10] and shells, of which some were re-worked from the Tombigbee sand. The interval thus composed of sand, phosphatic fossil molds and nodules, and shells of late Eutaw and early Selma age, has been considered a basal conglomerate, the best evidence of an unconformity—that is, of a break in sedimentation in this region, which in turn would indicate a period of erosion between the deposition of the Tombigbee sand and the beginning of accumulation of the Selma chalk. Or, it could mean a shallowing of the sea, but no actual land conditions, through a relatively short time interval.

North of central Lee County the Coffee sand equivalent of the lower Selma rests unconformably on the Tombigbee sand; and, inasmuch as parts of the Coffee sand are massive like the Tombigbee, the contact between the two is not so easily recognized, and its stratigraphic position not so easily determined, as is the Tombigbee-Selma chalk contact. However, the Tombigbee-Coffee contact does not show at the surface in Lee County.

THE MOOREVILLE TONGUE

The merging and intertonguing of the lower 200 feet or more of the Selma chalk with the Coffee sand are featured by two prominent tongues and several smaller ones. Projecting northwards 20 to 25 miles from the main body of the Selma in southern Lee County near the latitude of Plantersville, through parts of eastern Lee and western Itawamba, is a wedge known as the Mooreville tongue. It "appears to lose its identity by merging or minor intertonguing with the Coffee sand in the northern part of T.8 S., R.7 E., north of which no outcrops of chalk have been observed." The Mooreville tongue is composed almost wholly of impure clayey and sandy chalk and shaly, chalky, sandy clay (marl). The type locality is along U. S. Highway 78 some half a mile to three quarters of a mile west of Mooreville, where exposures have been made by the highway cut through the upper part of a ridge capped by Coffee sand, and by gullies in the slopes, especially on the west side of the ridge. The exposures show, beneath some 8 feet of weathered Coffee sand, 20 feet of leached dark shaly and sandy clay, and subjacent 20 feet of shaly greenish-gray chalky clay containing small crystals of gypsum in joint-cracks. About a tenth of a mile farther west, north of the highway, is a gully through Mooreville beds of a lower stratigraphic position. Near the base of this outcrop the material is a very dark-gray limy micaceous fine sand which dries a light bluish-gray. The sand grades upwards into an olive-drab lumpy weathered phase featured by innumerable small aggregates or crumbs or nodules of lime, which no doubt were formed and deposited by underground and surface water. These lime aggregates lie on the surface by thousands. The entire section, from the bottom of the small valley north of the highway and at the base of the westward-facing slope, to the top of the ridge south of the highway and east of a local road, measured more than 90 feet, of which vertical interval 65 feet are here assigned to the Mooreville, and the remainder to the Coffee. The base of the section is at an altitude of about 380 feet, and the Mooreville-Coffee contact about 445.

The characteristics of the Mooreville tongue of the Selma chalk will be better understood from descriptions of other outcrops, which will be described in south-north order.

The floor and the lower parts of the walls of the channel of Tulip Creek at the bridge for a local road (northern part, Sec.3, T.10 S., R.6E.), and for a short distance above and below the bridge, are a consolidated greenish-gray to bluish-gray micaceous very fine limy and sandy silt to silty or sandy clay, which dries whitish and is broken by a multitude of joints and fractures. Conchoidal jointing or fracture is conspicuous. This jointed limy clay or silt, of which at least 5 feet are exposed above the base of a small waterfall south of the bridge, appears to be very similar to the uppermost Mooreville which crops out at the type locality on the north side of U. S. Highway 78 a mile west of Mooreville.

A road cut in the northwest-facing wall of Tulip Creek valley a mile and a half north of Plantersville exposes strata of Mooreville and Coffee age.

SECTION OF THE SOUTHEAST WALL OF A CUT FOR TOMBIGBEE STATE PARK ROAD, IN THE SOUTHEAST WALL OF THE VALLEY OF TULIP CREEK NORTHEAST OF MISSISSIPPI STATE HIGHWAY 6, ABOUT 1.5 MILES NORTH OF PLANTERSVILLE (SEC.10, T.10S., R.6E.) (Figure 4).

	Feet	Feet
Psychozoic group		
Holocene system		
Recent series		
Recent formation		1.5
Soil and subsoil and other mantle rock, to the top of the valley wall	1.5	
Unconformity		
Mesozoic group		
Cretaceous system		
Gulf series		
Selma formation		
Coffee member, Tupelo tongue		46.4
Sand, gray where fresh, as below, but most of it red-brown from oxidation	35.0	
Sandstone, gray to light-yellow, fine-grained, not well consolidated	0.9	
Sand, gray where fresh, red-brown where weathered; streaked with yellow, brown, and gray	9.5	
Sandstone, limy, dull-white to light-yellow, having imperfectly developed shaly structure	1.0	
Mooreville member or tongue		41.3

	Feet	Feet
Clay, calcareous, sandy, very light-yellow to olive-drab, full of pockets and disseminated nodules and stringers of lime	5.0	
Covered, presumably same as interval above	10.0	
Material like that below, but differentiated by color near the surface: it is nearly olive-drab	1.7	
Material limy, clayey, silty, bluish to light-yellow, jointed, fossiliferous, like that below; also contains iron sulphide (marcasite) concretions, and iron oxide and lime concretions and nodules; various degrees of consolidation	5.5	
Projecting layer, much the same as that mentioned below; no sharp upper contact	1.0	
Sand, limy, dark-gray to light-gray, fossiliferous (white shells), bluish on dry surface, rather strongly indurated	1.0	
Material largely sand, much like that below, but more indurated; gray to olive-drab; projects beyond layers above and below; irregular, knobby surface and varying thickness	0.9	
Clay, calcareous, sandy, closely-jointed; breaks out in flattish blocks having a poorly developed shaly structure; dark bluish-gray where fresh and damp, dull whitish where dry; olive-drab tint in places, or light-gray to bluish on dry surface; fossiliferous; micaceous; contains lime accumulations and marcasite and limonite concretions	6.7	
Covered, presumably Mooreville, to the level of Highway 6 at junction with the Tombigbee State Park road	9.5	
Total, 87.7 feet.		

The lowermost 20-foot interval of this exposure has been described also as an indurated and jointed massive light-gray to tan sandy chalk containing oyster shells and fragments of other pelecypods, and the remainder of the exposure on the lower slope as a weathered structureless micaceous ferruginous sand. It is stated further in this description that the upper part of the exposure contains, 9 feet below the overlying sand, an indurated layer, part of which has a cobble-like structure embedded in a softer weathered matrix, and that 15 feet of structureless ferruginous to yellow micaceous fine sand, apparently the basal part of the Tupelo tongue of the Coffee sand, overlie the chalky sand to the hilltop. Shell fragments are found throughout the upper beds, and soft lime concretions are scattered down the hill exposure marking a profile of weathering. The writer cited assigns 50 to 55 feet of this exposure to the Mooreville.

The authors of "The Upper Cretaceous Deposits" assign at least part of the terrane described above to the Coffee sand "not far above the Mooreville tongue," but do not mention any Mooreville in the section: "Twenty-seven feet of fossiliferous, very calcareous dark-gray micaceous sand resembling impure chalk, containing *Exogyra ponderosa* Roemer and other common fossils, merges upward into fine angular-grained massive micaceous yellow sand containing some small grains of glauconite."

Figure 4.—Mooreville chalk, Tombigbee State Park road cut (Sec. 10, T.10 S., R.6 E.) 1.5 miles north of Plantersville and about 100 yards northeast of Highway 6. Photo by Harlan R. Bergquist.

Some four-tenths of a mile by Highway 6 south of the section just described, and east across the highway from Cottings small lake (SW.1/4, Sec.10) is a little-used road up the same ridge which here reaches a height of 85 feet above the lake. About 50 feet above the highway this road crosses a 10-inch layer of greenish-gray Coffee sandstone. Mooreville material is exposed here and there in roadside gullies to within 5.5 feet of the sandstone. The Mooreville-Coffee contact is marked by indurated sand lying on a greenish-gray to yellowish-gray very sandy and somewhat limy clay having shaly structure. Lime concretions are numerous in the clay, and limonite or iron rust pockets in the lower sand; also, thin fingers or tongues of clay are interworked with the basal sand. The contact is 44.5 feet above the highway, whereas the same contact in the Tombigbee

State Park road section is 41.3 feet above the same highway, which is slightly higher at the junction of the park road.

The surface trace of the Mooreville-Coffee contact is of course extremely irregular, because of the mature dissection of the Coffee by streams, most of which flow southward, southwestward, or southeastward. Several of these streams have cut through the sand and trenched the underlying chalky clay to different depths. Thus the vaguely-defined line of contact between chalk and sand extends far up some of the valleys, long tapering bending fingers from the main chalk outcrop area, as from a giant hand, interlocking with similar fingers extended as ridges in the opposite direction from the sand area (Plate 1). Good exposures of Mooreville material are few along this contact, because the chalky clay weathers to low slopes where exposed, and the sand washes down over it. Road cuts afford the best outcrops, as a rule, as exemplified by the Tombigbee State Park road section. Another cut (SW.1/4, Sec.11, T.10S., R.6E.), for the same road, in the southeast wall of Garrett Creek valley a little east of a road junction, exposes a good section of Coffee sand and some Mooreville. The contact is hard to fix accurately, because much of the Mooreville is a dark-gray limy sand similar to some of the Coffee, especially where weathered; however, the Mooreville sand appears to have more shells in it, and as a rule they are more conspicuous; furthermore, it has more of a tendency to be shaly, and to contain more lime concretions.

Almost all the part of the county south of the latitude of Plantersville is in the Selma chalk outcrop area, the Coffee sand, as stated, being represented only slightly along the northern edge of the area by thin fingers forming the uppermost parts of the ridges. The Mooreville-Coffee contact can be located approximately in several places, some of which are: (1) Some six-tenths to seven-tenths of a mile east of Plantersville, in the north wall of a road cut in front of a school building and church, where, according to Stephenson and Monroe, 45 feet of the Mooreville tongue, consisting of brown micaceous, argillaceous very fine-grained sandy chalk, are exposed in the east wall of Garrett Creek valley (east half of the line between Secs. 15 and 22, T.10S., R.6E.). The upper part of the section is purer than the lower part and contains *Exogyra ponderosa* Roemer and *Ostrea plumosa* Morton. The red sand at the top of the outcrop may represent the Coffee sand or may be a terrace deposit of Old Town Creek, according to the same writers. (2) Along a local road up the rather abrupt slope of the east wall of the valley of Skaggs Creek (north-central part, Sec.13, T.10S., R.6E.). (3) In the west wall of the valley of a tributary of Boguegaba Creek (eastern part, Sec. 5, T.10S., R.7E.), 2 miles south-southwest of Mooreville. (4) Two miles northwest of Mooreville (NW.1/4, Sec.20, T.9S., R.7E.), where the road shows a section about a quarter of a mile long, extending from the more or less weathered Mooreville through gradational shaly dark-gray clay into the Coffee sand, a vertical interval of 35 to 40 feet. (5) In the west wall of the valley of Boguefala (NE.1/4, SE.1/4, Sec.6, T.9S., R.7E.), 2 miles west of Eggville, where, above the bottom of the channel of the westernmost branch, some 45 feet of chalky clay and sand, fossiliferous and containing abundant lime concretions, are exposed by a road cut beneath 45 to 50 feet of olive-drab, brown, and red-brown sand extending to the summit of the hill north of a house; the lower interval is considered Mooreville, the upper, Coffee. Measured from a higher datum, this section has been described as 18 feet of weathered argillaceous tan chalk which contains sandy glauconite and streaks and pockets of secondary lime. The chalky part is interpreted as a cross-section of a minor tongue of the Mooreville. A similar exposure is shown by the walls of a road cut (E.1/2, Sec.33, T.8S., R.7E.), on the west slope of Sand Creek valley a mile north of Eggville.

The Boguefala section referred to above, the Tombigbee State Park road section, and the standard Mooreville section, are the best Mooreville-Coffee contact sections in the county, although the Mooreville shows in several places south of U. S. Highway 78 and east of the Tupelo meridian. The section east of Eggville, described in the discussion of the Coffee sand, includes, above a 23-foot covered interval, 32 feet of chalky clay and clay shale and clay which are assigned to the Mooreville. Stephenson and Monroe mention an exposure "On the Saltillo-Mantachie road 100 feet west of the Itawamba County line (NE.1/4, Sec.27, T.8S., R.7E.)," where "3 feet of dark-gray plastic micaceous clay (Mooreville tongue of Selma chalk) is overlain by 10 feet of micaceous red sand (Tupelo tongue of Coffee sand)."

The southeast wall of the valley of Smith Creek (Secs.25 and 36, T.10S., R.6E.) shows extensive chalk outcrops, and chalk is exposed along this valley wall well up towards the valley head. Two and a half miles west of Mooreville and half a mile north of U. S. Highway 78 (near the center, Sec.25, T.9S., R.6E.), in a pasture west and southwest of the road forks, the gray and greenish-gray clay of the weathered Mooreville is well exposed by gullies in a low slope. Some of the material resembles bentonite in appearance, but is very plastic. Lime concretions and disseminated lime are abundant, but fossils are few. This would be a good location for shallow borings for samples.

The westernmost surface appearance of the Mooreville tongue north of U. S. Highway 78 is a doubtful one on the southeast side of the Highway 78-Eggville road, near the base of the southwest wall of the valley of West Tulip Creek, some 200 yards west of the bridge (Sec.26 or 27, T.9S., R.6E.). The material is bluish-gray flaky clay, and it is overlain by brown to red-brown Coffee sand to the top of the ridge, perhaps 75 feet. Evidences of a succession of landslides are conspicuous here. Another place (NW.1/4, Sec.24, T.9 S., R.6E.) somewhat west of any unquestioned Mooreville outcrops, is about 3 miles northeast of East Tupelo, east of a road junction. This exposure shows as its lowest interval gray jointed limy and sandy clay shale, which is overlain by greenish to bluish laminated sandy clay; above the clay is brown, gray and yellow-streaked sand. The uppermost interval is Coffee sand; the others may be Mooreville. Possibly the clay of both these outcrops may belong to the Coffee sand; if it is Mooreville it is too high topographically to be consistent with a uniform westward dip of the beds, but inasmuch as the Mooreville tongue was involved in the deformation of the strata which created the Plantersville structure, the elevations of its outcrops are not strictly consistent with each other or with what they would be if the conditions of normal low-angle west dip prevailed.

The thickness of the Mooreville ranges from 150 to 250 feet. The Evans-Whiteside No. 1 well (Sec.16, T.9S., R.7E.) drilled in 1927 and 1928 about 2 miles north of Mooreville, passed through 160 feet of the Mooreville tongue of the Selma chalk, the entire thickness at this place; the town well at Mooreville penetrated 155 feet of the same unit; and wells in Tupelo logged thicknesses varying from 113 to 215 feet. The great discrepancy in thicknesses reported from wells which are located near each other probably is due chiefly to carelessness in classifying the material from the wells and in making logs.

THE ARCOLA MEMBER

The approximate stratigraphic position of the top of the Mooreville tongue in the southern part of Lee County, south of the Coffee sand outcrop area, is marked by the Arcola limestone. As already stated, this limestone bed in Lee County is the northernmost extension of the Arcola as a whole, and occupies a position about 10 feet below the base of the Tupelo tongue of the Coffee sand. In the area west and north of Nettleton, terraces and alluvium conceal the bed, but the Arcola is exposed at many places in the southeastern part of the county, and was traced as far north as the middle of the line between Secs.8 and 9, T.10S., R.7E. Not far north towards Mooreville it loses its identity in the Tupelo tongue. For a mile or two beyond the northernmost exposure the sandy clay contains phosphatic nodules which, presumably, represent the same zone, because phosphatic nodules and internal molds of mollusk shells are common both above and below the bed throughout much of its areal extent, being particularly conspicuous on weathered slopes above the limestone at several places in the county. At one locality (NW. Cor., Sec. 5, T.11S., R.7E.), 4 miles northeast of Nettleton, where the limestone caps a ridge, the molds and nodules are abundant below the Arcola.

East of Verona the Arcola limestone is overlain by the Demopolis member of the Selma; the position of the shell bed which lies on the Coffee-Demopolis contact farther north is some 45 feet higher. Stephenson and Monroe describe the section in the west wall of Old Town Creek valley along the Verona-Plantersville road as follows:

SECTION A MILE AND THREE QUARTERS EAST OF VERONA (SE.1/4, SEC.20, T.10S., R.6E.)

	Feet	Feet
Terrace deposit (Pliocene or Pleistocene)		25
Orange fine micaceous sand	25	
Selma chalk		61
Greenish-gray argillaceous, sandy, micaceous chalk becoming purer upward in the section; upper 30 or 40 feet consists of fine gray micaceous, sandy fossiliferous chalk (Coll. 6899); two phosphatic molds of gastropods were found within 5 feet of base	48	
Arcola limestone member; "Bored" limestone	1	
Sandy chalk mostly concealed to the flood plain of Old Town Creek	12	

Total, 86 feet.

THE DEMOPOLIS MEMBER

All the chalk in Lee County above the Arcola limestone belongs to the Demopolis member of the Selma. North of the latitude of Verona the lowermost 50-foot interval or so of the Demopolis tongues into the Coffee sand, and in the central and northern parts of the county is occupied by the Coffee. The outcrop area of the sand extends as much as 2.0 to 2.5 miles west of the Arcola limestone position. Conversely, the Demopolis outcrop area extends farther east by 2.0 to 2.5 miles in the latitude of Verona and southwards than it does north of Verona (Plate 1). The Demopolis area of outcrop, then, comprehends all the county west of the Coffee sand area, north of the latitude of Verona, and west of the Arcola limestone south of it.

The Demopolis chalk lies conformably on the Coffee sand member of the Selma, which, as has been stated, is, northwards from south-central Lee County, the equivalent of the lower 200 to 250 feet of the Selma. The contact is at the base of a shell conglomerate, a consolidated bed composed of fossil shells, chiefly *Ostreidae,* but many others also, especially *Gryphaea convexa, Exogyra costata,* and *Exogyra ponderosa,* cemented into a matrix of green sand and sandstone (Figure 5). This basal bed varies somewhat in thickness, but averages 1 foot to 2 feet, and commonly projects beyond the underlying Coffee sand. In places the shell bed has broken down and disappeared, and the silt or chalk of the Selma (Demopolis) rests directly on the Coffee sand. The shell bed shows in many places along the Coffee-Demopolis contact; in fact, it can be followed, interrupted by several breaks, from a point (Sec.29, T.10S., R.6E.), a mile or more southeast of Verona, to an outcrop (SE1/4, Sec.16, T.7S., R.6 E.), 1.5 miles north of Guntown, and its approximate position can be located in Baldwyn (Sec.2, T.7S., R.6E.). The locations of the eight best exposures are listed below:

a) In two or three places (NW.1/4, Sec.19, T.9S., R.6E.) at the heads of small valleys tributary to the valley of Old Town Creek.

b) In the south wall of the valley of Busfaloba Creek (Sec.13, T.9S., R.5E., especially in the SE.1/4 and the NW.1/4).

c) In the southwest wall of the valley of Mud Creek (Center, Sec.25, T.8S., R.5E.), east of old U. S. Highway 45.

d) Within the corporate limits of Saltillo. An excellent outcrop is at the top of the north wall of the cut for old Highway 45 (northern part, Sec.20, T.8S., R.6E.) in Saltillo at the top of the ridge a quarter of a mile or less from new Highway 45. South of this exposure, also, along the east wall of the valley of Flat Creek (W.1/2, Sec.20, T.8S., R.6E.) for a distance of nearly a mile, the shell bed shows here and there, two or three of these outcrops being very good.

e) On the west side of new U. S. Highway 45 (NE.1/4, SW.1/4, Sec.17, T.8S., R.6E.) some six-tenths of a mile north of the intersection of the highway with old 45 leading into Saltillo (Figure 5).

f) In the walls of a cut for a local road a mile east of Guntown; also in the walls of ravines and small valleys north and south of the road (Secs.26 and 35, T.7S., R.6E.).

g) Several places in Guntown, especially at the railroad crossing in the north-central part of town (Sec.27, T.7S., R.6E.).

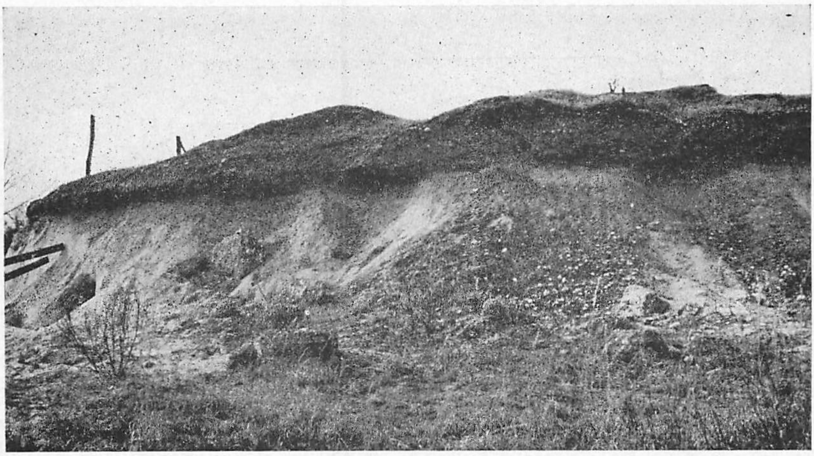


Figure 5.—Coffee sand member overlain by the projecting thin bed of shells of Exogyra ponderosa and Gryphaea convexa at the base of the Demopolis chalk member of the Selma formation at the western border of Saltillo (Sec. 17, T.8 S., R.6 E.). Photo by Harlan R. Bergquist.

h) In the wall of a pit (Sec.22, T.7S., R.6E.) on the east side of U. S. Highway 45, three quarters of a mile north of Guntown.

The exposed rock at the third location mentioned (c), consists of "6 feet of slightly glauconitic, yellow sand (Tupelo tongue of Coffee sand) overlain by slightly glauconitic, slightly sandy chalk (Selma), containing at the base a bed composed almost entirely of *Gryphaea convexa* (Say) and *Exogyra ponderosa erraticostata* Stephenson. The contact is very irregular but there is no evidence of an unconformity." The shell bed can be seen here for about 100 yards almost unbroken along the slope.

The section at the place named last on the list (h) has been described as follows:

SECTION IN PIT AT EAST SIDE OF U. S. HIGHWAY 45, SEC.22, T.7S., R.6E.

	Feet	Feet
Selma chalk		14.5
Dark-gray argillaceous, sandy chalk; lower 6 feet is a shell bed containing *Exogyra ponderosa* Roemer, *Gryphaea convexa* (Say) and other common fossils, and abundant phosphatic molds of fossils	14.0	
Shell bed composed largely of *Exogyra ponderosa* Roemer and *Gryphaea convexa* (Say) in hard sandstone	0.5	
Coffee sand		15.0
Fine glauconitic sand	15.0	

Total, 29.5 feet.

In the southern part of the county much of the lower Demopolis is hidden by terrace and alluvial deposits which cover considerable areas. West of the Coffee sand region, however, and west of the Arcola limestone outcrops south of the latitude of Verona, outcrops, both large and small, are numerous at higher stratigraphic levels, especially along the floors of the stream channels and along or near the southwest or west walls of the stream valleys, which, with relation to the rock structure, are the down-dip sides of the valleys, and with relation to the topographic features are the steep or up-dip faces of the cuestas. In fact, a general statement concerning the locations of the Selma outcrops will be true in most cases for western Lee County and also for other counties of the state: The outcrops are in or near the relatively steep slopes of the down-dip walls of the major valleys, and are absent from or few in the gentle up-dip slopes. For the most part the gentle slopes are developed on thick weathered material, and may be associated with extensive terraces. The dividing belts between the larger streams may be low rolling prairie or be practically flat.

Low chalk cliffs border the major valleys on the southwest or west in western Lee County. They may extend almost unbroken for miles, the most conspicuous features of the landscape. Such chalk walls are particularly prominent along Tubbalubba, Chiwapa, and Coonewah Creeks, and in places along Busfaloba and Mud Creeks. From a bridge (East-central part, Sec.27, T.11S., R.5E.) over Tubbalubba Creek 2.5 to 3.0 miles southwest of Shannon, the southwest wall of the broad flat creek valley can be seen as a continuous glaring white and bluish chalk cliff at least a mile long, featured by a well-defined terrace cut in the chalk. The terrace top appears to descend at a low angle up the valley (northwestwards). The Sample

3 series was taken from this terrace 200 yards west of a local road (SE. Cor., Sec.27, T.11S., R.5E.). The massive jointed bluish and dull-white chalk is excellently exposed, also, in the floor and walls of the creek above the bridge (Figure 6). The material in transit by the stream at this place consists for the most part of flattish sub-circular and elliptical chalk cobbles and pebbles.

Other places where large outcrops of Demopolis chalk may be seen along local roads are:

Figure 6.—Demopolis chalk floor and 16-foot wall of the channel of Tubbalubba Creek (Sec. 27, T.11 S., R.5 E.), 2.5 miles southwest of Shannon. March 22, 1945.

In the southwest wall of the valley of Chiwapa Creek (NW.1/4, Sec.22, T.11S., R.5E.) 3 miles west of Shannon (Sample 4 series).

A gullied exposure at the head of a short tributary of Coonewah Creek (SW.1/4, Sec.35, T.10S., R.5E.), 1.5 miles west of U. S. Highway 45 (Sample 5 series).

A vertical-faced chalk wall (SE.1/4, Sec.22, T.10S., R.5E.) of a cut for a road on the west side of the valley of Coonewah Creek, 2.5 miles west of Verona (Figure 7) (Sample E series).

In the southwest wall of Coonewah Creek valley (Sec.6, T.10S., R.5E.) on both sides of Highway 6 a little east of the Lee County-Pontotoc County line. The Reed and Fields lime pit here is a mile east of the county line and some 6 miles by highway west of Tupelo (Sample 6; Figure 8).

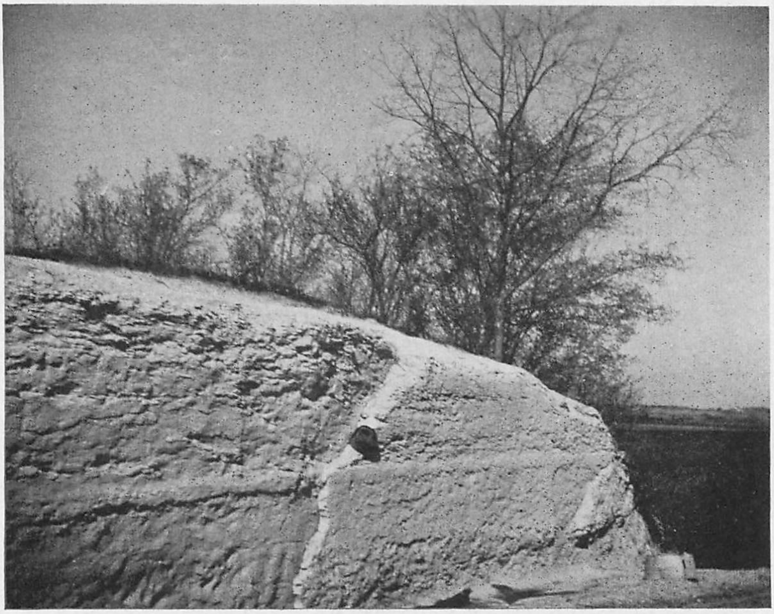


Figure 7.—Demopolis chalk, wall of road cut (SE.1/4, Sec. 22, T.10 S., R.5 E.) in the bluff of Coonewah Creek Valley 2.5 miles west of Verona. March 23, 1945.

In the vicinity of Belden (Sec.9, T.9S., R.5E.), where the 50-foot southwest wall of Busfaloba Creek valley is bare chalk for long distances on both sides of U. S. Highway 78 (Samples 7, 8, 8a, 8b, 8c, and others taken at an earlier date). The chalk wall reaches far to the southeast, extensive outcrops (SE.1/4, NW.1/4, Sec.15, T.9S., R.5E.) showing 1.5 miles east by south of Belden (Sample 9 series).

The southwest wall of Mud Creek valley (Sec.25, T.8S., R.5E.), east and west of old U. S. Highway 45. (Samples 10 and many others.)

Farther up the valley of Mud Creek the chalk of the southwest wall is well exposed, and the stream through considerable distances

Figure 8.—Demopolis chalk, Reed and Fields old lime pit (Sec. 6, T.10 S., R.5 E.) on the north side of Highway 6, 6 miles west-southwest from Tupelo. March 13, 1945.

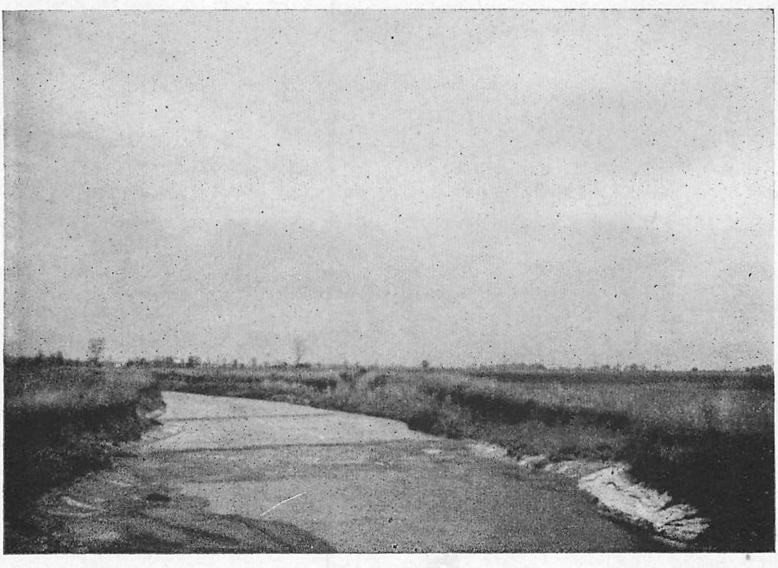


Figure 9.—Demopolis chalk floor of the channel of Mud Creek (SW.1/4, Sec. 2, T.8 S., R.5 E.); rapids caused by resistant layers. March 28, 1945.

flows on solid white and blue chalk, of which some layers are sufficiently resistant to cause rapids (Figure 9).

In the northwestern corner of the county (NE.1/4, Sec.11, T.7S., R.5E.), almost on the Union County line, a 30-foot vertical chalk bluff bounds the channel of Dry Creek, a tributary of Tishomingo Creek, for a few rods above the Bethany road bridge. A feature of this exposure is a considerable number of chalk bowlders, one or two of which is at least 4 to 5 feet in diameter, lying in the stream

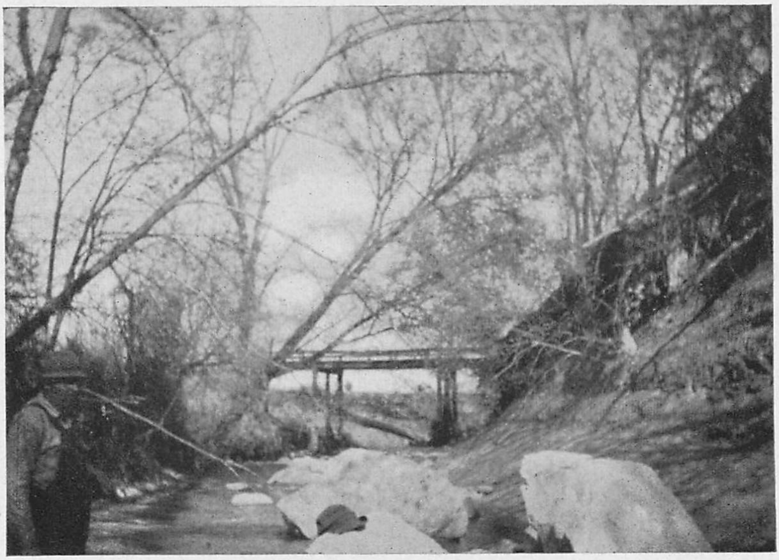


Figure 10.—Demopolis chalk, 30-foot bluff and fallen masses, Dry Creek (NE.1/4, Sec. 11, T.7 S., R.5 E.), in the northwestern corner of Lee County. March 28, 1945.

at the foot of the bluff (Figure 10). Tishomingo Creek, also, in the same valley a mile or less southwest of Bethany, flows on a floor of solid chalk.

Southeast of Tupelo, in the west wall of the valley of Old Town Creek, especially near the heads of its short tributaries, are many chalk outcrops, some of which are extensive. Notable among these are the exposures made by a cut for the Gulf, Mobile & Ohio Railroad a mile north of Verona, and the numerous ravines and gullies east of the cut (SW.1/4, Sec.18, T.10S., R.6E.). In the walls of this railroad cut the massive bluish to gray chalk is well shown, as are the conchoidal masses produced by close curved jointing or fracture (Figure 11).

THE COFFEE MEMBER[7c]

The Coffee member of the Selma formation, named from a section exposed at Coffee Landing, in Hardin County, Tennessee, is composed of "irregularly bedded glauconitic sand and interbedded clay, much like the typical beds of the Eutaw formation." As has been stated, it is the equivalent, north of Itawamba County, Missis-

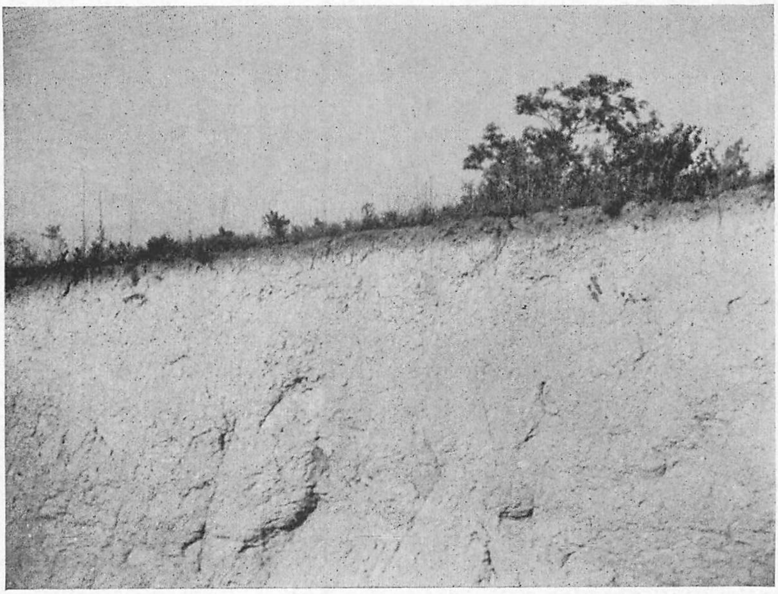


Figure 11.—Chalk wall, showing massive structure and jointing, Gulf, Mobile & Ohio Railroad cut (SW.1/4, Sec. 18, T.10 S., R.6 E.) a mile north of Verona. April 27, 1945.

sippi, of the lower 200 feet or more of the chalk, and the age equivalent of all the Selma chalk south of Tupelo up to and including the *Diploschiza cretacea* zone. The chalk merges northwards into the sand by lateral gradation and major and minor intertonguing. The chief tongues are the Mooreville chalk, extending northwards from the main body of Selma chalk through eastern Lee County and western Itawamba, and the overlying Tupelo tongue of the Coffee sand extending southwards in Lee County to a little south of the latitude of Plantersville. Thus, from Lee County northwards to and beyond the Tennessee state line the Coffee sand lies on the Tombigbee sand member of the Eutaw formation and underlies the middle or Demopolis member of the Alabama Selma chalk.

Evidence of the merging and intertonguing of the chalk with the Coffee sand toward both south and west is adduced by Stephenson and Monroe: "South of Tupelo the Coffee sand appears to merge into chalk both toward the south and toward the west, for on the tops of the hills east of Plantersville red weathered sand, presumably derived from the Coffee sand, is exposed, whereas between Old Town Creek and Verona and for at least a mile and a half north of the latitude of Verona there is no break between chalk correlated with the Mooreville tongue and the main body of the chalk. The chalk in this area is not so pure as that higher in the section and undoubtedly was affected by the currents which were transporting and depositing sand to the east and north. Sandy chalk equivalent to the Tupelo tongue of the Coffee sand, is exposed from 1 1/2 to 1 3/4 miles east of Verona. As one passes northward from Verona (Center, Sec.18, T.10S., R.6E.), the chalk merges laterally into sand. About 1 mile north (Center, west edge of Sec. 7), 12 feet of hard chalk is exposed, containing a bed of flaky calcareous sandstone 4 feet above the base. All of the chalk in this exposure is probably represented by sand in a cut on U. S. Highway 45 and in outcrops in the hills to the west of the road, on the northward-facing slope of Kings Creek Valley (Sec. 31, T.9S., R.6E.), half a mile south of the St. Louis-San Francisco Railway crossing."

About a third of Lee County, roughly the territory north of the Plantersville parallel and east of the Tupelo meridian, is included in the Coffee sand outcrop area, which is 7 to 10 miles wide. Good exposures are many, but only a few can be given specific mention in this report.

The Tupelo tongue "is a body of dark-gray mostly massive calcareous glauconitic sand" about 100 feet thick. The type locality is in East Tupelo, a mile east of the city limits of Tupelo, where deep cuts have been made for the old Fulton road which extends due east from the bend in U. S. Highway 78 at the foot of the east wall of Old Town Creek Valley. The section here is described by Stephenson and Monroe:

SECTION IN ABANDONED PORTION OF THE FULTON ROAD, 1 1/2 MILES EAST OF TUPELO

	Feet	Feet
Coffee sand (Tupelo tongue)		80
Weathered massive reddish ferruginous marine sand, grading downward into yellowish-green massive slightly glauconitic sand	30	
Massive gray more or less calcareous, glauconitic sand with several widely separated ledges of calcareous sandstone. *Gryphaea convexa* (Say) abundant in a layer 15 to 25 feet below the top, and *Exogyra ponderosa* Roemer and *Gryphaea convexa* (Say) fairly abundant in a layer 10 feet below the top (Colls. 6453 and 6900); base about 10 feet higher than the bottom lands of Old Town Creek	50	

A little above the bottom of the hill, slate-gray fine sand is well exposed in the north wall of the cut, especially on the west slope of the hill a few yards east of a house. Also the same interval crops out on the south side of Highway 78, at the foot of the hill. Farther east in the old road, particularly in the walls of the cut at the top of the hill, the more weathered sand shows, yellow and blue and green, with dark-gray streaks through it, presenting a mottled appearance, or a rather intricate pattern of differential weathering. In fact, the contact between the relatively unweathered sand below and the weathered sand above follows the profile of the hill roughly. All the sand is fine; the gray layers especially are fossiliferous, and the entire section contains indurated nodular beds at irregular intervals stratigraphically (Figure 12). The nodular sandstone of these layers is extremely tenacious; calcite crystals show where the beds are most firmly cemented and most resistant. Four such indurated beds show in the north wall of the cut farthest west, separated by intervals of 32, 6, and 13 feet, in ascending order. The uppermost two crop out in a cut farther east, and in one place the interval between them includes a bed of white sand containing numerous shells.

Chalk of the Mooreville tongue is exposed along U. S. Highway 78 west of the type locality and in the walls of the valleys of Tulip Creek and South Tulip Creek. South of this chalky lowland is an outlier of the Tupelo tongue which includes the red sand hills of Tombigbee State Park and the area for a mile or two surrounding it. Sand ridges from the outlier extend northward to the highway half a mile west of Mooreville and southward through the sections lying 2 miles and farther east of Plantersville. Some exposures of Coffee sand in this region are worthy of more than passing attention.

About half a mile southeast of the Mooreville outcrop in the channel of Tulip Creek (Northern part, Sec.3, T.10S., R.6E.) is the section of Coffee sand described below:

Figure 12.—Coffee sand, type exposure of the Tupelo tongue, East Tupelo (Near the center, Sec. 33, T.9 S., R.6 E.), north wall of cut for old Fulton road, at top of hill. March 19, 1945.

SECTION EXPOSED BY ROAD-CUT IN THE SOUTHEAST WALL OF THE VALLEY OF TULIP CREEK (SW.1/4, SEC.2, T.10S., R.6E.)

	Feet	Feet
Selma formation		
Coffee member		75.0
Sand, red-brown silty and clayey, to level of houses, one on each side of road, near the top of the hill	20.0	
Sand, dull-white limy silty, micaceous on the surface, gray where fresh, very fossiliferous	15.0	
Sandstone, calcareous fossiliferous extremely indurated, dark-gray where fresh, dries light-gray	1.0	
Sand, calcareous, dark-gray where fresh, light-gray to dull-white on exposed surface; fossiliferous; *Exogyra* layer	4.5	
Covered	5.0	
Sand, gray where fresh, brown with iron rust where weathered; fine; probably much of it slumped	15.0	
Covered, presumably Coffee sand, to level of flood plain	14.5	

In the south wall of the valley of South Tulip Creek (N. part, Sec.2, T.10S., R.6E.) is a long cut for a local road, which shows a good section of the weathered phase of the Coffee sand, but is too shallow to expose the different units of the sand. Near the lower end of this cut a 6-inch to 8-inch dark-gray sandstone is crossed by the road.

Along a road leading east to Tombigbee State Park from the road junction (SW.1/4, Sec.11, T.10S., R.6E.), are several cuts in the Coffee sand, exposing two or three beds of sandstone. Some 200 yards southwest of the west gate of the park and 11 feet below it, the road crosses a calcareous fossiliferous sandstone, dark-gray where fresh, whitish on the dry exposed surface, and about 10 inches thick.

At the road junction (Sec.6, T.10S., R.7E.) is a fairly good exposure of Coffee sand, most of it the weathered phase.

In the east wall of the valley of Tulip Creek about 200 yards east of the road bridge over the creek (SW. Cor., Sec.18, T.9S., R.7 E.), a road cut reveals 8 feet of soft yellow and gray fine micaceous, glauconitic, calcareous sandstone (almost a sandy, argillaceous chalk) containing *Exogyra ponderosa* Roemer, *Exogyra ponderosa erraticostata* Stephenson, and a few phosphatic molds of gastropods. The material is similar to that of the Tombigbee State Park road referred to above.

One of the best sections of Coffee sand in the county is exposed by road cuts in the west wall of the valley of Sand Creek east of Eggville. A description of this section follows:

SECTION EXPOSED IN WALLS OF CUTS (SECS.3 AND 4, T.9S., R.7E.) FOR MANTACHIE ROAD, WEST WALL OF THE VALLEY OF SAND CREEK EAST OF EGGVILLE. THE SECTION EXTENDS SEVEN-TENTHS OF A MILE WESTWARDS FROM SAND CREEK BRIDGE TO THE TOP OF THE BLUFF AT EGGVILLE.

	Feet	Feet
Recent formation		2.0
Soil, brown sandy loam to silt loam; sub-soil, clayey and sandy; other mantle rock; soil contains little humus	2.0	
Selma formation		
Coffee member		85.3
Sand, red-brown and yellow oxidized, silty	15.0	
Sand, olive-drab, fine; color due to oxidation of iron in original gray sand; some hard nodular layers; about	12.0	
Sandstone, gray (Sample 12)	0.8	

Sand, very dark-gray (Sample 11) grading upwards into lighter gray mixed with olive-drab and yellow (oxidized part); large oyster shells (Sample 11a)	17.0	
Sandstone, dark-gray (Sample 10)	1.0	
Sand, yellowish-gray to olive-drab mottled (Sample 9)	4.5	
Covered interval, about	10.0	
Sand, yellow and greenish and brown mottled (Samples 7 and 8)	24.5	
Sand, dark-green glauconitic (Sample 6)	0.5	
Mooreville tongue or member		55.0
Clay shale or light-gray to yellowish-gray micaceous sandy and silty calcareous clay containing lime concretions especially noticeable on the exposed surface, and also many shells, as well as rust pockets. The shaly clay is darker near the top, and at the very top is light-gray (Samples 1 to 5)	32.0	
Covered interval, including alluvium of creek flat, about 10 feet; colluvium, sand and clay, more a sticky, sandy clay containing lumps of the underlying light-gray to olive-drab sandy clay shale and some shell fragments, to water-level of Sand Creek; about	23.0	
Total, 142.3 feet.		

The 0.8-foot hard layer shows in relief diagonally across the face of the sand outcrop (Figure 13), and dips South 20 degrees West about 2 feet in 187.5, or at the rate of about 56 feet to the mile. However, this may not represent regional dip, or even the true dip for any considerable area, because local diagonal bedding is not uncommon in the Coffee sand, and these thin knobby sandstones may follow the diagonal bedding.

Stephenson and Monroe describe the Coffee sand part of this section as follows:

SECTION IN RATLIFF ROAD, 11 1/4 MILES NORTHEAST OF TUPELO.

	Feet
4. Massive, greenish-gray argillaceous, glauconitic sand, with a discontinuous ledge of greenish-gray calcareous, micaceous sandstone 10 inches thick about 5 ft. above the base	35
3. Greenish-gray very argillaceous, calcareous sand containing *Ostrea plumosa* Morton	6
2. Very dark-gray compact argillaceous, slightly glauconitic sand containing near the base poorly preserved specimens of *Hamulus squamosus* Gabb and other common fossils	8
1. Lighter greenish-gray massive glauconitic, calcareous sand, containing a few fossil shells and internal molds	6
	55

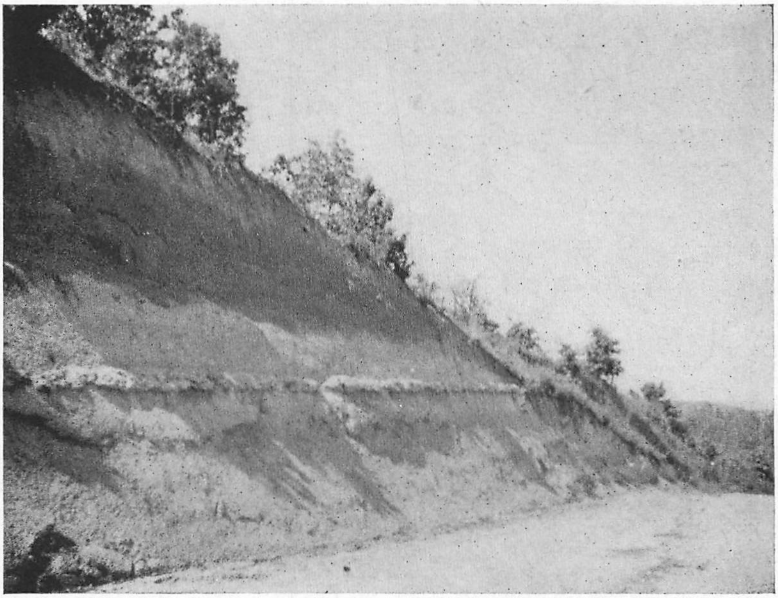


Figure 13.—Coffee sand, exposure east of Eggville, wall of cut for Ratliff road (Eastern part, Sec. 4, T.9 S., R.7 E.). April 27, 1945.

Some three-quarters of a mile southwest of this outcrop, a little west of a road junction, a fresh road cut (SW.1/4, Sec.4, T.9S., R.7E.) exposes a few feet of limy sand containing fossils, among which are a few *Exogyrae*. The fresh sand is fine, blue, and micaceous, and includes a thin sandstone or two.

A long cut (Center, Sec.1, T.9S., R.6E.) from the road junction at the top of the west wall of Tulip Creek Valley to the bottom of the valley, shows a very good section of the Coffee sand.

In a short road leading from the local public road to a farm house (SW.1/4, Sec.7, T.9S., R.7E.), in the east wall of the valley of Tulip Creek, two layers of calcareous Coffee sandstone crop out, separated by a vertical interval of 5 to 6 feet. The upper of these sandstones is at an altitude of about 371 feet. West of this place 300 yards (NW. cor., Sec.18, T.9S., R.7E.) Tulip Creek a little south of the bridge flows between low vertical walls of laminated micaceous fine silty sand containing numerous marcasite concretions. The freshly exposed sand is a midnight-blue, but oxidizes to olive-green and coffee-brown, and dries to a light greenish-blue. The bed of the creek channel some 60 yards south of the bridge has an altitude of 321 feet, 44 feet below the lower of the two sandstones mentioned above. Some three-quarters of a mile farther north by west (NE.1/4, Sec.12, T.9S., R.6E.), at another local road bridge over Tulip Creek, the water has cut a shallow gorge in the sand, which shows as light-gray 3-foot to 4-foot walls.

Several cuts along the road east from Saltillo show the Coffee sand very well. Of these, the cut at the road junction (common corner, Secs.13,14,23, and 24, T.8S., R.6E.), 3.2 miles east of the railroad at Saltillo, merits special mention, as does the cut at the crossroads a mile and a half farther east (SW.1/4, Sec.18, T.8S., R.7E.), where fine micaceous yellow sand is overlain by dark-gray argillaceous, micaceous sand. Two or three road cuts between these two display the sand and clay laminae clearly. In the southeast quarter of the section referred to above (Sec. 18), a thin bed of bentonite is exposed in a ditch at the side of the road.

The section described below shows the characteristics of the Coffee sand in the central part of the Coffee area of outcrop:

SECTION OF NORTHEASTWARD-FACING SLOPE OF PUNCHEON CREEK VALLEY (SEC.17, T.8S., R.7E.)

	Feet	Feet
Selma formation		
Coffee sand member		87.0
9. Massive light-gray compact micaceous, sparingly glauconitic fine to very fine sand; contains a slightly indurated layer 21 feet above base; balls of iron pyrites common	45.0	
8. Compact fine sand (like overlying bed) containing phosphatic nodules	0.5	
7. Hard calcareous sandstone	0.5	
6. Compact light-gray calcareous sand containing a few oysters and pebbles of phosphate	1.0	
5. Compact calcareous sand containing abundant shells of *Exogyra ponderosa* Roemer, *Ostrea* sp., *Gryphaea* sp., phosphatic molds of mollusks, and a large piece of phosphatized bone	1.0	
4. Compact light-gray sparingly glauconitic fine sand	3.0	
3. Concealed by colluvium	5.0	
(The part of the section described below is in a pit on the east side of the road at the foot of the hill)		
2. Stratified gray and brown, more or less ferruginous, highly glauconitic sand; bed 8 feet above base contains flakes of gray clay	20.0	
1. Concealed to flood plain of Puncheon Creek	11.0	

A cut for a local road in the southwest wall of the valley of Twentymile Creek (Center, Sec.29, T.7S., R.7E.) gives a good exposure of Coffee sand, particularly of an 8-inch to 10-inch indurated very fossiliferous layer.

About 4.4 miles east from Highway 45 at Guntown, an outcrop of Coffee sand shows distinct intervals and prominent bedding (Sec. 30, T.7S., R.7E.). At the base the material is light-yellow and is capped by a layer about 1 foot thick of brown limonite-cemented sand which projects over the yellowish sand; above the cemented layer is dove-gray fine micaceous sand shot through with stains and streaks of iron rust; yellowish or tan sand overlies this, and red-brown sand at the top. The section has been described as follows:

SECTION EXPOSED BY HILLSIDE ROAD CUT ABOVE MANTACHIE CREEK VALLEY, 3 MILES EAST OF GUNTOWN (NW.1/4, SW.1/4, SEC.30, T.7S., R.7E.)

	Feet	Feet
Selma formation		
Coffee sand member		55.0
Indurated ferruginous sand layer, weathered; forms a protective ledge		
Sand, fine tan	15.0	
Clay and silt; thin beds and lenses of micaceous silty gray clay, interbedded with gray or tan silt; plus or minus	20.0	
Sand, red and yellow fine-grained, 15 to	20.0	

Such an arrangement and succession seem to characterize the Coffee sand in many exposures.

Coffee sand crops out conspicuously at and in the vicinity of a road junction 3 miles southeast of Baldwyn (western part, Sec.19, T.7 S., R.7E.). The hill slopes in and near the roads northeast and northwest from the junction, and the walls of the road cuts, expose the sand as well as it is exposed at any other place in the county. The section is described below:

SECTION OF UPPER COFFEE SAND 3 MILES SOUTHEAST OF BALDWYN, ALONG A HILLSIDE ROAD CUT ABOVE THE VALLEY OF TWENTYMILE CREEK (NW.1/4, SEC.19, T.7S., R.7E.)

	Feet	Feet
Selma formation		
Coffee sand member		129.0
7. Sand, fine micaceous tan to reddish-brown; unaltered glauconite in scattered spots	32.0	
6. Interbedded silty gray clay and fine micaceous gray sand; thin layers of silt; streaks of tan and pale yellow silt; grades into the bed below	8.0	

5. Clay, silty to sandy tan and gray; interbedded with fine micaceous tan and gray sand; clay content highest in the upper part, and grades downwards so that in lower 2 feet gray sand predominates; the gray sand contains lenses of gray clay	13.0
4. Sand, fine glauconitic gray; tan streaks and mottlings; thin clay partings at intervals; basal 2 feet unweathered dark-gray with fossil imprints in upper half. The bed grades into the bed above	26.0
3. Clay, silty to sandy micaceous glauconitic dark-gray; thin-bedded; sand lenses in upper part; a few scattered fragments of oyster shells	12.0
2. Covered	9.0
1. Clay, very sandy micaceous; mottled gray and brown through most of the bed, but highly weathered to brown in the upper part; scattered carbonized plant remains; thin layers of fine sand and of smooth gray clay	29.0

The carbonized plant remains in the lowest bed (1) suggest shallow water or shoaling conditions during deposition with plant contributions from nearby land. This was the only locality at which plant remains were noted.

Half a mile farther south (W.1/2, Sec.19) are clay beds of the same stratigraphic position as those of the section, exposed by road cuts on hilltops. They are largely unweathered gray silty clay interbedded with silt, and show clearly defined bedding and lamination.

Along the southwest edge of its outcrop area, the Coffee sand merges with and tongues into the chalk in such a manner that no Coffee sand is exposed west of the valley of Old Town Creek farther south than old Highway 45 some 1.5 miles south of Tupelo (Sec.7, T.10S., R.6E.). The section described below indicates the sand-chalk relationships almost at the southern edge of the town:

SECTION ON NORTHWARD-FACING SLOPE OF KINGS CREEK VALLEY, U. S. HIGHWAY 45

	Feet	Feet
Selma formation		
Demopolis member		15.0
Very argillaceous, sandy, micaceous chalk; base not well exposed; contains *Exogyra ponderosa* Roemer, and other common fossils	15.0	
Coffee member (Tupelo tongue)		49.0
Light-brown calcareous, argillaceous, glauconitic, sparingly micaceous sand containing a few small marcasite concretions	20.0	
Sandstone perforated by borings	0.5	

Light-brown fossiliferous sand	6.0
Hard gray calcareous sandstone	3.0
Gray calcareous sand weathering into coffee-colored calcareous, micaceous, glauconitic sand	9.0
Hard calcareous brown sandstone	0.5
Weathered brown sand; to flood plain	10.0

Total, 64.0 feet.

West of the highway 100 yards or less, many shells, among which *Gryphaea convexa* (Say) is conspicuous, lie on top of the ridge, probably residual from the thin eastern border zone of the chalk. The approximate contact trace between the Coffee member and the overlying middle Selma (Demopolis) can be followed westward along the valley wall, descending at a low angle until it is at valley floor level so that the entire ridge is chalk. About a quarter of a mile west of the highway, gullies expose, except for thin covered intervals here and there, a section from the bottom of the valley wall almost to the top, but nowhere a sharp contact between the sand and the chalk. The sand below, including two sandstones, seems to grade upwards through laminated clayey and limy sand into sandy, limy clay, and through this into sandy and clayey chalk, all fossiliferous.

East of the highway the face of the southwest wall of Kings Creek valley shows Coffee sand only, at least as far as some place north of the Community Hospital. The northernmost hill east of the highway is entirely Coffee sand. In the face of the valley wall about 150 yards southeast of the highway two indurated beds crop out, one 16 feet above the creek flat, the other 30 feet above the same datum. No other good exposure exists along the valley wall between new Highway 45 and old Highway 45 except at a place or two 250 to 300 yards northwest of the old highway, where two sandstones and some interbedded sand are exposed. At one of these outcrops, one sandstone is about 11 feet above the valley flat, another about 19 feet. Still farther southeast, on the west side of old Highway 45, the upper part of the Coffee sand, including two sandstones about 8 feet apart, shows in the basal zone of the valley wall and in a ditch at the foot of the bank. The lower sandstone, a strongly indurated 1-foot bed, is the floor of the ditch for several feet, and forms a ledge over which the water falls. This sandstone is about 10 feet above the flood plain of Kings Creek (or Old Town Creek) which here has an elevation of 260 to 280 feet. Numerous shells, including *Exogyra ponderosa* Roemer, lie along the top of the bank for several rods just above the upper sandstone; this bed may correspond to the shell bed at the base of the Demopolis chalk farther north. No exposure of Coffee sand was seen farther southeast along the southwest wall of the valley of Old Town Creek, but the shell belt which may indicate the Coffee-Demopolis contact was traced as far as the south-central part of Sec.7, T.10S., R.6E., where shells are scattered over the flat at the foot of the bluff below the bend in old Highway 45. The terrane between the new and old highways above a relatively thin interval appears to be chalky material which should be considered part of the Selma chalk (Demopolis member); but obviously, if the stratigraphic relationships were those of a series of monoclinal low westward-dipping strata of uniform thickness, this region should be Coffee sand. Merging and interwedging of sand and chalk, or gradation of one into the other, seem to be the most plausible explanation of the conditions here. In this connection reference is again made to the exposure (about the center of the west edge, Sec.7, T.10S., R.6E.), along Highway 45, where 12 feet of hard chalk contain a bed of flaky calcareous sandstone 4 feet above the base.

That the top of the sand descends southwards along the highway, on the west side, is shown in fresh exposures made by grading and excavations for building sites. One of these fresh outcrops, on the south side of a bottling plant, and across the highway from Station WELO tower, shows two indurated beds separated by a vertical interval of a few feet; probably they are the uppermost beds of the Kings Creek valley bluff. Only 250 to 300 yards south of this fresh sand outcrop, the part of the Community Hospital hill directly west of the hospital, across the highway, shows chalk only, yet the altitudes are essentially the same. Obviously the sand dips beneath the chalk in this short distance, or the two members merge into each other.

North of Tupelo, soft, slightly glauconitic yellow sand is exposed by numerous cuts along U. S. Highway 45 and along the many county roads to the east. At several places along both the old and new highways, cuts through the hills show remnants of the highly fossiliferous indurated basal sandy chalk of the Demopolis (Figure 5). Such remnants also cap several hills east of Guntown in the area of a Demopolis outlier. For the most part, however, the chalk overlying the Coffee sand has been reduced to thin residual clay.

The best exposure of Coffee sand north of Tupelo is in the Highway 45 cut in the southwest wall of Old Town Creek valley (northern part, Sec.19, T.9S., R.6E.), a little more than a mile north of the city limits. The upper Coffee sand is excellently exposed in the walls of this fresh cut (Figure 14), and another or two farther south, from a little above the flood plain of Old Town Creek to the base of the Demopolis chalk at the top of the bluff.

Figure 14.—Coffee sand, 50-foot wall of U. S. Highway 45 cut (Northern part, Sec. 19, T.9 S., R.6 E.) a mile north of Tupelo. March 19, 1945.

The horizon of the Arcola limestone, which is near the top of the Mooreville tongue of the Selma chalk, can be traced for a few miles into the Coffee sand. The most northerly evidence of the Arcola is the scattered limestone cobbles in the fields 1.5 miles east of the eastern boundary of Tombigbee State Park (Sec.8, T.10S., R.7E.), but the zone of phosphatic nodules and internal molds of mollusk shells associated with the limestone bed can be identified at several localities north of the northernmost cobbles. A mile north of the farthest north limestone cobble, phosphatic molds are present in the sandy chalk soil of fields at the upper end of South Tulip Creek valley. Across the valley along U. S. Highway 78, 2 miles west of

Mooreville, abundant nodules and mollusk molds are scattered through sandy chalk exposed by gullies in a pasture 200 yards north of the pavement. Nodules in the Coffee sand can be seen along the ridge east of the east fork of Tulip Creek at localities which are 1 mile, 2 miles, and 3 miles north of the aforementioned location near Highway 78. One locality (SW.1/4, SW.1/4, Sec.19, T.9S., R.7E.) is on the north slope of a hill north of a road and east of a frame house. The exposure appears to show minor intertonguing of the Coffee sand and Mooreville tongue of the chalk; at the top the material is very chalky whereas, separating the basal 2 feet of unweathered gray micaceous sandy clay is an interval of fine-grained glauconitic tan calcareous sand containing oyster shells. In the upper part of the sand are chalky streaks and hard phosphatic buff-colored glauconitic nodules and mollusk molds. Phosphatic nodules are very abundant along with a few mollusk molds and scattered *Exogyra* shells in gullies in the overlying sandy chalk.

The second of these localities is a road cut (Section line, NW.1/4, NE.1/4, Sec.19, T.9S., R.7E.) on the west-facing slope east of Tulip Creek Valley. Here phosphatic nodules are scattered in weathered residual material above an indurated calcareous glauconitic sand.

Mollusk molds and phosphatic nodules are in a weathered sand lying above a somewhat indurated calcareous glauconitic sand in the wall and bed of a section-line road cut, near a private road (SW.1/4, SW.1/4, Sec.7, T.9S., R.7E) on the east slope of Tulip Creek Valley, 3 miles north of Highway 78.

The diastem above the Arcola limestone may be represented at the base of the fifth interval of the Puncheon Creek section (Sec.17, T. 8S., R.7E.), described on a previous page.

PLIOCENE (?), PLEISTOCENE, AND RECENT DEPOSITS

Terrace-forming processes have operated on a large scale in the valley of the Tombigbee River, not only along the lower and middle reaches of the river, but in the valleys of the headwater branches. Terraces are prominent in several parts of Lee County, and appear to slope upstream at a low angle and merge with present flood plains.[7] They are especially well developed in the southern part of the county, west of Nettleton along both walls of Old Town Creek Valley. Cuts for U. S. Highway 45 E in both walls of the valley, and borrow pits in both walls, expose the terrace material. Also the light-yellow to light-brown and mottled mixture of sand and clay which forms the terrace of the south wall of Coonewah Creek Valley north and east of Shannon is exposed by a cut for Highway 45. Southwest of Shannon, much of the area (Secs.25 and 26, T.11S., R.5E.), is terrace top. The road which extends west from its junction with Highway 45 at the center of Section 25 traverses a flat surface for a mile or more, west of which distance it is traced down a gentle slope to the Tubbalubba Creek flood plain. From the bridges over the creek a good view can be had of a chalk terrace along the southwest wall of the valley. Northeast of Shannon, and south of Verona, too, the area between the valleys of Coonewah and Old Town Creeks is largely terrace top. Shallow outcrops show brown clayey and silty sand. East of Verona the section of the west wall of Old Town Creek valley includes as its uppermost interval 25 feet of orange fine micaceous sand, a remnant of a Pliocene or Pleistocene terrace.[7]

West and northwest of Saltillo, the region between Mud and Flat Creeks, and Mud and Euclautubba, is largely terrace. Relief is less than 20 feet over considerable areas.[8] Small outcrops here and there show yellowish clayey and silty sand. West of Guntown, also, between the valleys of Tishomingo and Euclautubba Creeks, the topography is much the same. But some of the best natural terraces border the valleys of Campbelltown and Twentymile Creeks, in the northeastern part of the county, particularly along the former stream 2 miles or more south-southeast of Baldwyn, and northeast of Twentymile Creek in the northeastern corner of the county (T.7S., R.7E.).

In general the terraces consist of fine to medium tan and brown sand containing a variable clay and silt content. Colors may range from gray to red-brown, and rust pockets and spots are common. The age of these terrace deposits is difficult or impossible to determine with accuracy, but the brown loam, a soil type, of which the eastern edge rests on parts of the Cretaceous area of Mississippi, consists in part of loess, a glacial silt. Apparently, then, the highest stream terraces are at least as old as the Pleistocene loess, and some of their material may have been in its present position as far back as Pliocene time.[7]

PALEONTOLOGY[7d]

EUTAW FORMATION, TOMBIGBEE MEMBER

All Cretaceous formations of Lee County are fossiliferous. The Tombigbee sand member of the Eutaw, especially the upper 50 feet of it, contains locally many marine fossils, including such prominent pelecypods as *Exogyra ponderosa* Roemer; *Inoceramus,* several species; *Ostrea plumosa* Morton and two or three other species of *Ostrea,* and two or three species of *Pecten;* cephalopods such as *Baculites asper* Morton; *Placenticeras,* and *Mortoniceras;* and remains of vertebrates, especially teeth and vertebrae. The Tombigbee member contains a greater number of fossils than the Lower or typical Eutaw contains, but much of the member as a whole is not fossiliferous. The upper half of the Tombigbee sand is included in the *Exogyra ponderosa* faunal zone. The entire member is strongly glauconitic, and marine glauconite is, according to some authorities, the product of chemical reactions between the organic matter of dead shell-bearing animals and the associated minerals of the silts and muds. Glauconite is said to originate chiefly in the interior of shells.[10] If this theory of the origin of marine glauconite is sound, the mineral itself is evidence of the former presence of great numbers of organisms in the Tombigbee sand. Also, the lime content of the unit denotes the former presence of marine organisms.

THE SELMA FORMATION

THE MOOREVILLE, ARCOLA, AND DEMOPOLIS MEMBERS

The Selma formation, including the Mooreville, Arcola, and Demopolis members, is dominantly chalk, unconsolidated limestone, of which the lime represents comminuted shells, tests, and bones of marine animals, or the remains of plants. Chalk is, then, a rock of organic origin. It has been said to be composed of organic remains, largely of foraminifera, and to have once been an ooze of some kind. Pure chalk is "nearly pure carbonate of lime in exceedingly fine subdivision."[10] However, late studies of the chalk of the Gulf Coastal Plain have tended to show that "the calcareous remains of foraminifera and other marine organisms form only a small part of the chalk; from 85 to 98 percent of the calcium carbonate is made up of the calcareous remains of minute flagellate algae called *coccolithophores* which lived in the warm clear and relatively shallow waters covering portions of the submerged Coastal Plain; these plant organisms can be seen only with a high-power microscope, for their micro-skeletons are from 2 to 10 microns (.00008 to .0004 inch) long."

The Selma chalk is fossiliferous almost everywhere, and in certain strata fossils are so numerous that they form an important part of the lithologic content, as, for example, the shell bed lying on the Coffee sand at the base of the Demopolis member of the chalk. Several distinct and fairly well defined fossil zones have been recognized: The *Exogyra ponderosa* zone; the *Exogyra costata* and *Exogyra cancellata* zones; the *Diploschiza cretacea* zone, and others. More specifically, the Selma includes parts of two major fossil zones, the *Exogyra ponderosa* and the *Exogyra costata.* The *Exogyra ponderosa* zone comprises the lower two-thirds of the formation and beds of equivalent age; the *Exogyra costata* zone comprises the upper third of the Selma and the Prairie Bluff chalk, and their equivalents. Six minor zones within the *Exogyra ponderosa* zone have been differentiated: (1) The basal beds of the Selma; (2) the section between the basal beds and the Arcola limestone member; (3) the Arcola limestone member; (4) the section between the Arcola limestone member and the *Diploschiza cretacea* zone; (5) the *Diploschiza cretacea* zone; and (6) the upper part of the *Exogyra ponderosa* zone. Lee County includes a section across the entire width of the Selma chalk part of the *Exogyra ponderosa* zone, and across roughly half the width of the *Exogyra cancellata* zone, which is part of the *Exogyra costata* zone.

The *Diploschiza cretacea* zone, so named from a conspicuous guide fossil, *Diploschiza cretacea* Conrad, can be traced through southern Lee County to a point 2 miles south of Tupelo. The fossil referred to is a small scoop-shaped pelecypod which commonly is associated with *Terebratulina filosa* Conrad, a fluted brachiopod about the same size. The interval of chalk containing these fossils is thicker in the counties south of Lee, reaching a maximum thickness of about 60 feet, but thins to 2 feet or a little more or less at its northern end. In the southwest wall of Chiwapa Creek valley, on the Shannon-Troy road (N.1/2, Sec.22, T.11S., R.5E.), *Diploschiza cretacea* was found throughout a 30-foot interval. The northernmost place at which fossils of this zone have been found is about 300 feet south-southeast of the site of old Clark school (SE.1/4, NE.1/4, Sec.12, T.10S., R.5E.); the zone apparently passes into and is lost in the Tupelo tongue of the Coffee sand not far north of this place. About a mile and a half north of Verona (NE.1/4, NW.1/4, NE.1/4, Sec.13, T.10S., R.5E.), *Diploschiza cretacea* Conrad and *Terebratulina filosa* Conrad were noted, associated with other common fossils of the zone.

Collections of fossils have been made from all the zones named above. The more important fossils are named in the following summary, and the geographic and stratigraphic positions of the localities from which they were obtained are indicated:

Collections from locations 2, 4, 5, and 6 (a to j) are from the *Exogyra ponderosa* zone.

2) Fossils from the banks of a small branch tributary of Long Creek, half a mile east of Mooreville on U. S. Highway 78, from the Mooreville tongue of the Selma chalk, representing the sub-zone between the basal beds of the Selma and the Arcola limestone member:

Vermes (worms)
  Hamulus onyx Morton
Mollusca
  Pelecypoda
    Veniella conradi (Morton)
    Etea carolinensis Conrad?

4) Fossils from an outcrop one and three-fourths miles east of Verona (SE.1/4, Sec.20, T.10S., R.6E.), representing the section between the Arcola limestone member and the *Diploschiza cretacea* zone:

Vermes
  Hamulus onyx Morton
  Hamulus squamosus Gabb
Mollusca
  Pelecypoda
    Gryphaeostrea vomer (Morton)
    Exogyra ponderosa Roemer
    Anomia argentaria Morton
    Paranomia scabra (Morton)

5) Fossils from washes in a field east of the Tupelo-Verona road (NE.1/4, NW.1/4, NE.1/4, Sec.13, T.10S., R.5E.), 2.5 miles south of Tupelo, representing the *Diploschiza cretacea* zone:

Mollusca
  Pelecypoda
    Ostrea plumosa Morton
    Ostrea falcata Morton
    Exogyra ponderosa Roemer
    Diploschiza cretacea Conrad

6) Fossils from ten localities, as specified below, representing the upper part of the *Exogyra ponderosa* zone:

a) A cut on the Gulf, Mobile & Ohio Railroad just north of the station at Guntown; the base of the Demopolis chalk just above the Coffee sand:

Mollusca
  Pelecypoda
    Ostrea plumosa Morton
    Gryphaea mutabilis Morton
    Gryphaea convexa (Say)
    Gryphaeostrea vomer (Morton)
    Exogyra ponderosa Roemer
    Anomia argentaria Morton
    Paranomia scabra (Morton)

b) A mile west of Guntown:

Mollusca
  Pelecypoda
    Ostrea plumosa Morton
    Ostrea falcata Morton
    Gryphaea mutabilis Morton
    Exogyra ponderosa Roemer

c) Bald spot on the Blair road, 2 miles west of Guntown:

Mollusca
  Pelecypoda
    Ostrea falcata Morton
    Gryphaea mutabilis Morton
    Gryphaeostrea vomer (Morton)
    Exogyra ponderosa Roemer

d) U. S. Highway 45 (Sec.17, T.8S., R.6E.), a mile west by north of Saltillo:

Mollusca
  Pelecypoda
    Gryphaeostrea vomer (Morton)
    Exogyra ponderosa erraticostata Stephenson

e) Chesterville road, 1.5 miles west of Tupelo:

Mollusca
  Pelecypoda
    Gryphaea convexa (Say)
    Exogyra ponderosa Roemer

f) Chesterville road, 3.3 miles west of Tupelo:

Mollusca
Pelecypoda
Ostrea panda Morton
Ostrea falcata Morton
Gryphaea convexa (Say)
Gryphaeostrea vomer (Morton)
Exogyra ponderosa Roemer

g) Pontotoc road (Mississippi Highway 6) 3 miles west of Tupelo:

Mollusca
Pelecypoda
Gryphaea mutabilis Morton
Gryphaea convexa (Say)

h) Pontotoc road (Mississippi Highway 6) 3.5 miles west of Tupelo:

Mollusca
Pelecypoda
Ostrea falcata Morton
Gryphaea convexa (Say)

i) Bed of Coonewah Creek at the crossing of Mississippi Highway 6, about 5.8 miles west by south of the business center of Tupelo:

Mollusca
Pelecypoda
Exogyra ponderosa Roemer

j) In an exposure (Center, Sec.25, T.8S., R.5E.) near the road on the north-facing slope of Mud Creek valley, about 2 miles southwest of Saltillo, of the basal indurated ledge and chalk above the Coffee sand:

Mollusca:
Pelecypoda
Exogyra ponderosa Roemer
Ostrea falcata Morton
Ostrea plumosa Morton
Gryphaea convexa (Say)
Gryphaea mutabilis Morton
Gryphaeostrea vomer (Morton)
Paranomia scabra (Morton)
Anomia argentaria Morton
Anomia tellinoides Morton
Pecten quinquecostatus?
Trigonia sp.

Gastropoda
  Gyrodes petrorsus (Morton)
  Turritella sp.
  Pyropsis? sp.
Vermes
  Hamulus squamosus Gabb
Vertebrata
  Shark teeth.

1) Fossils from bald spots and gullies in the *Exogyra cancellata* zone on the westward-facing slope of Tishomingo Creek valley a quarter of a mile west of Bethany:

Mollusca
  Pelecypoda
    Inoceramus sp.
    Ostrea plumosa Morton
    Ostrea tecticosta Gabb
    Ostrea falcata Morton
    Gryphaea mutabilis Morton
    Exogyra costata (Say) (Wide costae)
    Exogyra cancellata Stephenson
    Anomia argentaria Morton
    Anomia tellinoides Morton
    Paranomia scabra (Morton)
    Veniella conradi (Morton)

2) Fossils from gullies in the *Exogyra cancellata* zone south of the Troy road, 8 to 9 miles west of Shannon:

Mollusca
  Pelecypoda
    Ostrea plumosa Morton
    Ostrea panda Morton
    Ostrea falcata Morton
    Gryphaeostrea vomer (Morton)
    Exogyra costata (Say) (Wide costae)
    Exogyra cancellata Stephenson
    Anomia argentaria Morton
    Paranomia scabra (Morton)

On the lower eastward-facing slope of Okeelala Creek valley, 2 miles west of Baldwyn, from 20 feet or more of bluish chalky limestone of the *Exogyra ponderosa* zone, the following fossils were collected:

Vermes
    Hamulus onyx Morton
Mollusca

Pelecypoda
- Ostrea plumosa Morton
- Ostrea falcata Morton
- Gryphaea mutabilis Morton (large and numerous)
- Gryphaeostrea vomer (Morton)
- Exogyra ponderosa Roemer
- Anomia argentaria Morton

From a bald spot at the top of the hill (NE.1/4, Sec.8, T.11S., R. 5E.) overlooking Chiwapa Creek valley, about 5 miles west-northwest of Shannon, *Exogyra cancellata* Stephenson, *Ostrea plumosa* Morton, *Gryphaea mutabilis* Morton, and *Paranomia scabra* (Morton) were obtained from the *Exogyra cancellata* zone.

The boundary between the *Exogyra ponderosa* zone and the *Exogyra costata* zone can be traced rather readily through Lee County because of the juxtaposition here and there of an exposure of terrane containing fauna of the *ponderosa* zone and an outcrop of chalk from which fauna of the *costata* zone can be collected. For example, hard chalk containing three beds composed almost wholly of the shells of *Gryphaea convexa* (Say), a fossil which, with rare exceptions, is restricted to the *Exogyra ponderosa* zone, crops out about 3.5 miles northwest of Saltillo, in the bed of the canal of Mud Creek just north of the road (SW.1/4, Sec.2, T.8S., R.5E.). Less than a mile farther west along the same road, hard chalk of the west wall of Mud Creek Valley contains *Exogyra cancellata* Stephenson and other common fossils of the *Exogyra costata* zone.

THE COFFEE MEMBER

The Coffee sand member of the Selma formation, particularly the Tupelo tongue, is very fossiliferous in places. Three localities where collections were made are referred to by Stephenson and Monroe:

1) The abandoned cut of the Tupelo-Fulton road (Figure 12) on the westward-facing slope of Old Town Creek valley (Sec.33, T.9 S., R.6E.), 1.5 miles east of Tupelo, where the upper beds are exposed. As already stated, this is considered the type section of the Tupelo tongue. The fossils collected here were:

Mollusca
- Pelecypoda
  - Ostrea plumosa Morton
  - Ostrea sloani Stephenson
  - Gryphaea convexa (Say)

Gryphaeostrea vomer (Morton)
Exogyra ponderosa Roemer
Anomia argentaria Morton

Vertebrata
Shark teeth

2) The cut exposing the upper beds of the Coffee, on U. S. Highway 45 on the northward-facing slope of Kings Creek Valley (Sec.31, T.9S., R.6E.), half a mile south of the St. Louis & San Francisco Railroad at the west edge of Tupelo. The fossils collected here consisted of:

Mollusca
Pelecypoda
Ostrea plumosa Morton
Gryphaea convexa (Say)
Exogyra ponderosa Roemer
Lima aff. Lima reticulata Forbes
Paranomia scabra (Morton)

3) The road cut on the northward-facing slope of Mantachie Creek Valley (S.1/2, Sec.9, T.8S., R.7E.), north of a county consolidated school, about 1.5 miles west of the Itawamba County line, and 2 miles due west of Ratliff. Lower beds of the Coffee sand crop out at this place. The fresh material is a dark-gray glauconitic and micaceous fine-grained sand containing well-preserved mollusk shells. The names of the fossils collected are:

Vermes
Serpula lineata (Weller)
Hamulus onyx Morton

Mollusca
Pelecypoda
Nucula aff. Nucula percrassa Conrad
Idonearca aff. Idonearca wadei (Imlay)
Exogyra ponderosa Roemer
Exogyra ponderosa erraticostata Stephenson
Pecten (Camptonectes) aff. Pecten (Camptonectes) berryi Stephenson
Paranomia scabra (Morton)
Anatimya aff. Anatimya anteradiata Conrad
Cymella cf. Cymella ironensis Stephenson
Etea aff. Etea carolinensis Conrad
Crassatella sp.
Brachymeris carolinensis (Conrad)
Cardium (Granocardium) aff. Cardium (Granocardium) alabamense (Gabb)

Cyprimeria aff. Cyprimeria alta Conrad
Linearia aff. Linearia metastriata Conrad
Corbula crassiplica Gabb
Scaphopoda
Dentalium aff. Dentalium ripleyanum Gabb
Gastropoda
Acmaea cf. Acmaea occidentalis (Hall and Meek)
Polinices rectilabrum (Conrad)
Gyrodes supraplicatus (Conrad)
Gyrodes aff. Gyrodes alveatus Conrad
Laxispira sp.
Turritella trilira Conrad
Turritella quadrilira Johnson
Anchura? aff. Anchura? lobata Wade
Morea cf. Morea cancellaria Conrad
Drilluta? aff. Drilluta? major Wade
Pseudoliva? cf. Pseudoliva? attenuata Wade
Odontofusus sp.
Haplovoluta sp.
Cephalopoda
Eutrephoceras sp. (small)

The sand of a small exposure in the southwest wall of the valley of Puncheon Creek, a mile west of the section described on a preceding page, and about three-tenths of a mile north of the road, contains an abundant molluscan assemblage. The north slope of a spur from a ridge lying to the south forms the south bank of the creek. At a point 150 yards east of a wagon bridge to a field (SE.1/4, NE.1/4, NE.1/4, Sec.18, T.8S., R.7E.) the bank has caved and exposed 3 to 4 feet of soft fine-grained glauconitic tan sand beneath slumped tree roots. The chalky and friable mollusk shells are very abundant beneath the projecting mass of roots. The forms named below were noted:

Vermes
Worm tubes
Mollusca
Pelecypoda
Nucula cf. Nucula percrassa Conrad
Idonearca capax (Conrad)
Gervilliopsis aff. Gervilliopsis ensiformis
Inoceramus proximus Tuomey
Ostrea falcata Morton
Ostrea sp.
Exogyra ponderosa Roemer
Exogyra sp. (small)
Trigonia angulicostata?

Trigonia aff. Trigonia eufalensis Gabb
Pecten quinquecostatus? Sowerby
Anomia argentaria Morton
Paranomia scabra (Morton)
Veniella conradi (Morton)
Crassatella pteropsis Conrad
Cardium kummeli Weller
Pteria? petrosa (Conrad) Meek
Gastropoda
Polinices rectilabrum Conrad
Laxispira cf. Laxispira lumbricalis Gabb
Turritella trilira Conrad
Turritella sp. (fine revolving lines)
Scaphopoda
Dentalium
Cephalopoda
Baculites sp.
Sphenodiscus sp.
Arthropoda
Crab "leg"

A few fossils were found in the bed of Tulip Creek north of a bridge (NE.1/4, Sec.12, T.9S., R.6E.), about 3.5 miles west of the Eggville community. A 4-foot to 5-foot interval of fine-grained argillaceous and micaceous glauconitic dark-gray sand is exposed in the bed and banks of the stream for a quarter of a mile north of the bridge. Mollusk shells are scattered through the exposure. *Gryphaeostrea vomer* and *Gervilliopsis* aff. *Gervilliopsis ensiformis* are very abundant. Also noted were *Ostrea falcata, Baculites ovatus, Sphenodiscus* sp., and *Turritella* sp. Most of the shells are too fragile to collect.

Some other fossils found here and there in the Coffee sand of Lee County are named in the discussion of the stratigraphy. For the most part they are species included in the lists given in the foregoing text, but *Hamulus squamosus* Gabb, *Legumen* sp., and *Xenophora* sp. were found associated with *Hamulus onyx* Morton, *Gryphaeostrea vomer* (Morton), *Exogyra ponderosa* Roemer, and *Paranomia scabra* (Morton) half a mile southwest of the courthouse at Tupelo, scattered on the surface soil of gray calcareous sand on a hill south of and some 35 feet above a creek bottom. These fossils were weathered from a stratum near the top of the Tupelo tongue of the Coffee sand.

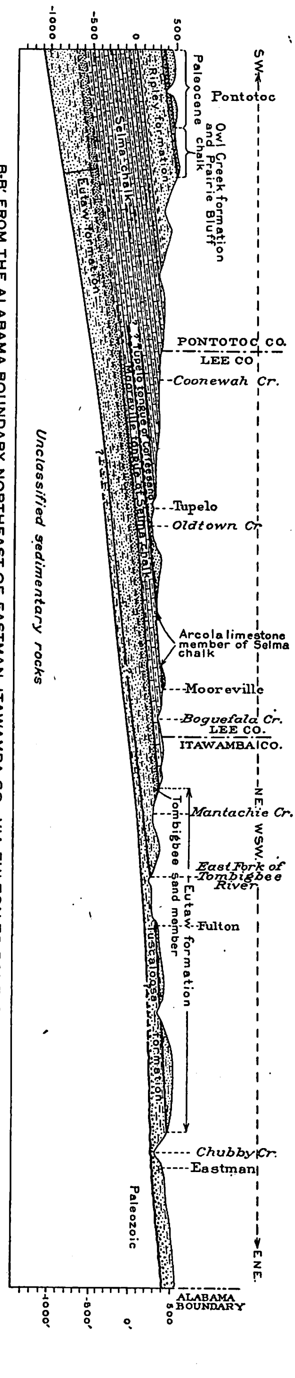
A comparison of the name lists of fossils from the various localities shows that *Exogyra ponderosa* Roemer was the only fossil found at all the places described. *Paranomia scabra* (Morton) was present at four of the outcrops. In fact, the whole of the Coffee sand is included in the *Exogyra ponderosa* faunal zone. Also, the Coffee includes the horizon of the *Diploschiza cretacea* zone, which is readily distinguishable in the Selma chalk, but loses its identity in the extreme top of the Tupelo tongue.

Fossils of plants are more or less abundant in the Coffee sand. Commonly they are comminuted plant fragments and scattered small macerated pieces of lignite, although pieces of silicified wood of various sizes, and even entire silicified logs, have been found, as well as large pieces of lignite.

STRUCTURE

The regional structure of the Cretaceous strata of Mississippi is monoclinal, and in general the Lee County terrane is not an exception. Except for some irregularities, the beds dip west or a little north or a little south of west some 30 feet a mile (Plate 2). In the latitude of Tupelo the strike is near to north-south, and the dip west.[7] Comparison of the elevations of a key bed at different places may serve to indicate roughly the degree of dip, or the amount in a unit distance. For examples: The shell conglomerate at the Coffee-Selma contact has an elevation of about 440 feet above mean Gulf level a mile and three-tenths east of Guntown, and 380 a mile west of Guntown—that is, the elevation differs 60 feet in 2.3 miles, indicating a westward dip of about 27 feet a mile. The elevation of the jointed limy clay of the Mooreville at the exposure three quarters of a mile west of Mooreville is about 380, and that of the Tulip Creek exposure (Sec.3, T.10S., R.6E.) approximately 3.5 miles farther west and 1.5 miles south, is near 265; thus this horizon descends west-southwest 115 feet more or less in 3.5 miles, or at the degree of about 33 feet a mile.

The unconformity between the Eutaw and Selma formations, which is exposed in the southeastern corner of the county, is the only other definitely determined major structural feature, and although in some places outside Lee County the contact is a sharp irregular surface, in other places no evidence of a physical break exists.[7] Interruption of deposition probably took place in some areas, but only shallowing of the sea in other areas. No sharp Eutaw-Selma contact was found in Lee County. Another possible unconformity is immediately above the Arcola limestone in the Selma for-



B-B' FROM THE ALABAMA BOUNDARY NORTHEAST OF EASTMAN, ITAWAMBA CO., VIA FULTON TO PONTOTOC, PONTOTOC CO.

Plate 2.—Geologic cross-section from the Alabama boundary through Itawamba, Lee, and Pontotoc Counties, to Pontotoc.

mation, where phosphatic nodules, phosphatic molds of fossils, and reworked cobbles of limestone are believed to be a basal conglomerate, of which the base has been interpreted as a diastem, possibly an unconformity, similar to that at the base of the Selma.[7]

Minor structural features—bedding, lamination, joints, fracture, flow and plunge structure, contemporaneous erosion surfaces, and others—are present in the county formations. Any exposure shows one or more of these features, but some one or other of the outcrops shows certain of them more sharply than do others. Clearly defined lamination is conspicuous in the Coffee sand at many places: (1) The walls of a road cut (eastern part, Sec.15, T.8S., R.7E.), less than a quarter of a mile west of a road junction which is on the Alabama-Mississippi line; (2) the walls of a road cut (NE.1/4, SW.1/4, Sec.25, T.7S., R.6E.), 1.5 miles east of Guntown; (3) road cuts (Secs.19 and 30. T.7S., R.7E.), about half a mile northwest of Chapelville; (4) the east wall of the channel of Tulip Creek south of a local road bridge (NW. cor., Sec.18, T.9S., R.7E.), about 2 miles northeast of Auburn school; (5) the walls of a ravine (west-central part, Sec.7, T.8S., R.6E.), near a bridge over Euclautubba Creek a mile northwest of Saltillo. Other places might be mentioned. The massive structure of the Coffee sand can be observed at many places, also, among which the type locality in East Tupelo (Figure 12), and the Highway 45 cut a mile north of Tupelo (Figure 14), are prominent. Joints are present in the Selma chalk almost everywhere, but are especially noticeable in large exposures. The chalky clay of the Mooreville at the type locality, three-quarters of a mile west of Mooreville on the north side of Highway 78, is cut by two main sets of joints, one trending about northeast-southwest, the other at a high angle to it. The massive structure of the general body of the chalk can be observed in many places, also (Figures 6, 7, 8 and 11).

At least one departure from the regional monoclinal structure has affected the terrane east, southeast, and south of Plantersville. In this part of the county the Arcola limestone is an excellent key bed for the determination of a folded structure, because it is well defined and readily identifiable in the generally featureless chalk; it is a white or light creamy tan indurated bed having a pitted or otherwise irregular surface and an approximately uniform thickness of 1.0 to 1.5 feet. In fact, it is so well defined that it has been traced across the Upper Cretaceous outcrop belt of northeast Mississippi from Alabama to the latitude of Tombigbee State Park, 2 miles south of Mooreville in Lee County. North of the latitude of the park the Arcola is lost in the Coffee sand, but phosphatic nodules like those commonly found above the Arcola can be traced a few miles farther north in the sand.

In the area east and southeast of Plantersville the Arcola is exposed at numerous places for several miles along hillsides and ridges. In general the outcrop pattern follows the southwesterly drainage of this area, and some excellent exposures are on the tops or sides of northeast-southwest trending ridges. The Arcola crops out also in gullies and road cuts, and at a few isolated places in lowlands in the western part of the area. This limestone is not exposed continuously along the hills and ridges, being hidden at many places by colluvium and vegetation, but weathered ledges or cobbles mark its trend through pastures and cultivated fields.

Beginning along the northwest-facing slope of the southeast wall of the valley of Carmichael Creek at a point (NW.1/4, Sec.11, T.11S., R.6E.) 4 miles north of the county line in Nettleton, several exposures of the Arcola are traceable to the northeast. At this place cobbles of the limestone are scattered along the slope west of the road and are abundant in a field northeast of a small church. Associated phosphatic nodules are numerous in the field and *Inoceramus* cf. *proximus* Tuomey and other plecypod molds are present in the cobbles. The limestone cobbles form a train along the slope through fields and pastures to Highway 6 (SW.1/4, Sec.1) where exposures are on each side of the road cut. Along the south slope of this ridge are cobbles of Arcola in a cotton field east of the highway. In the northeast corner of the same section good exposures show in a north-facing slope and a hillside pasture near the edge of a wood south of the section-line road.

Farther to the northeast and adjacent to a road junction (SW. Cor., Sec.31, T.10S., R.7E.) the exposures continue and can be traced northeasterly across the section, in the fields along the slope of a valley tributary to Leeper Creek Valley. In the section (NE.1/4, SE.1/4, Sec.30) to the north, the train of limestone cobbles extends through woods and fields to a series of gullies on both sides of a lane. Abundant phosphatic nodules and a few phosphatic internal molds are associated with the limestone in these gullies. From there the line of outcrop swings about half a mile eastwards across a small valley and trends northeastwards through fields (W.1/2, Sec.29), crossing the road near the center of the section. About four-tenths of a mile north of this road are thin limestone ledges in small gullies in the woods.

Near the southern edge of Section 20 on the north are excellent exposures in numerous gullies in the woods and in the pasture below the house east of the road bend (Center, S.1/2, Sec.20). Cobbles are strewn across the field to the northeast and lie in gullies in the pasture south of the road (NE.1/4, NE.1/4, Sec.20). To the north the exposures west of Boguegaba Creek extend along the slope. The limestone crops out in a local road cut near the southwest corner of Section 16, and about half way across the section (W.1/2, Sec.16) the train of cobbles bends northwest, extending into the southeast corner of Section 8, where it shows in a road about 15 feet below red sand. Cobbles are scattered in the field near the road and to the northwest across the grass slopes and cotton fields to the Coffee sand hills. Still farther northwest the phosphatic nodule and fossil mold zone above the Arcola appears at several points in the Mooreville chalk and the Coffee sand.

A mile west of Union Church on Highway 6, the Arcola is exposed in place in the east road ditch near the base of a hill (NW.1/4, Sec.2, T.11S., R.6E.) south of the road forks, and cobbles are scattered in the fields to the west and southwest. Northeastward across the fields, east of Smith Creek (Sec.35, T.10S., R.6E.), the limestone cobbles are scattered almost uninterruptedly. Cobbles lie in situ in the pasture west of the section-line road (SE.1/4, NE.1/4, Sec.35), and the rock is exposed to the northeast by gullies on slopes (NW.1/4, Sec.36) west of a negro tenant house near the wagon road on the ridge. From these gullies the train of cobbles can be traced across the section to the road in the northeast corner, thence northwards along the east range-line (Sec. 25). Cobbles lie in the field (NW. Cor., Sec.30, T.10S., R.7E.) south of the Plantersville road, and the exposures can be traced northward into the next section where numerous gullies (NW.1/4, Sec.19) show the limestone in place (Figure 15). North of the section-line road, 3 miles east of Plantersville, is an exposure in a ditch (SW. Cor., Sec.18, T.10S., R.7E.), and farther west (SE. Cor., Sec.13, T.10S., R.6E.) the cobbles can be traced until lost in the hills of the Coffee sand a mile south of Tombigbee State Park.

Five isolated exposures of the Arcola are distributed as follows: On the west-facing slope of Leeper Creek Valley south of the road

(NW. Cor., Sec.5, T.11S., R.7E.) 4 miles northeast of Nettleton; a ledge in the road ditch south of the road near the west end of the canal bridge (W.1/2, Sec.3, T.11S., R.6E.), half a mile west of the Frisco Railroad; a ledge in the north end of the railroad cut a tenth of a mile north of the road crossing (N.1/2, Sec.34, T.10S., R.6E.), 2.5 miles south of Plantersville; in the east-facing slope of Old Town Creek Valley, north of the road (SE. Cor., Sec.20, T.10S., R.6E.), 2 miles east of Verona; and in the fields about half a mile southeast (NW.1/4, Sec.28).

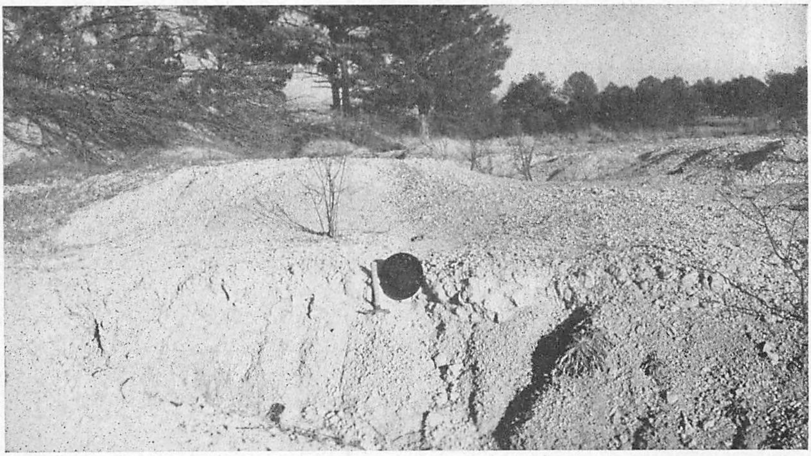


Figure 15.—Outcrop of Arcola limestone (NW.1/4, Sec. 19, T.10 S., R.7 E.) 3 miles east of Plantersville. Photo by Harlan R. Bergquist.

Exposure of this bed at so many localities suggests structural conditions other than normal regional dip, and altimeter readings of elevations indicate that such conditions exist, as stated in the press release of October 6, 1943, and shown on the map (Plate 3) accompanying it, both of which are reproduced herewith.

For immediate release.

Oxford, Miss., October 6, 1943. A geological structure of the type favorable to oil and gas accumulation, discovered East and South of Plantersville by Dr. H. R. Bergquist, micro-paleontologist, during the joint field investigations by Lee County and the Mississippi State Geological Survey, was announced today by Dr. William Clifford Morse, State Geologist.

It is an anticlinal fold or nose in the surface Cretaceous rocks. "Of a certainty," Dr. Morse said, "the force which produced the fold in the surface rocks affected the underlying Paleozoic beds, but since the two divisions are

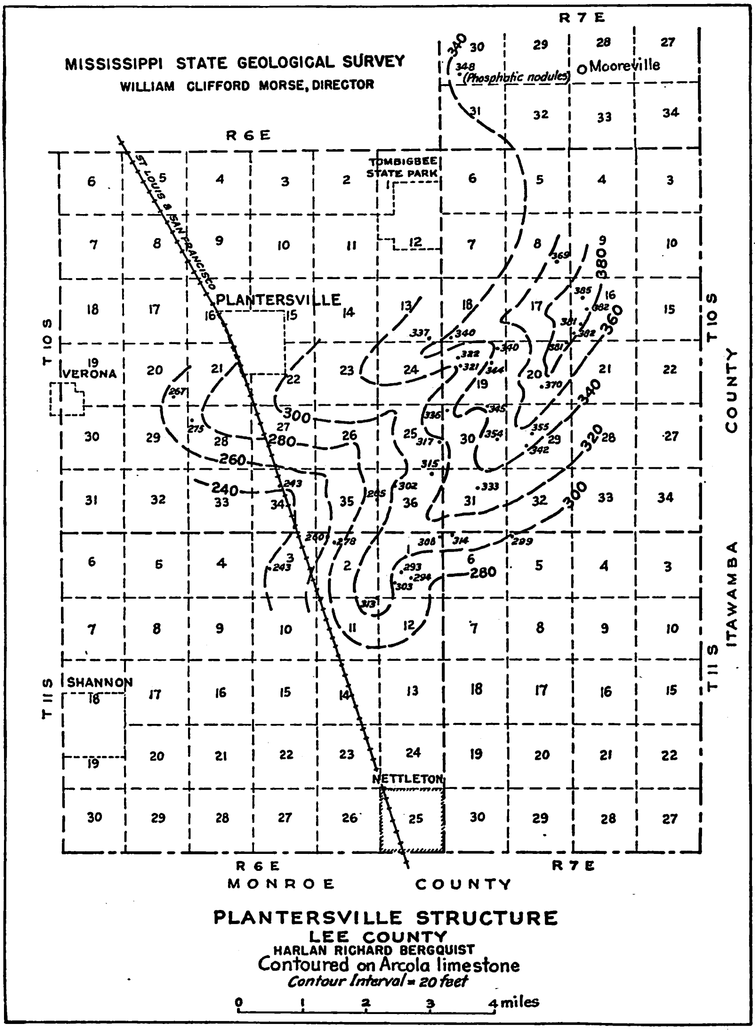


Plate 3.—Map of the Plantersville structure, by Harlan R. Bergquist.

not conformable, the force may not have overcome earlier deformation of the older Paleozoic beds. Nevertheless the bitumen oil residue in these old Paleozoic beds in Northeastern Mississippi and Northwestern Alabama warrant the testing of the Plantersville structure to determine if it trapped any of the oil that so freely escaped at the surface outcrops in Tishomingo County. Despite the hard rock in a similar structure at Pontotoc and despite the tight sand in the Tula well in Lafayette County, the Nation's need for oil is so great," Dr. Morse added, "as to be a further reason for testing the Plantersville structure, which extends from a point three miles South of Mooreville to a point three miles North of Nettleton."

Dr. Morse and his staff are working on the bulletin that is to be issued on Lee County in summarizing the studies and findings made as a result of the joint field investigations by his Survey and Lee County. As soon as the studies have been completed, the bulletin will be issued and released.

In view of the present urgent need of oil, Dr. Morse today gave out the statement of the discovery of the structure favorable to oil and gas accumulation.

The Plantersville structure is, then, an anticlinal nose which extends 6 miles through the area under control, and trends southwest from the highest mappable point 3 miles south of Mooreville. Near the southern visible end, 4 miles north of Nettleton, the nose appears to swing towards the south with a synclinal nosing on the northwest. This synclinal re-entrant has produced an enlarged nosing westward from the highest area south of Mooreville (Plate 3).

The elevation of the Coffee-Demopolis contact was determined at 40 outcrops along the strike from southeast of Verona to north of Guntown, but no notable departure from the normal regional dip was revealed, although the elevations, ranging from 440 east of Guntown to less than 300 southwest of Saltillo, showed local irregularities.

Other possible key beds in the Lee County strata are:

1) Sandstones in the Coffee member of the Selma formation. A detailed study and comparison of these sandstones as exposed in many places, including a careful determination of relative elevations, might reveal some system in their number, spacing, and thickness, and make possible the identification of a certain bed or beds over considerable areas. However, it must be admitted that such field observations as have been made suggest that these knobby sandstones are local, and that they differ in number, thickness, and stratigraphic position, even in relatively short distances.

2) In a place or two exposed strata of the Coffee or the Mooreville were seen to contain numerous marcasite concretions or nodules, which may be most concentrated in a certain zone.

3) Fossil zones of the chalk have been mentioned. Another zone which has been observed at several widely separated places is a bed which contains immense numbers of the shells of *Ostrea falcata* Morton.

GEOLOGIC HISTORY

The geologic history of any part of the Earth's body includes all events which have affected that part of the planet since it came into existence. Strictly speaking, then, an account of the geologic history of Lee County should be the story of all rocks which underlie the surface of the county; but inasmuch as in practice the narrative of geologic history of a region commonly is restricted to the events connected with the rock units which crop out at the surface, in this sense the geologic history of the county begins towards the close of the Eutaw age in Mississippi, when the area now known as Lee County was a part of a far-reaching sea, relatively shallow, but deeper than the sea which immediately preceded it in the same area.[7] Sedimentation processes were dominant; currents and waves were ruffling the water at and near the surface, transporting sand for the most part, which settled to the bottom below the depth of wave action, so that where it is seen now it shows little or no bedding, but a homogeneous massive structure. The processes which lead to the formation of glauconite were operative, also, in this sea, and marine animals, both invertebrates and vertebrates, were numerous, as indicated by the abundance of the fossil remains in certain layers.[7] The sea was, of course, subject to the effects of all atmospheric conditions incident to the climate, which probably was subtropical, much as it is today, if we interpret correctly the suggestions afforded by the quantity and kind of sediment and the number and variety of animal and plant fossils. Also, the region may have been affected, at least indirectly, by volcanic activity, suggested by thin beds of bentonite; and by minor crustal disturbances, especially toward the close of the Eutaw age. These movements brought about a retreat of the water from much of the sand floor, which during a relatively short period was exposed to rainfall and stream action. Except for minor irregularities, the eroded surface was an even plain, and never at any considerable elevation above sea-level; in fact, parts of it probably never emerged, but had the sea much shallowed over them. Further crustal warping or tilting, perhaps, initiated another advance of the sea, and the returning marine waves and currents and tides eroded this Tombigbee sand along the fluctuating shore-line, tossed and rolled and wore down the shells and skeletons of animals, and deposited the mingled sand and silt and comminuted lime they were shifting, on the uneven surface, producing an unconformity.[7] As the sea reached farther and farther east, the land-derived sediment was a progressively smaller proportion, and lime from marine plants and animals a progressively greater proportion, of the whole in the expanses west of the strand line. Chalk became predominant, but some sand and silt and clay was present everywhere, too. The absence of cross-bedding in the chalk, as seen today, seems to indicate that the water in which the chalk accumulated was from the beginning sufficiently deep to place the bottom below the reach of waves and currents. The deposition of sand continued in the northeastern part of the area much longer than in the southeastern part. The deposition of the chalky sand, silt, and clay which was associated with the advance of the Selma sea was followed by a short-lived clearing of the water, a temporary almost complete cessation of clastic sedimentation, and during this brief time pure limy sediments accumulated on the sea floor, ultimately forming the Arcola limestone.[7] Possibly these limy sediments resulted from chemical precipitation, and part of the consolidation seems to have taken place along with deposition. The accumulation of this lime apparently was followed after a short interval either by a brief period of uncovering and erosion of the sea bottom or a marked shoaling of the water, and this change was in turn followed shortly by a resumption of the deposition of chalk along with lessening quantities of sand and silt. In the southern and western parts of the county area the aggregation of chalk continued for a very long time, but in the northeastern part the inflow of sand from the territory to the east continued long after it had ceased in the south. The sand thus accumulated is now known as the Coffee sand. In time the water cleared; the chief sedimentation was organic: chalk was the dominant material being deposited on the sea bottom over the entire area now included by the west half of Lee County.

The areal pattern of the Lee County formations seems to indicate that the major part of the drainage from the land to the east was towards the northwest and the southeast during early Selma time. The northwest drainage carried large quantities of sand, but southward along the coast only small, short streams entered the gulf, and there was little clastic sedimentation. Thus lime was accumulating in the southern part of the region which is now Lee County, contemporaneously with the Coffee sand farther north.[7]

ECONOMIC GEOLOGY

SOILS[3]

The soil is the most valuable mineral resource of Lee County, as it is of all other dominantly agricultural regions. In the broad sense, soils can be classed as a mineral resource, because by far the greater part of most soils is mineral matter, derived from weathered rock. If a soil is composed of mineral matter left by the decay of rock which once occupied the space where the soil now is, it is known as a residual soil; if it consists of mineral matter which has resulted from the disintegration and decomposition of rock at places more or less distant from the present location of the soil, it is transported soil. In a general way the upland soils of the county are residual, and the terrace and flood-plain soils are transported. Commonly the transported soil, subsoil, and other rock waste of a region have not been carried far. This is especially true of the flood-plain and terrace material which lies wholly within the region, and of course of much restricted forms such as colluvium and alluvial fans. More often than not, then, the soil of any region reflects the character of the rock of that region. This relationship exists in Lee County: the soils, both residual and transported, of the Tombigbee sand and Coffee sand areas are dominantly sandy, but subordinately silty and clayey, and the soils of the Selma chalk territory are sandy and silty iron oxide-stained clay, either without lime or containing only small percentages of it.

In 1916 a comprehensive survey and study of the soils of Lee County were made by the Bureau of Soils of the U. S. Department of Agriculture, in co-operation with the Mississippi State Geological Survey, and although methods of soil study developed since that time, and more recent discoveries, if applied to the same soils, might not confirm all the findings of the old survey, yet the earlier study provides an easily understandable classification and description of the soils of the county. A summary of the more significant of such data in the report on the Bureau of Soils survey as relate to the lithology of the soils seems pertinent in the present discussion.

The authors of the report referred to recognized three formations, the Selma chalk, the Yellow Loam, and the "unconsolidated sands," as the parent materials of all the soils of the county. The "Yellow Loam" probably is itself secondary for the most part, derived by weathering from material which was once part of the subjacent formations; possibly also it is partly loess. The "unconsolidated sands" are the Coffee sand and the Tombigbee sand.

The Bureau of Soils report names and describes 21 soil types and 5 sub-types or phases. The map which accompanies the report shows the location and shape of each patch of each and every type, and the relative areas and mutual relationships of the tracts—in short, the areal soil pattern. Most of these types and phases are included by a few prominent series; four series comprehend 208,640 acres of the 286,720 acres of the county—that is, 72.6 percent. The area and its percentage of the whole, of each of the four series, may be indicated:

Oktibbeha series, 62,592 acres, 21.8 percent;
Pheba series, 59,840 acres, 20.8 percent;
Catalpa series, 45,120 acres, 15.7 percent;
Ruston series, 41,088 acres, 14.3 percent.

Mechanically, the soils are classified as loams and clays and a little chalk, the loams being sub-classified as clay loams, silty clay loams, fine sandy loams, and silt loams. The Oktibbeha series is composed of two types, one a clay, the other a silt loam; the Pheba of a fine sandy loam type, a silt loam type, and a clay loam type; the Catalpa series of three types, a silty clay loam, a fine sandy loam, and a silt loam; and the Ruston series of fine sandy loam. As the descriptive terms indicate, loam is a mixture of sand, silt, and clay, and the types are distinguished on the basis of the relative proportions of these components.

The Oktibbeha series is developed in the Selma chalk outcrop area. The clay is the chief type, and the shallow phase, differentiated by its relative thinness (the Houston chalk being in numerous places less than three feet beneath the surface) occupies an area eight times as great as that of the typical Oktibbeha clay. The shallow phase is represented pretty well over the entire chalk region, but especially southwest and west of Tupelo, and around and west of Guntown. The surface soil is a granular clay, dark reddish-brown to brownish-red, "grading at a depth of a few inches into heavy red clay in which various shades of reddish-brown and yellowish-brown are mixed with grayish or drab." In most places whitish, yellowish, or greenish-yellow chalky material, highly calcareous, lies within 30 inches of the surface, and partially decayed limestone or chalk a few inches deeper. In local depressions this soil may be dark colored and loamy. With few exceptions the surface soil is acid, as is the subsoil to the depths reached by the red or brown color; the high lime content does not extend much above the light-colored sticky clay which immediately overlies the soft lime rock.

The typical Oktibbeha clay is reddish-brown to chocolate-brown to a depth of one inch to five inches, underlain by reddish-brown or brownish-red heavy, plastic clay up to 10 inches thick. The lower subsoil commonly is a mottled reddish, drab, and yellowish, sticky clay, grading downwards into clay of a lighter color. In few places is the limestone closer to the surface than three to four feet. The typical Oktibbeha clay is chiefly in the vicinity of Tupelo and in the eastern and southeastern parts of the county, overlying the Mooreville tongue in the eastern part.

The Oktibbeha silt loam consists of a gray to light-brown silt loam soil 6 to 8 inches deep and a red or reddish-brown moderately compact silty clay loam subsoil down to 20 to 25 inches, below which it grades into a heavy, plastic clay, more or less mottled with gray, light-drab, and reddish-brown. Where the lime rock is only a few feet down, the lower subsoil may be a compact, adhesive clay. A tendency to granulate is pronounced in the subsoil. The soil may contain considerable very fine sand in places. The Oktibbeha silt loam is distinctly acid, and in most places is deficient in organic matter. It occupies broad undulating to gently rolling ridges, especially in the northern part of the county west of U. S. Highway 45.

The Pheba fine sandy loam is grayish near the surface, but yellowish from a depth of 2 to 3 inches to 6 to 10 inches, below which is a dull-red to yellowish-red or buff, somewhat friable silty clay. The yellow becomes more prevalent with depth, and at about 18 to 20 inches below the surface the subsoil commonly is a mottled yellowish and grayish, compact clay, containing sufficient fine sand to make it friable. In most places this subsoil stratum contains rusty-brown or dark concretions, and when dry is tough, resembling hardpan. The mottling and the dark, ferruginous materials may appear in streaks. In places the lower subsoil is a mottled red, yellowish, and grayish, plastic clay.

The Pheba fine sandy loam lies on the undulating to gently rolling uplands, being best developed on slopes and in places of pronounced relief. Patches of this soil type are scattered widely over the county, but the most considerable areas are in the northeastern and southern parts.

The typical Pheba silt loam is grayish to light-brownish at and slightly below the surface, but grades at a very shallow depth to pale-yellowish. The silt loam is underlain at 8 to 10 inches by a reddish-yellow to dull-red or buff, somewhat friable silty clay loam or silty clay. Deeper, the subsoil is more yellowish, and grayish mottlings appear, and at 16 to 28 inches below the surface lies a compact layer of clay or sandy clay, mottled yellowish and grayish and in many places reddish. The lower subsoil is in places drab, mottled with yellow, and contains rusty-brown and dark ferruginous concretions and similar segregated material. The surface soil and subsoil are acid. The soil is deficient in lime and in organic matter. The record of the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil is given below, in percentages:

Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Soil	0.1	1.0	1.8	7.5	10.8	70.3	8.5
Subsoil	0.1	0.6	1.0	3.9	6.5	60.5	27.2
Lower subsoil	0.3	1.5	1.8	8.1	12.8	56.0	19.3

The Pheba silt loam is the dominant soil on the undulating to rolling topography of the county, especially on the wide inter-stream divides of the western part.

The Pheba clay loam was derived from the other two members of the Pheba series by erosion. It is reddish, and is underlain at a depth of 4 to 5 inches by dull-red or reddish-yellow moderately friable clay which grades downwards into yellow. At 15 to 20 inches a mottled yellowish and reddish compact clay, resembling hardpan, impedes the circulation of moisture and air. Mottled red, yellowish, and drab plastic clay underlies the hardpan in places.

The record of the results of mechanical analyses of samples of the Pheba clay loam is tabulated below, in percentages:

Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Soil	0.0	1.6	3.0	14.4	7.4	51.9	21.9
Subsoil	0.1	1.4	2.8	16.6	6.3	51.8	21.0
Lower subsoil	0.2	2.6	4.4	25.6	10.4	37.4	19.2

This soil type is best represented west of Saltillo and just north of Tupelo, but numerous small areas are scattered over the county in association with the Pheba fine sandy loam and silt loam, near Verona and Shannon, for example. In general the Pheba clay loam lacks lime and organic matter.

Of the Catalpa series, the silty clay loam is the most extensive.

The surface soil is brown to dark-brown in general, but shows some rusty-brown mottlings at slight depth. It is underlain 8 to 10 inches below the surface by a somewhat plastic silty clay, light-gray to nearly white, but mottled with yellow and brown. The lower subsoil is in places a light-drab, tenacious clay with little mottling. This soil is limy in many places, due to wash from the calcareous upland soils, but elsewhere it is neutral or acid. The subsoil is acid. One sample, from the surface to a depth of 8 inches, contained 2.12 percent of CaO; another, from the 8-inch to 24-inch depth, 0.72; and a third, from 24 to 36 inches down, 0.78. The mechanical analyses record is as follows:

Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Soil	0.1	0.6	1.6	13.2	8.6	49.8	25.8
Subsoil	0.2	0.6	0.8	11.8	7.6	45.8	33.0
Lower subsoil	0.0	0.2	0.5	13.5	8.8	41.9	35.2

The Catalpa silty clay loam is the chief soil of all the larger creek bottoms.

The Catalpa fine sandy loam is composed of a light-brown surface soil a few inches thick, grading downwards into a heavier and more coherent fine sandy loam which may be pale yellow or yellowish-brown. Commonly the lower subsoil is a sticky sandy clay or silty clay, gray or drab, and mottled with yellowish-brown and rusty-brown. The typical Catalpa soil should contain considerable lime, but the Catalpa fine sandy loam, both soil and subsoil, is decidedly acid. It is the predominant type along the small streams which drain the Coffee sand region where the Ruston fine sandy loam is the chief upland soil. The mechanical analyses record follows:

Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Soil	0.0	0.1	0.2	33.2	34.6	23.8	7.8
Subsoil	0.0	0.4	0.5	26.4	26.4	30.0	16.2
Lower subsoil	0.0	0.2	0.5	26.8	25.8	28.6	17.8

The Catalpa silt loam is brown, and is underlain at about 8 to 12 inches by mottled yellowish and grayish, somewhat stiff and plastic silty clay loam to silty clay. The subsoil shows rusty-brown mottling. The type is present along many of the smaller streams of the eastern and southeastern parts of the county, and to some extent in the larger valleys.

Results of mechanical analyses of samples of the Catalpa silt loam are recorded below:

Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Soil	0.2	0.6	0.9	4.2	18.0	63.5	12.5
Subsoil	0.0	0.8	1.4	8.4	18.6	43.1	27.5

The Ruston fine sandy loam consists of grayish fine sand or loamy fine sand, grading at a depth of a few inches into pale-yellow loamy fine sand, which at about 6 to 10 inches passes into dull-red or brownish-red, friable sandy clay. Deeper, the subsoil is in many places silty and compact, and in other places more sandy; at 30 to 40 inches it may grade into yellow or mottled yellowish, brownish, and grayish loamy fine sand. Considerable textural variation, as well as variation in the proportions of the components, in both soil and subsoil, results from differences in topographic position, the sandier soil being where the surface is rough, and the heavier soil on the broader divides. In the more hilly areas the subsoil is underlain by gray or mottled gray, yellow, and brown silty fine micaceous sand; in the broader ridges by a compact sandy clay.

Throughout the 3-foot section the sands and clays and silts are acid, but numerous exposures of limy rock show on the lower hill slopes, and wells on the ridges penetrate lime-bearing material at depths of 10 to 40 feet.

A hilly phase, the soil section of areas so hilly that they are of little value for cultivation, is variable, but consists predominantly of a light-colored fine sandy loam surface soil and a red, friable sandy clay subsoil.

The Ruston series is confined to the northeastern and east central parts of the county (the Coffee sand region).

WATER[6]

Water, particularly subsurface water, is abundant in Lee County. Much of the average annual precipitation of 48 inches sinks into the soil and descends to the water-table, helping to maintain an adequate reservoir of easily accessible ground-water. This is more especially true of the part which falls on the sand areas, but even in the territory underlain by the Selma chalk, the low relief and the high percentage of flat or gently sloping surface offset in large measure the effect of the relatively impervious chalk by tending to restrict and retard the run-off. On the other hand, of the areas underlain by the Coffee sand and the Tombigbee sand, a relatively high proportion is steep slope, which tends to favor run-off and thus counterbalance the effect of the openness of the sands. And of course everywhere forest or other plant cover contributes to the retention of the water.

The quantity of surface water, and its distribution in time and place, vary within wide limits, of course, as the volume and distribution of precipitation vary. Except during and for a short time after heavy rains, surface water is present only in depressions, where it forms pools or ponds or small lakes, and in drainage channels which have been cut below the lowest water-table of the region, or in channels which are fed either by rains or springs outside the county, or by local springs or seepage. Surface water is not used on a large scale for domestic purposes. In earlier times cisterns and other artificially constructed basins for storing rain water were used, and still are to some extent, notably in the Black Prairie Belt. Live stock quite commonly obtain water from ponds and streams. Springs supply some water, also.

In many parts of the county the people draw their water supply from shallow dug or bored wells. Such wells are common in the sand areas, where subsurface water can be reached easily; for examples, in and near Saltillo, Guntown, and Baldwyn, where wells 25 to 80 feet deep obtain water from the Coffee sand. That water is abundant in the upper part of the Coffee sand is attested by seepage and small springs in numerous places immediately beneath the shell bed at the base of the Selma.

By far the greater part of the water supply of the county is drawn from the Eutaw formation, which varies in depth below the surface from 1000 feet more or less near the western boundary, to 100 or less near the eastern boundary. Both the Lower Eutaw and the Tombigbee sand are water-bearing. The Tuscaloosa formation also contains abundant water, but only a few wells in Lee County reach it. The Tupelo tongue of the Coffee sand is an important source of water for the west-central part of the county, and the main Coffee formation supplies the northwestern part.

The stratigraphy and structure of this part of the state provide almost perfect artesian conditions, at least in the Selma chalk area. As stated above, the Tuscaloosa and Eutaw formations are excellent aquifers, and the relatively impervious overlying Selma chalk is an adequate cover. Normally all strata of Lee County dip almost westward some 30 feet to the mile, and hence rise eastward by the same measure to their outcrops; the water-bearing beds thus crop out in eastern Itawamba County and in the state of Alabama. These surface exposures are the intake areas of the aquifers; precipitation on them, or stream waters, sinks into the sands and works down dip as far as the water already present will permit. The absorption of water by the sand formations under the chalk cover has been going on so long that before wells began their draw-down the formations were full of water, and the "head," or hydrostatic pressure, in the western part of the county, many miles from the intake area, and in some places 200 to 300 feet lower, was so great that, at least in the lowlands, it would force the water to the surface or above through any well or other opening which pierced the restraining cover. These are the so-called "flowing wells." Most of them are on flood plains or low terraces, because the head is not strong enough to force the water out of wells in the higher lands. In general, for the creation of a flowing well, the elevation of the mouth of the well must be more than enough less than the elevation of the intake area to allow for a friction loss of 1 foot to the mile, roughly, of distance between the well and the intake region. Most of the one-time flowing wells of Lee County have ceased to flow, because the heavy draft on the reservoir beds from the hundreds of wells now in use has lowered the static head. At Tupelo, where the heaviest demands on the underlying aquifers have been made, no well can now be classed as a flowing well. However, at a few places in the county the flow from wells has survived: in the terrace plains which border the valley of Old Town Creek near Nettleton; on the level lands adjacent to Old Town Creek in the vicinity of Plantersville; on the bottom lands of some creeks near Shannon; on low grounds near Saltillo; in the creek and branch valleys east of Baldwyn, and in other low places here and there. The volume is not great; in most cases only a few gallons a minute. Some of the flowing wells near Baldwyn a few years ago yielded 20 gallons or more a minute.

Numerous wells of Lee County have been sunk into the Coffee sand, the Tupelo tongue, the Tombigbee sand, and the Lower Eutaw, but few have reached the Tuscaloosa. Except from the few flowing wells referred to, the water must be pumped from the level of the static head, the depth of which below the surface in any certain well depends of course on the hydrostatic pressure, the location of the well, and its elevation. The locations in the table include not only the town, village, or community center named, but its immediate vicinity, also.

DATA ON DEEP WELLS OF LEE COUNTY[6]

Location	Altitude feet	Depth feet	Source of Water
Baldwyn	400	250-500	(a) Lower Coffee sand (b) Lower (main) Eutaw
Belden	300-325	135-310	Tupelo tongue of Coffee
Bethany	360-380	200-400	Coffee sand
City Point	245	230	Eutaw (flowing well)
Guntown	395	400-500	Eutaw
Mooreville	395	175	Eutaw
Nettleton	250-254	100-550	Eutaw; Tuscaloosa (?)
Plantersville	256	140-300	Sand in Mooreville tongue; Eutaw
Saltillo	302-320	300-400	Eutaw
Shannon	240-253	300-400	Eutaw
Tupelo	260-280	300-1000	Eutaw; Tuscaloosa (?)
Verona	298-315	250-425	Eutaw

The table[6] which follows presents the record of the results of mineral analyses (in parts per million) of water from five representative wells and from all three of the chief water-bearing formations: No. 1 is from the Tupelo tongue of the Coffee sand; No. 2 is (questionably) from the Tuscaloosa formation; and Nos. 3, 4, and 5 are from the Eutaw formation.

MINERAL ANALYSES OF GROUND WATERS FROM LEE COUNTY

	1	2	3	4	5
Silica (SiO_2)	25.0	18.0	27.0	42.0	35.0
Iron (Fe)	0.23	0.97	0.05	.05	0.55
Calcium (Ca)	9.4	27.0	30.0	43.0	11.0
Magnesium (Mg)	5.6	4.2	4.8	7.5	2.3
Sodium, Potassium (Na; K)	101.0*	23.0	44.0*	53.0*	67.0*
Carbonate radicle (CO_3)	25.0	0.0	6.7	5.8	41.0
Bicarbonate radicle (HCO_3)	202.0	124.0	107.0	125.0	69.0
Sulphate radicle (SO_4)	38.0	8.5	6.7	5.0	7.6
Chloride radicle (Cl)	13.0	10.0	60.0	96.0	35.0
Nitrate radicle (NO_3)	0.96	0.00	0.33	0.21	0.89
Total dissolved solids at 180° C	324.0	149.0	243.0	339.0	249.0
Total hardness as $CaCO_3$ (calculated)	46.0	85.0	95.0	138.0	37.0

*Calculated

Well No. 1 is at Belden, 300 yards southeast of the Frisco station; No. 2 is at Nettleton, near the center of the town; No. 3 is at Tupelo, 1,000 feet southwest of the post office; No. 4 is at Tupelo, 125 feet west by north of the waterworks, and No. 5 is at Verona, a tenth of a mile northeast of town.[6]

AGRICULTURAL LIMESTONE

Of all the mineral plant foods, lime is the most nearly essential—indeed, it is almost the *sine qua non.* Not only does it supply calcium or an equivalent to plants, but it promotes their health and growth in other ways, such as helping to keep phosphorus in an available form, and reducing the loss of potash through leaching.[14] Lime for such agricultural purposes may be any one of a variety of soluble chemical compounds, of which the chief and effective element is calcium or magnesium, commonly calcium.[15] The chief source of agricultural lime is the great formations of limestone, chalk, and marl which were built during the millions of years past by the accumulation of shells, tests, and skeletons of marine organisms, or by chemical precipitation from the water, on the floors of ancient seas. Chemically, these great deposits are dominantly calcium carbonate, a compound of calcium, carbon, and oxygen ($CaCO_3$). By far the greater part of the lime applied to soils has been in the form of ground limestone or chalk or marl. Any one of these rock types, to be an adequate source of agricultural lime for commercial purposes, should contain a minimum of 70 percent of calcium carbonate.[15] The Agricultural Adjustment Administration's specifications for agricultural lime set 90 percent, or 1800 pounds per 2000-pound ton of raw material, as the required percentage of $CaCO_3$ for a ton of lime, the basis of soil-building payments.[15]

As has been stated, the Selma chalk outcrop area includes something like two-thirds of Lee County. The thickness of the Selma in the county may be 450 to 500 feet; outcrops are numerous and extensive, especially in the western part, and the thickness of rock which could be worked would be limited only by the problems of drainage, removal of the rock, and so on. The old State lime pit at Okolona, Chickasaw County, shows a face of 15 feet above water-level, and probably would show 10 feet more if the water were drained off. Mellen notes: "The Selma chalk and the Prairie Bluff chalk of northeastern Mississippi offer the simplest production problems of any of the lime materials. Acre beyond acre in the Black Prairie has no soil or other overburden to move. The deposits of massive, uniformly textured brittle chalk are so thick that 20 to 40 feet can commonly be worked by blasting."[15]

In Lee County, then, chalk and limestone containing the necessary percentage of calcium carbonate are abundant, and the conditions for excavating the rock are good. Of course the content of clay, sand, silt, and other impurities runs much higher in some localities than in others, and in some strata than in other strata, as brought out in the discussion of the stratigraphy; but the required quantity of calcium carbonate can be obtained from even highly impure chalk by simply using a greater tonnage. For example, the A A A requirements can be met by the use of a 70-percent $CaCO_3$ chalk by the application of about 2570 pounds of the raw material to the land as the equivalent of a ton of lime. In short, if an accurate chemical analysis of the rock to be used is available, the actual weight of the material required to meet the A A A specifications can be computed by dividing the percentage of calcium carbonate shown by the analysis, into 1800. Chemical analyses commonly are made on the "dry basis"—that is, the samples to be analyzed are first dried at a temperature a little higher than the boiling point of water.[15] Naturally, limestone which is very low in $CaCO_3$ is not so suitable for liming soil, because not only must large quantities of it be used, involving much labor and expense, in order that the necessary lime may be applied, but the clay, sand, silt, water, etc., applied at the same time may be deleterious to the soil, and go far toward offsetting the benefit of the lime. As has been stated, agricultural limestone, for practical use, should contain 70 percent or not much under, of calcium carbonate. However, in spite of the considerations mentioned above, some rather impure Selma chalk of Lee County has been used locally on a small scale as raw material for fertilizer. Some chalk intended for the liming of soils has been taken from the west wall of Coonewah Creek Valley on the north side of Mississippi State Highway 6 (NE.1/4, SE.1/4, Sec.6, T.10S., R.5E.) about a mile east of the Lee County-Pontotoc County line. The excavation is known as the Reed and Fields lime pit (Figure 8). The chalk was crushed, after air-drying, in a hammer mill. Three samples from this pit have been analyzed: One was found to contain 67.30 percent of $CaCO_3$;[15] another, 68.96 percent, and the third, 71.14 percent. At no other place in Lee County has chalk been dug out on any considerable scale for use as a source of agricultural lime, but a little southwest of Okolona, Chickasaw County, some 20 miles south of Tupelo, and not more than 6 miles south of Lee County, Demopolis chalk has been quarried for longer or shorter periods through 20 to 25 years or more. Two pits today show where the operations were carried on. The larger of these pits, now full of water almost to the level of a former outlet, is approximately 200 feet long and 150 feet wide, and the surrounding face of chalk ranges in height above water-level from near 0 at the eastern end to some 15 feet at the western end. The smaller pit, 350 to 400 yards northwest of the larger, and at about the same level, has been in operation recently, and the crusher is still there. The chalk from the more recent pit contained 74.77 percent of $CaCO_3$.

The Demopolis chalk of the south wall of the valley of Busfaloba Creek crops out extensively in numerous places, especially east of Belden. Two distinct intervals show, a lower 9 feet thick belonging to the high-calcium facies, and an upper sandy fossiliferous chalk some 30 feet thick. One sample from the lower interval was found to contain 80.06 percent $CaCO_3$. Mellen expressed the opinion that the lime content of the lower interval is sufficiently high to warrant transportation for long distances into the surrounding counties.[15]

Logan states the average results of three analyses of limestone from the G. W. Ritter land, half a mile east of Belden: Moisture, 1.0; Lime (CaO), 44.80; Calcium carbonate ($CaCO_3$), calculated, 83.27. Also he records the average results of three analyses of limestone from the O. F. Vaughan property, 2.5 miles west of Shannon: Moisture, 1.45; Lime (CaO), 44.56; Calcium carbonate ($CaCO_3$), calculated, 79.52. A sample of Selma chalk from an exposure about two blocks south of the public school building at Baldwyn analyzed 29.74 percent of lime, and contained 52.94 percent of calcium carbonate, 0.51 percent of phosphoric acid, and 0.3080375 percent of potash. These percentages would indicate that the rock would produce 1058.8 pounds of calcium carbonate per ton, 10.2 pounds of phosphoric acid, and 6.16 pounds of potash.[16]

The analyses records tabulated as part of the discussion of Portland cement materials show conclusively that large bodies of the chalk in the western part of the county are suitable also for agricultural limestone. Rock to be used for liming of soils could be taken from any one of the localities named.

WOOL ROCK

Mineral wool is a glassy fibrous material composed chiefly of calcium and aluminum silicates. In the mass it resembles loose wool or cotton. Although the term "mineral wool" is applied to any type of insulation wool, including rock wool, slag wool, and glass wool or silk, this brief discussion is confined to rock wool, which may be made from limestone, dolomite, shale, clay, and sandstone or quartz—that is, from natural rock materials referred to collectively as wool rock.[11]

As stated above, rock wool commonly is composed of calcium and aluminum silicates, chiefly. Certain investigators have found advantages in considering the composition of rock wool in terms of a four-component system consisting of lime, silica, alumina, and magnesia, regarding all other substances as impurities. However, tests have proved that neither alumina nor magnesia is essential to the production of rock wool. Satisfactory rock wool has been produced from lime and silica only.[21]

In many places in Lee County the Selma chalk, an impure limestone, contains sufficient silica to satisfy the requirements for the manufacture of rock wool. Alumina is present, also, in appreciable proportion, and small quantities of iron, maganese, sulphur, and other impurities. The magnesia content of the Lee County chalk analyzed was negligible.

The principle applied in the manufacture of rock wool is the same as that involved in the production of the natural rock wool—"Pele's hair"—during volcanic eruptions: a stream of molten rock is directed in such a way as to come in contact with a jet of steam or air, by which it is blown into a swarm of very small globules. As these are propelled through the air at high speed, due to friction with the air they are spun into fine threads which cool and solidify into rock wool fibers. If the conditions are not exactly right, part of the globule will not be drawn out into a thread, but will harden into "shot."[11] Most mineral wools contain shot, but, other factors being equal, the smaller the shot content the better grade the wool.

Twenty-three samples of Selma chalk from Lee County outcrops, all except two from four localities, were analyzed and tested as possible wool rock. The outcrops referred to are scattered along the basal zone of the Demopolis member of the chalk, ranging up to 40 feet or more above the Coffee-Demopolis contact. The northernmost locality from which samples were taken is a mile or a little more east of Guntown, and the southernmost is 1.5 miles east of Verona. All these localities are easy of access and reasonably near to a railroad and to U. S. Highway 45.

(1) Perhaps the most favorable locality in the county for quarrying the chalk is on the Knight and Bucy properties, in the

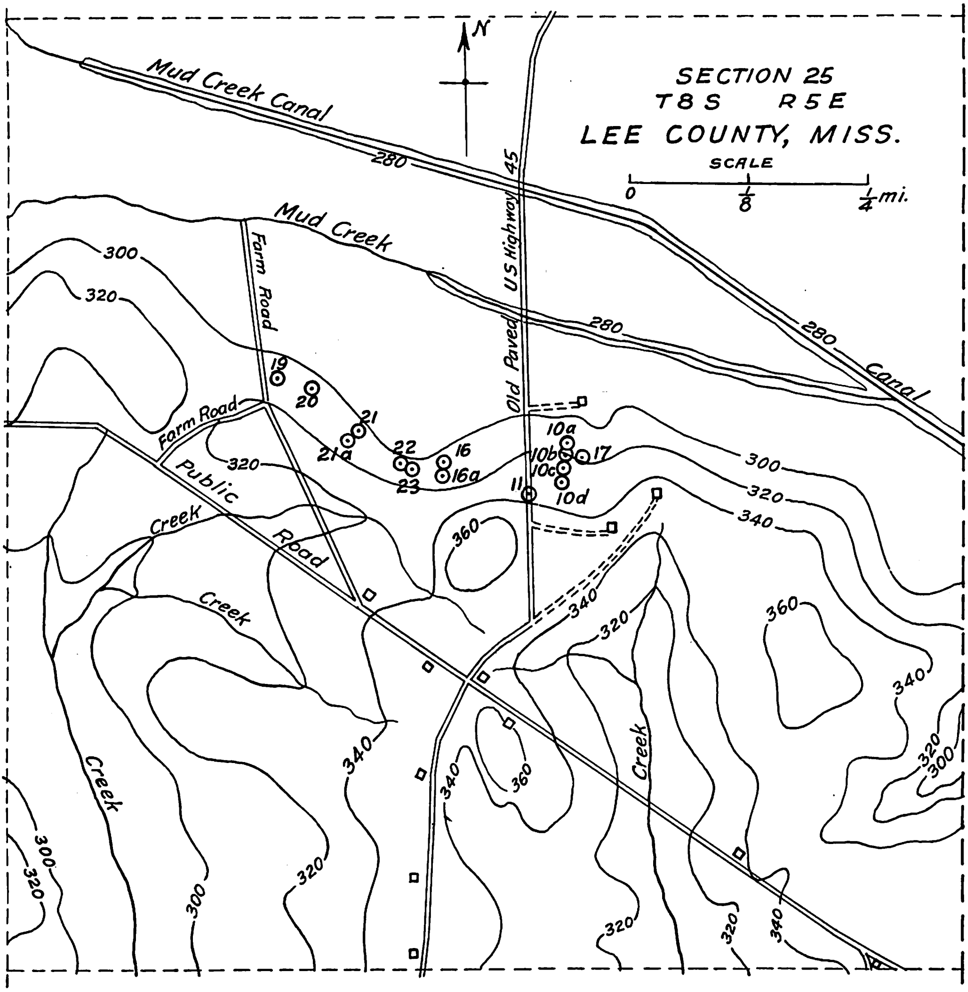


Figure 16.—Topographic map of Mud Creek Bluff at the crossing of old paved U. S. Highway 45 (Sec. 25, T.8 S., R.5 E.) showing the locations from which the samples of chalk were taken.

central part of Sec.25, T.8S., R.5E., about 6 miles north of Tupelo. At this place the chalk is exposed almost continuously in the south wall of the valley of Mud Creek, on both sides of old Highway 45, for a total distance of a half a mile, more or less, and through a vertical interval of 30 to 40 feet above the Coffee-Demopolis contact. The bluff, underlain by probably at least 20 to 25 feet of chalk, trends southeast for another half a mile (Figure 16). The overburden of loose mantle rock, subsoil, and soil, ranges in thickness from a few inches to 15 feet. The locality is 2.5 miles west of the Gulf, Mobile & Ohio railroad and less than 1.5 miles west of U. S. Highway 45, but is 3.5 miles from the station at Saltillo, the nearest point at which the railroad can be reached by road. Fourteen samples, numbered and located on the map (Figure 16), were obtained from this Mud Creek bluff. Results of chemical analyses by Herbert Safford Emigh, Chemist of the Ceramics Laboratory, Mississippi State Geological Survey, are tabulated below:

Sample 11, consisting of bluish to gray sandy chalk, was taken from the east wall of the old Highway 45 cut a little below the top of the bluff, through an interval extending from 25 feet above the Coffee sand to 28 feet above it.

CHEMICAL ANALYSES

Sample 11

Raw		Calcined	
Ignition loss	28.82		
Silica (SiO_2)	25.13	SiO_2	35.30
Combined, R_2O_3	12.71	R_2O_3	17.86
Lime, CaO	32.04	CaO	45.01
Miscellaneous	1.30	Miscellaneous	1.83
Sulfur trioxide, SO_3	1.30		

Samples 10a, 10b, 10c, and 10d were dug from the floor of a gully in the valley wall some 50 yards east of the old highway, through successive 5-foot intervals, beginning (10a) 10 feet above the Coffee sand.

CHEMICAL ANALYSES

Sample 10a

Raw		Calcined	
Ignition loss	24.76		
Silica, SiO_2	32.69	SiO_2	43.45
Combined, R_2O_3	11.69	R_2O_3	15.54
Lime, CaO	30.77	CaO	40.89
Miscellaneous	0.09	Miscellaneous	0.12
Sulfur trioxide, SO_3	0.89		

Sample 10b

Raw		Calcined	
Ignition loss	27.51		
Silica, SiO_2	24.73	SiO_2	34.11
Combined, R_2O_3	14.68	R_2O_3	20.25
Lime, CaO	32.29	CaO	44.55
Miscellaneous	0.79	Miscellaneous	1.09
Sulfur trioxide, SO_3	1.23		

Sample 10c

Raw		Calcined	
Ignition loss	28.84		
Silica, SiO_2	24.70	SiO_2	34.71
Combined, R_2O_3	12.59	R_2O_3	17.69
Lime, CaO	31.89	CaO	44.82
Miscellaneous	1.98	Miscellaneous	2.78
Sulfur trioxide, SO_3	0.79		

Sample 10d

Raw		Calcined	
Ignition loss	29.28		
Silica, SiO_2	23.15	SiO_2	32.74
Combined, R_2O_3	11.57	R_2O_3	16.36
Lime, CaO	33.11	CaO	46.82
Miscellaneous	2.89	Miscellaneous	4.08
Sulfur trioxide, SO_3	None		

COMPLETE CHEMICAL ANALYSES

Combined Samples 10a, 10b, 10c, 10d

Raw, 110° Centigrade		Calcined	
Ignition loss	27.26		
Silica, SiO_2	27.02	SiO_2	37.15
Alumina, Al_2O_3	7.54	Al_2O_3	10.37
Iron oxide, Fe_2O_3	3.14	Fe_2O_3	4.32
Titania, TiO_2	0.50	TiO_2	0.69
Lime, CaO	31.50	CaO	43.31
Magnesia, MgO	0.63	MgO	0.87
Manganese, MnO_2	0.02	MnO_2	0.03
Alkalies, Na_2O, K_2O	1.12	Na_2O, K_2O	1.54
Sulfur, SO_3	0.84		
Carbon dioxide, CO_2	22.71		

Sample 17 was taken from an outcrop in the eastward-facing wall of a small tributary valley about 100 yards east of old Highway 45, from an interval ranging from 5 feet above the Coffee sand to 8 feet above it.

CHEMICAL ANALYSES

Sample 17

Raw		Calcined	
Ignition loss	27.98		
Silica, SiO_2	25.06	SiO_2	34.80
Combined, R_2O_3	12.86	R_2O_3	17.85
Lime, CaO	32.95	CaO	45.76
Miscellaneous	1.15	Miscellaneous	1.59
Sulfur trioxide, SO_3	0.81		

Sample 16 was taken from an exposure near the head of a ravine in the bluff 100 to 150 yards west of the old highway, through an interval extending from 5 feet above the Coffee sand to 10 feet above it.

CHEMICAL ANALYSES

Sample 16

Raw		Calcined	
Ignition loss	25.56		
Silica, SiO_2	30.45	SiO_2	40.90
Combined, R_2O_3	12.35	R_2O_3	16.59
Lime, CaO	30.84	CaO	41.43
Miscellaneous	0.80	Miscellaneous	1.08
Sulfur trioxide, SO_3	0.94		

Sample 16a came from the interval ranging from 10 feet above the Coffee sand to 15 feet above it, and superjacent to the Sample 16 interval.

Sample 16a

Raw		Calcined	
Ignition loss	27.76		
Silica, SiO_2	25.40	SiO_2	35.16
Combined, R_2O_3	13.39	R_2O_3	18.54
Lime, CaO	32.42	CaO	44.88
Miscellaneous	1.03	Miscellaneous	1.42
Sulfur trioxide, SO_3	0.99		

About 225 yards west of the old paved highway, Sample 23 was taken from the head of a gully through an interval extending from 12.5 feet above the Coffee sand to 15.5 feet above it.

CHEMICAL ANALYSES

Sample 23

Raw		Calcined	
Ignition loss	26.62		
Silica, SiO_2	31.02	SiO_2	42.27
Combined, R_2O_3	12.17	R_2O_3	16.58
Lime, CaO	30.26	CaO	41.23
Miscellaneous	——	Miscellaneous	——
Sulfur trioxide, SO_3	None		

Sample 22 was taken from the head of a gully some 250 yards west of the old highway, through a 5-foot interval, beginning 10.5 feet above the Coffee sand.

CHEMICAL ANALYSES

Sample 22

Raw		Calcined	
Ignition loss	26.68		
Silica, SiO_2	29.82	SiO_2	40.67
Combined, R_2O_3	11.50	R_2O_3	15.68
Lime, CaO	31.16	CaO	42.50
Miscellaneous	0.84	Miscellaneous	1.15
Sulfur trioxide, SO_3	1.02		

Samples 21 and 21a were dug from near the head of a gully about 350 yards west of old Highway 45, Sample 21 through the interval ranging from 8 feet above the Coffee sand to 12 feet above it, and Sample 21a through the superjacent interval.

Sample 21

Raw		Calcined	
Ignition loss	26.42		
Silica, SiO_2	31.16	SiO_2	42.35
Combined, R_2O_3	11.50	R_2O_3	15.63
Lime, CaO	30.74	CaO	41.78
Miscellaneous	0.18	Miscellaneous	0.24
Sulfur trioxide, SO_3	None		

Sample 21a

Raw		Calcined	
Ignition loss	27.68		
Silica, SiO_2	27.82	SiO_2	38.47
Combined, R_2O_3	12.02	R_2O_3	16.62
Lime, CaO	31.70	CaO	43.84
Miscellaneous	0.78	Miscellaneous	1.07
Sulfur trioxide, SO_3	0.33		

Complete Chemical Analyses

Combined Samples 21, 21a

Raw, 110° Centigrade		Calcined	
Ignition loss	26.35		
Silica, SiO_2	30.32	SiO_2	41.16
Alumina, Al_2O_3	6.86	Al_2O_3	9.31
Iron oxide, Fe_2O_3	3.14	Fe_2O_3	4.26
Titania, TiO_2	0.40	TiO_2	0.54
Lime, CaO	31.18	CaO	42.34
Magnesia, MgO	0.69	MgO	0.94
Manganese, MnO_2	0.02	MnO_2	0.03
Alkalies, Na_2O, K_2O	1.35	Na_2O, K_2O	1.83
Sulfur, SO_3	0.47		
Carbon dioxide, CO_2	22.37		

Sample 20 was taken through a 5-foot interval beginning 10 feet above the Coffee sand, near the head of a ravine about a quarter of a mile west of old Highway 45.

Chemical Analyses

Sample 20

Raw		Calcined	
Ignition loss	25.61		
Silica, SiO_2	33.21	SiO_2	44.64
Combined, R_2O_3	11.83	R_2O_3	15.90
Lime, CaO	29.27	CaO	39:35
Miscellaneous	0.08	Miscellaneous	0.11
Sulfur trioxide, SO_3	None		

Sample 19, the farthest west sample from the Mud Creek bluff, represents an interval extending from 13 feet above the Coffee sand to 15 feet above it, from near the head of a ravine a little below the top of the slope, 65 yards or so west of the Sample 20 site, and just east of a farm road.

CHEMICAL ANALYSES

Sample 19

Raw		Calcined	
Ignition loss	26.63		
Silica, SiO_2	30.50	SiO_2	41.57
Combined, R_2O_3	12.00	R_2O_3	16.36
Lime, CaO	31.15	CaO	42.46
Miscellaneous	----	Miscellaneous	----
Sulfur trioxide, SO_3	None		

From the analyses it would seem that the chalk of the Mud Creek bluff on both sides of old paved Highway 45 is good wool rock, at least for the distance and through the vertical intervals represented by the samples. Samples 10a, 10b, 10c, and 10d provided the raw material from which excellent light-colored rock wool was blown in the laboratory. The inference is warranted, also, that the chalk in a half-mile length of bluff east and southeast of the area sampled, is suitable for the manufacture of rock wool. In short, at this favorably situated locality is a body of high-grade wool rock close to a mile in length, of undetermined but very considerable width, and of an average thickness of at least 15 to 20 feet, under light overburden.

Wool rock as good as that of the Mud Creek area constitutes part of an outlier of Demopolis chalk about 1.5 mile east by south from the Gulf, Mobile & Ohio Railroad station at Guntown, on the south side of the Guntown-Ratliff graveled road. Here the basal Demopolis chalk and the upper part of the Coffee sand have been deeply eroded, exposing bare rock through a vertical interval of 15 to 20 feet under 5 feet or less of weathered material. Outcrops are many on the flanks of the flat-topped hills for a total distance of nearly a mile. Samples 15 and 15a were taken from an outcrop (NE.1/4, Sec.35, T.7S., R.6E.) some 250 yards south of the graveled road (Figure 17), Sample 15 through the interval extending from 5 feet above the Coffee sand to 10 feet above it, and Sample 15a through the succeeding 5-foot interval.

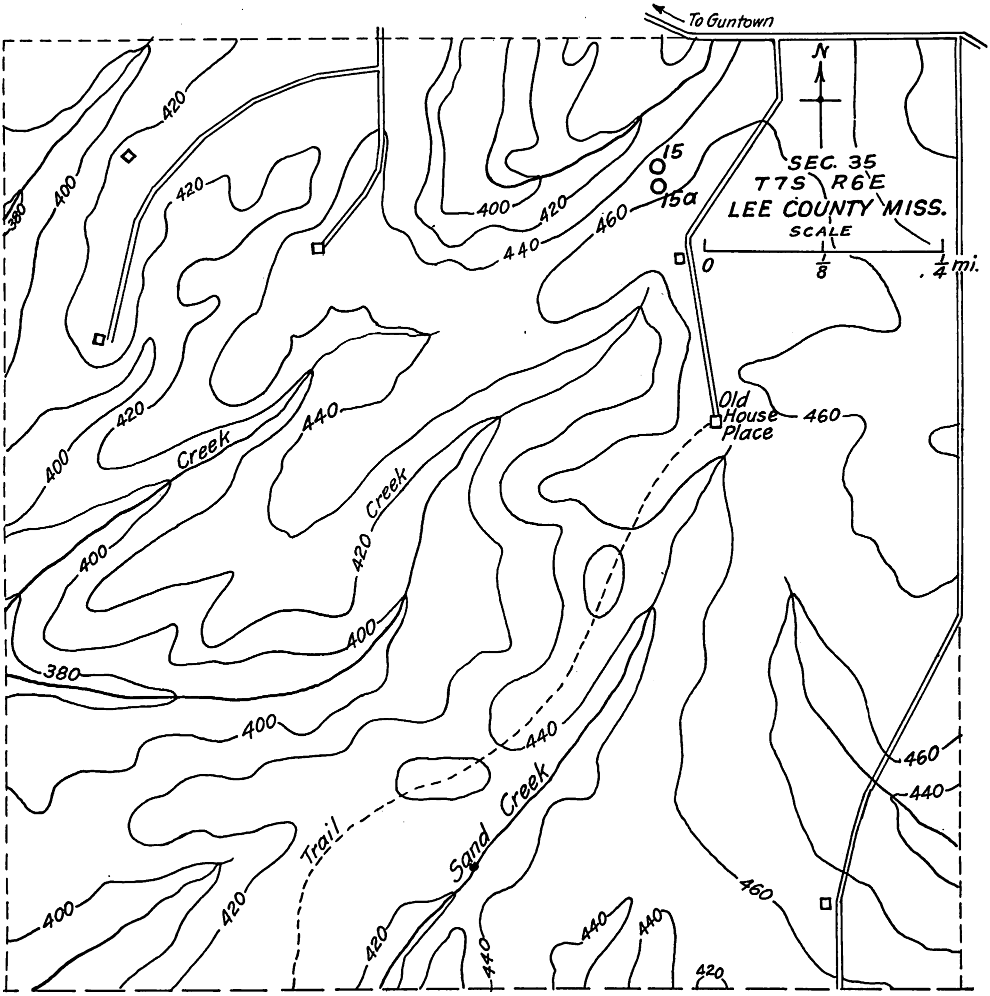


Figure 17.—Topographic map of the area (Sec. 35, T.7 S., R.6 E.) southeast of Guntown showing the locations from which the samples of chalk were taken.

Chemical Analyses

Sample 15

Raw		Calcined	
Ignition loss	24.48		
Silica, SiO_2	33.71	SiO_2	44.64
Combined, R_2O_3	12.58	R_2O_3	16.66
Lime, CaO	28.73	CaO	38.04
Miscellaneous	0.50	Miscellaneous	0.66
Sulfur trioxide, SO_3	None		

Sample 15a

Raw		Calcined	
Ignition loss	27.24		
Silica, SiO_2	28.18	SiO_2	38.73
Combined, R_2O_3	14.01	R_2O_3	19.25
Lime, CaO	31.30	CaO	43.02
Miscellaneuos	——	Miscellaneous	——
Sulfur trioxide, SO_3	None		

COMPLETE CHEMICAL ANALYSES

Combined Samples 15, 15a

Raw, 110° Centigrade		Calcined	
Ignition loss	25.84		
Silica, SiO_2	30.90	SiO_2	41.66
Alumina, Al_2O_3	8.17	Al_2O_3	11.02
Iron oxide, Fe_2O_3	2.98	Fe_2O_3	4.02
Titania, TiO_2	0.43	TiO_2	0.58
Lime, CaO	29.76	CaO	40.13
Magnesia, MgO	0.69	MgO	0.93
Manganese, MnO_2	0.02	MnO_2	0.03
Alkalies, Na_2O, K_2O	0.70	Na_2O, K_2O	0.94
Sulfur, SO_3	None		
Carbon dioxide, CO_2	22.35		

On the basis of the analyses of Samples 15 and 15a, the chalk in this area is good wool rock, and the extent of the outcrops indicates a tonnage sufficient for the requirements of a rock wool plant for an indefinite period. Overburden is light, drainage good, and the location with reference to transportation lines is reasonably favorable.

The other samples collected in the search for wool rock proved not to have the proper composition for use in their natural state; lime or silica was too high.

Sample 12 was obtained from a chalk outcrop at the head of a gully (northern part, Sec.36, T.8S., R.5E.) about eight-tenths of a mile south of the top of the Mud Creek valley bluff, and 75 yards more or less west of old Highway 45. Stratigraphically, it ranged from 25 feet above the Coffee sand to 29 feet above it, as closely as could be determined.

CHEMICAL ANALYSES

Sample 12

Raw		Calcined	
Ignition loss	32.58		
Silica, SiO_2	18.46	SiO_2	27.38
Combined, R_2O_3	9.24	R_2O_3	13.71
Lime, CaO	37.72	CaO	55.94
Miscellaneous	2.00	Miscellaneous	2.97
Sulfur trioxide, SO_3	0.96		

Sample 13 was taken from an exposure 1.5 miles east of Verona, on the north side of the Verona-Plantersville road (SE.1/4, Sec.20, T.10S., R.6E.).

CHEMICAL ANALYSES

Sample 13

Raw		Calcined	
Ignition loss	17.83		
Silica, SiO_2	50.57	SiO_2	61.54
Combined, R_2O_3	10.27	R_2O_3	12.50
Lime, CaO	20.78	CaO	25.29
Miscellaneous	0.55	Miscellaneous	0.67
Sulfur trioxide, SO_3	None		

Samples 14, 14a, and 14b were dug from an outcrop (Sec.13, T.9S., R.5E.) on the Murphy (formerly the Berry) property, about 200 yards east of a local public road, in the east wall of a small tributary of Old Town Creek. The place is a little more than a mile northwest of Tupelo, and a mile west of U. S. Highway 45. The local roads are easily passable in dry weather, but are bad in rainy weather. Overburden is all but absent from the chalk over a considerable area. Sample 14 is from the 5-foot interval beginning 10 feet above the top of the Coffee sand; 14a from the 12.5 to 15.0-foot interval at an outcrop 60 yards east of 14; and Sample 14b from directly above 14a, 16 feet to 20 feet above the Coffee sand.

CHEMICAL ANALYSES

Sample 14

Raw		Calcined	
Ignition loss	17.22		
Silica, SiO_2	47.68	SiO_2	57.60
Combined, R_2O_3	14.84	R_2O_3	17.93
Lime, CaO	17.92	CaO	21.65
Miscellaneous	2.34	Miscellaneous	2.92
Sulfur trioxide, SO_3	0.43		

Sample 14a

Raw		Calcined	
Ignition loss	16.42		
Silica, SiO_2	48.70	SiO_2	58.27
Combined, R_2O_3	15.62	R_2O_3	18.69
Lime, CaO	17.17	CaO	20.54
Miscellaneous	2.09	Miscellaneous	2.50
Sulfur trioxide, SO_3	1.24		

Sample 14b

Raw		Calcined	
Ignition loss	24.31		
Silica, SiO_2	33.85	SiO_2	44.72
Combined, R_2O_3	12.91	R_2O_3	17.06
Lime, CaO	28.87	CaO	38.14
Miscellaneous	0.06	Miscellaneous	0.08
Sulfur trioxide, SO_3	None		

Samples 18 and 18a were taken from an outcrop (SE.1/4, Sec.13, T.9S., R.5E.) about 1.5 miles northwest of Tupelo, a mile west of U. S. Highway 45, and 60 yards north of a local road. Sample 18 was dug from the wall of a gully 4 feet to 7 feet above the Coffee sand; Sample 18a from the interval extending 17 feet above the Coffee sand to 20 feet above it. About 25 feet of chalk shows here, and the overburden is thin over a considerable area.

Chemical Analyses

Sample 18

Raw		Calcined	
Ignition loss	14.64		
Silica, SiO_2	49.92	SiO_2	58.48
Combined, R_2O_3	10.39	R_2O_3	12.17
Lime, CaO	20.12	CaO	23.57
Miscellaneous	4.93	Miscellaneous	5.78
Sulfur trioxide, SO_3	4.31		

Sample 18a

Raw		Calcined	
Ignition loss	28.01		
Silica, SiO_2	26.26	SiO_2	36.48
Combined, R_2O_3	10.98	R_2O_3	15.25
Lime, CaO	33.67	CaO	46.77
Miscellaneous	1.08	Miscellaneous	1.50
Sulfur trioxide, SO_3	1.02		

A sample taken through a 4-foot to 5-foot interval just above the Coffee sand and below the interval of Sample 10a of the Mud Creek bluff samples, was too low in lime to be good wool rock. It was found to contain only 16.43 percent of CO_2 and 37.35 percent of $CaCO_3$. Material from this zone could be used in a mixture with a high-lime rock.

Partial analysis of a sample taken from near the base of the east wall at the north end of the Gulf, Mobile & Ohio Railroad cut a mile north of Verona showed a CO_2 content of 27.16 percent, and a $CaCO_3$ content of 61.75 percent. The percentage of CO_2 suggests that the chalk may be wool rock. Extensive outcrops on the east side of the railroad at this place (Figure 11), and smaller outcrops on the west side of U. S. Highway 45, a little farther west, promise abundance of raw material, but the intertonguing of the chalk and the sand might interfere seriously with uniformity of composition.

TEST CONCLUSIONS

ROCK WOOL POSSIBILITIES

(Thomas Edwin McCutcheon, B. Sc., Ceramic Engineer)

Chemical analyses of the 23 samples from the Selma chalk indicate that the material from a few feet above the base of the deposit (Demopolis member) to approximately 25 feet above it is suitable for making a good grade of rock wool. The chalk is high in silica in the lower portion and becomes richer in calcium in the upper part of the exposed sections. Some of the samples from approximately 5-foot intervals are too high in silica and some are too high in calcium. In most cases a composite of the lower and upper parts makes an ideal wool rock. A number of samples representing approximately 5-foot intervals are well suited for making rock wool.

Samples 10a, 10b, 10c, and 10d, each representing a continuous 5-foot interval, were combined in equal proportions, melted, and blown into a good quality of light-colored wool. The composite sample melts to a glass at 2200° F., but must be heated to a considerably higher temperature to produce a sufficiently liquid melt. The chemical analysis of the composite sample indicates a deficiency of silica which may be supplied by extending mining operations downward into the high silica base, or by including in a composite a higher proportion of material of the composition of Sample 10a, or by omitting from the composite the upper 5 feet of the deposit. The sulphur content of the composite sample in terms of sulphur trioxide averages 0.727 percent, which is not enough to be objectionable. The sulphur content of the unweathered chalk is not known.

Sample 11 represents a 3-foot interval of the chalk 25 to 28 feet above the base of the deposit. The chemical analysis of the sample is typical of the upper part of this zone of the chalk. Although the calcium content is higher and the silica content is lower than might be desired, the material is within the limits of wool rock. The sulphur content of this sample is higher than the average, but such variation may be expected from weathered material.

Sample 12 represents a 3-foot interval 26 feet to 29 feet above the base of the local deposit. The calcium content of this sample is too high to permit its use as wool rock unless it is blended with a material containing a high proportion of silica.

Sample 13 represents a 2-foot interval, 3 feet to 5 feet above the Arcola limestone. The material is too high in silica to be of value when used alone, but may be desirable for blending with the high-calcium Arcola limestone.

Sample 14 represents a 5-foot interval of chalk 10 feet to 15 feet above the base of the local deposit. The material is too high in silica to be used alone, but would be a desirable constituent to blend with chalk having a high calcium content such as that typical of the local upper part.

Samples 14a and 14b represent 2.5-foot and 4-foot intervals of a discontinuous section of the Selma 12.5 feet to 20.0 feet above the local base. A composite of the two intervals would be too high in silica to make a good wool; however, chalk containing a higher proportion of calcium is available at the same location and could be used in the blend.

Samples 15 and 15a represent two continuous 5-foot intervals of the chalk from 5 feet to 15 feet above the local base. Both samples, either separately or composite, are suitable for rock wool. The samples contained no sulphur.

Samples 16 and 16a represent two 5-foot intervals of a discontinuous section of the Selma, 5 feet to 15 feet from the base of the local deposit. Sample 16 has an ideal wool rock composition. Sample 16a also is suitable for making rock wool separately or as part of a blend with sample 16. The sulphur content is nearly 1 percent for both samples, but is not so high as to be objectionable.

Sample 17 is an acceptable wool rock material, but is rather high in calcium. Although the sample was taken 5 feet to 8 feet above the base of the local deposit, it is not typical of other samples from the lower section of the local chalk.

Samples 18 and 18a represent two 3-foot intervals in the lower and upper portions of the local chalk deposit. Sample 18a is a suitable wool rock material. Sample 18 contains too much sulphur for use as wool rock even though it could be blended with a high-calcium chalk to overcome its calcium deficiency. The samples represent too small a portion of the exposed section to admit of a proper evaluation of the material.

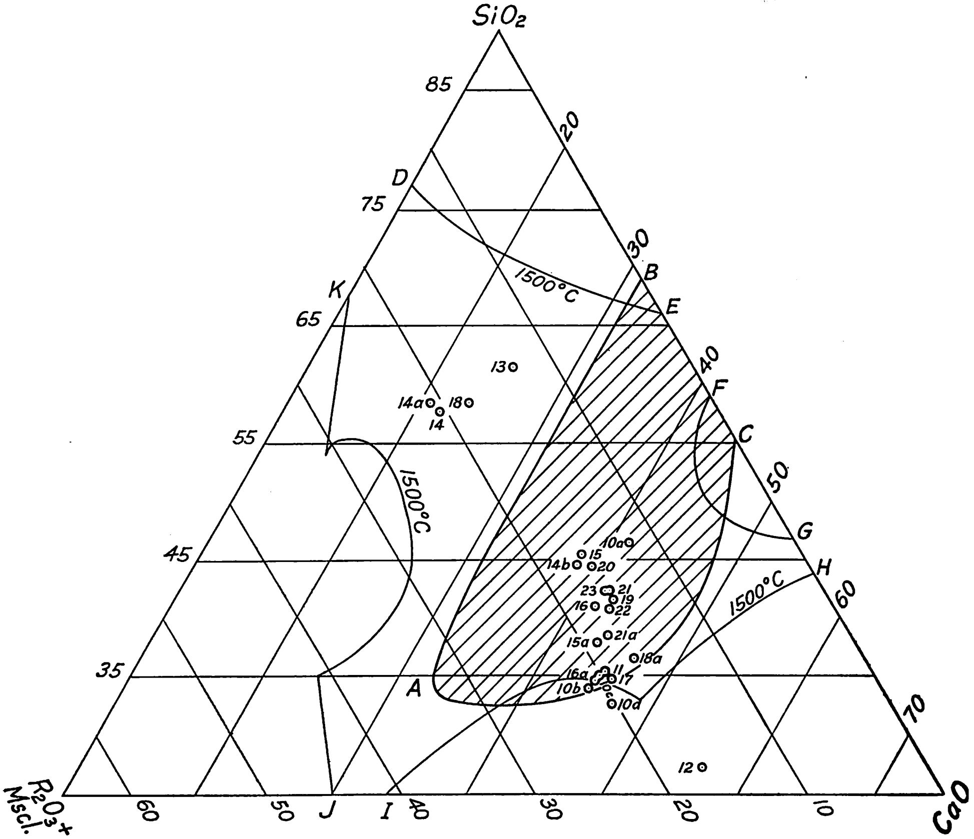


Figure 18.—A diagrammatic adaptation of the ternary system.

Samples 19, 20, 21, 21a, 22, and 23 represent 2-foot to 5-foot intervals discontinuous in the chalk 8 feet to 16 feet above the base of the local deposit. The samples were unusually uniform in composition and are ideal for making rock wool. The average sulphur content is very low.

The diagrammatic adaptation of the ternary system (Figure 18) consisting of SiO_2-Al_2O_3-CaO, from Bulletin 61, page 190, of the Illinois State Geological Survey,[21] is useful for showing the composition of the Selma chalk suitable for making rock wool inasmuch as the quantity of minerals other than SiO_2-Al_2O_3-CaO in the typical chalk is insignificant. In this figure the Al_2O_3 co-ordinate is considered as R_2O_3 plus miscellaneous elements.

The shaded area enclosed by the lines A-B-C represents a range of compositions, consisting of SiO_2-Al_2O_3-CaO, which are known to be suitable for making rock wool having fiber diameters ranging from 3 to 10 microns when the melt is heated to 1500° C. The lines D-E, F-G, H-I, and J-K are the 1500° C. isotherm. The area enclosed by these lines represents compositions of SiO_2-Al_2O_3-CaO which will melt at or below 1500° C. Within the 1500° C. isotherm, only the SiO_2-Al_2O_3-CaO compositions in the shaded area (bounded by the lines A-B-C) melt to a liquid of sufficiently low viscosity to be blown into a good quality of rock wool.

The small circles on the diagram represent the composition of the Selma chalk collected for this study. It is to be noted that most of the Selma chalk samples have compositions suitable for making rock wool.

The composite analysis recorded below indicates in general the composition of Illinois rock from which rock wool was made by the laboratories of the Illinois Geological Survey.[21]

AVERAGE ANALYSES OF 22 SAMPLES OF BED ROCK DEPOSITS FROM WHICH ROCK WOOL WAS PRODUCED EXPERIMENTALLY

	Percent
SiO_2	31.73
Ignition loss	27.28
CaO	26.96
MgO	7.89
Al_2O_3	5.79
Fe_2O_3	2.21
Total	101.86

Experiments conducted by the Illinois Geological Survey found that the carbon dioxide (CO_2) content of the rock was a useful index to the value of the rock for the manufacture of rock wool: that any rock having a CO_2 content between 20 percent and 30 percent may be considered possible raw material for rock wool.[11, 21] However, this so-called index is useful chiefly as a quick test, necessary in prospecting, by which materials unsuitable for use in the manufacture of rock wool may be eliminated.[21] In any particular region, and for a large body of rock, the CO_2 content criterion is suggestive only, and not conclusive, as to whether or not the material is good wool rock. The actual limits of composition would have to be determined experimentally.[11]

CEMENT MATERIALS

PORTLAND CEMENT

"Portland cement is the product obtained by pulverizing clinker consisting essentially of hydraulic calcium silicates, to which no additions have been made subsequent to calcination other than water and/or untreated calcium sulfate, except that not to exceed 1 percent of other materials may be added, provided such materials have been shown not to be harmful by tests acceptable to Committee C-1 on Cement." This is the definition of Portland cement approved by the American Society for Testing Materials, as formulated in its "Standard Specifications for Cement," which became effective September 2, 1940.[11] The Missouri Bureau of Geology and Mines prefers to define Portland cement as follows: "By Portland cement is meant the finely ground product obtained by reducing the clinker produced in burning to incipient fusion intimate mixtures of finely pulverized argillaceous and calcareous materials which shall consist approximately of three parts of carbonate of lime to one part of silica, alumina and iron oxide and to which there has been made no addition greater than 3 percent subsequent to calculation."[11]

Perhaps the definitions could be clarified by statements that are not designed to be a definition. Portland cement is a hydraulic cement manufactured from materials that must contain lime carbonate and silica, and may contain small quantities of other substances, such as alumina and iron oxide. The ratio of calcium carbonate to silica, alumina, and iron oxide should be approximately 3 to 1, and in any case can vary only within narrow limits. The raw materials are pulverized, intimately mixed, and burned to incipient fusion; the resulting clinker is pulverized, sacked, and sold as the Portland cement of commerce. Both definitions quoted above make a point of the specification that only slight additions are permissible after calcination; but the A. S. T. M. definition specifies that, except for water and/or untreated calcium sulphate, not more than 1 percent of other materials may be added, whereas the Missouri Bureau of Geology and Mines definition includes the provisions that no addition greater than 3 percent shall be made subsequent to calcination. "The chief requirement is that the final mixture shall contain about

75 to 77 percent of calcium carbonate and about 20 percent of alumino-siliceous materials."[11] The ratio of lime (CaO) in the cement to the silica, alumina, and iron oxide together should not be less than 1.6 to 1, or more than 2.3 to 1.[12] Magnesia in excess of 3 percent is harmful; alkalies and sulphates should not exceed 3 percent.[11]

All true Portland cements have approximately the same composition, whatever the raw materials used. The allowable range of percentages of the various constituents of Portland cement is: Silica (SiO_2), 19 to 26; Alumina (Al_2O_3), 4 to 11; Iron oxide (Fe_2O_3), 2 to 5; Lime (CaO), 58 to 67; Magnesia (MgO), 0 to 5; Sulphur trioxide (SO_3), 0 to 2.5; Alkalies, 0 to 3.[11] Crider gives the following figures, based on a study of 81 analyses of American brands of Portland cement: Lime (CaO), 58.07 to 65.44; Silica (SiO_2), 19 to 24; Alumina (Al_2O_3) and Iron oxide (Fe_2O_3) together, 6.0 to 13.5; Magnesia (MgO), a trace to 3.5; Alkalies (K_2O, Na_3O), up to 2.25, and Sulphur trioxide (SO_3) a fraction of 1 to 2.786. He states the averages as, CaO, 62.0; SiO_2, 21.75; Al_2O_3 plus Fe_2O_3, 10.5.[12]

To be suitable for use in the manufacture of Portland cement, then, rock or other mineral substances must contain calcium carbonate and silica; relatively small proportions of other compounds are allowable. The rocks most commonly used are: limestone and shale; limestone and clay; marl and clay; chalk and clay; pure limestone and clayey limestone; and limestone and granite.[11] The limestone, marl, and chalk provide the lime carbonate, and the shale, clay, clayey limestone, and granite, are sources of silica, alumina, iron oxide, and the other constituents. These rock materials may be combined and mixed in various ways and proportions in order to obtain the required composition of the cement.[11] Dolomite and dolomitic limestones can not be used, because of their content of magnesia.[11]

The raw materials, in addition to having the proper composition, also must show proper physical character, must be extensive and must have a favorable location with respect to market and fuel supplies.[11] It would seem that the ideal geologic and geographic conditions for the establishment and continuous operation of a large Portland cement plant would be present where an immense deposit of almost pure limestone, underlain by thick shale or clay, and under a cover easily removable but sufficiently thick to protect the rock against excessive weathering, lies well above but bordering a navigable waterway, towards which it dips at a low angle, on one side, and near a trunk railroad on the other, both waterway and railroad leading from the place to large shipping and manufacturing centers at no great distance, preferably ports for ocean-going vessels. Obviously a pavement highway or two near by would help. It is almost unneccessary to say that such a set of conditions exists in very few places, if at all. Commonly a combination of two or three of the favorable factors is all that can be found, or hoped for, in any one locality, and these may determine the selection of the site for the plant; but the other requisite factors will have to be satisfied by bringing in items such as materials or power from places more or less distant. If both the essential kinds of rock are not present at a chosen site, in almost every case the argillaceous (clayey) rock is brought in, because three-fourths of the cement is derived from the calcareous (lime) rock. Of course, if an extensive and thick series of strata of a composition exactly or approximately that of ideal cement rock—three parts of lime carbonate to one part of silica, alumina, and iron oxide combined—could be found, the problem of raw materials would be solved at much less expense than is involved in most cases, but no such a body of rock has been discovered. One or the other major constituent must be added in a pure state, or both obtained in an essentially pure state and mixed in the proper proportions.[11]

Portland cement has the property of setting, in drying from a wet state, to a hard rock. Mixed with gravel or sand or other more or less coarsely divided mineral substance, it forms concrete. Portland cement concrete is perhaps the most widely used of all mineral structural materials, with the possible exception of brick.

That large bodies of the Demopolis chalk of Lee County contain sufficient calcium carbonate to satisfy the lime requirements for Portland cement raw material is indicated by the record of analyses of representative samples from a belt of outcrop extending from the Chickasaw County line northwards to the vicinity of Belden. The records of complete analyses show, also, that much of the chalk meets the requirements for Portland cement raw material in the matter of other components than calcium carbonate: Magnesia, sulphates, and alkalies are low, and iron oxide and alumina are well under the maximum allowable. The deficiency of silica would necessitate the addition of siliceous rock.

Tubbalubba Creek Valley is bounded on the southwest by a low chalk bluff, which shows conspicuous blue and white outcrops for long distances and to a height of 25 to 30 feet above the valley flat. From one of these exposures (SE. Cor., Sec.27, T.11S., R.5E.) on the Bright property about 200 yards west of a local public road, Samples 3, 3a, 3b, 3c, 3d, and 3e were taken. Sample 3 was dug from the foot of the terrace a little above the base of the outcrop, for analysis as a guide to the composition of the rock in this vicinity; the other samples (3a-3e) were taken through a 10-foot interval in ascending order from the base of the exposure, some 15 feet above the creek flat, each sample representing a 2-foot interval. The uppermost sample, 3e, came from 15 feet below the crest of the ridge, but chalk is exposed almost to the top.

LIME CONTENT OF SAMPLES OF NO. 3 SERIES

Sample	CaO	CO_2	$CaCO_3$
3	41.32	32.43	73.75
3a	40.14	31.52	71.66
3b	42.37	33.25	75.62
3c	44.54	34.97	79.51
3d	44.11	34.62	78.73
3e	41.69	32.74	74.43

Analysts: B. F. Mandlebaum, of Sample 3; H. S. Emigh, of others

The chalk cliffs which border the valley of Chiwapa Creek on the southwest are conspicuous on both sides of the graveled road at a place (NW.1/4, Sec.22, T.11S., R.5E.) 3 miles due west of Shannon. From the gullied slopes here a little below a tenant cabin the samples of the No. 4 series were taken, on the Renshaw, Rogers, and Etheridge properties, through an interval of 18 feet, measured from the bottom of a gully 13 feet below the road and about 17 feet above the creek flat. Sample 4a consists of material from the lowermost 3 feet, and Samples 4b, 4c, and 4d each represents a successive 5-foot interval, in ascending order. Sample 4, the first taken, designed to be a guide sample, is from the same interval as 4c.

LIME CONTENT OF SAMPLES OF NO. 4 SERIES

Sample	CaO	CO_2	$CaCO_3$
4	45.45	35.67	81.12
4a	42.54	33.54	76.08
4b	42.94	33.64	76.58
4c	45.21	35.49	80.70
4d	45.74	35.91	81.65

COMPLETE CHEMICAL ANALYSES

Combined Samples 4a, 4b, 4c, and 4d

Raw, 110° Centigrade		Calcined	
Ignition loss	36.68		
Silica, SiO_2	10.10	SiO_2	15.96
Alumina, Al_2O_3	3.82	Al_2O_3	6.04
Iron oxide, Fe_2O_3	1.86	Fe_2O_3	2.94
Titania, TiO_2	0.37	TiO_2	0.58
Lime, CaO	45.79	CaO	72.35
Magnesia, MgO	0.75	MgO	1.19
Manganese, MnO_2	Trace	MnO_2	-------
Alkalies, Na_2O, K_2O	0.45	Na_2O, K_2O	0.71
Carbon dioxide, CO_2	34.44		
Sulfur, SO_3	0.36		

Analyst, H. S. Emigh

Another sample, 4e, taken from an outcrop in the same bluff about a quarter of a mile east of the exposure from which the others of the No. 4 series came, represents an interval ranging from 16 feet above the creek flat to 20 feet above, stratigraphically lower than the others. The analysis of Sample 4e showed 40.99 CaO, 31.77 CO_2, and 72.76 $CaCO_3$.

The sample from the O. F. Vaughan land, 2.5 miles west of Shannon, referred to by Logan,[16] which sample analyzed, CaO, 44.56, $CaCO_3$, 79.52, probably was obtained from near the site of the No. 4 series.

Another locality featured by prominent outcrops of chalk is th·· Old Union Community, on the southwest wall of Coonewah Creek Valley a mile to a mile and a half west of a store and gasoline station on U. S. Highway 45 some 2 miles south of Verona. From a large bald spot (SE.1/4, SW.1/4, Sec.35, T.10S., R.5E.) at the head of a short valley on the Marshall T. Adams land north of the local public road, the samples of the No. 5 series were taken. Sample 5, the index sample, was dug out perhaps 5 to 10 feet above the base of the outcrop, in the left wall of the small valley; Sample 5a came from the interval extending from the base to 4 feet above it, and 5b from the superjacent 4-foot interval. Each of the other samples of the series, 5c to 5k inclusive, except the uppermost, represents a 2-foot interval, in ascending order. Sample 5k, the uppermost, consists of chalk from a 3-foot interval. Thus the total thickness sampled at this place is 19 feet, but chalk extends still higher, under some 15 feet of overburden.

LIME CONTENT OF SAMPLES OF No. 5 SERIES

Sample	CaO	CO_2	$CaCO_3$
5	42.97	33.72	76.69
5a	43.58	34.22	77.80
5b	44.87	35.23	80.10
5c	41.31	32.44	73.75
5d	39.66	31.12	70.78
5e	45.89	36.02	81.91
5f	44.65	35.06	79.71
5g	44.83	35.20	80.03
5h	44.56	34.99	79.55
5i	45.45	35.68	81.13
5j	45.45	35.68	81.13
5k	41.86	32.85	74.71

COMPLETE CHEMICAL ANALYSES
Samples 5c through 5k

Raw, 110° Centigrade		Calcined	
Ignition loss	36.42		
Silica, SiO_2	10.94	SiO_2	17.18
Alumina, Al_2O_3	4.05	Al_2O_3	6.36
Iron oxide, Fe_2O_3	1.88	Fe_2O_3	2.95
Titania, TiO_2	0.30	TiO_2	0.47
Lime, CaO	46.22	CaO	72.57
Magnesia, MgO	0.39	MgO	0.61
Manganese, MnO_2	Trace	MnO_2	——
Alkalies, Na_2O, K_2O	0.25	Na_2O, K_2O	0.39
Carbon dioxide, CO_2	34.16		
Sulfur, SO_3	0.31		

Analyst, H. S. Emigh

In the same bluff about a quarter of a mile northwest of the Sample 5 series site, at a road junction (NW.1/4, SW.1/4, Sec.35, T.10S., R.5E.), a deep road cut and many gullies have bared the chalk of a considerable area. Sample F was taken at this place through an interval 10 feet to 13 feet above the valley flat; Sample F 1 from the Interval extending from about 5 feet above the flat to 8 feet above it, and F 2 from the interval 23 feet to 28 feet above the flat.

LIME CONTENT OF SAMPLES OF F SERIES

Sample	CaO	CO_2	$CaCO_3$
F	45.24	35.52	80.76
F 1	41.93	32.93	74.86
F 2	41.19	32.33	73.52

Analyst, H. S. Emigh

The samples of the E series were taken at a road junction (SE. 1/4, Sec.22, T.10S., R.5E.) 2.5 miles due west of Verona, where the west wall of the valley of Coonewah Creek is bare chalk. Sample E 1 was taken from the vertical face of the north wall of the road cut (Figure 7), through an interval extending from road level to 3 feet above. The other samples constitute a regular series through a total thickness of 14 feet, Sample E 2 consisting of material from the lowermost interval, extending from the base of the exposure, 4 feet above the creek flat, to 2 feet higher; Sample E 3 of material from the next higher 2-foot interval, and so on. The soil and subsoil lying on the uppermost chalk interval sampled, is 2 to 3 feet thick.

LIME CONTENT OF SAMPLES OF E SERIES

Sample	CaO	CO_2	$CaCO_3$
E 1	44.83	35.19	80.02
E 2	43.14	33.86	77.00
E 3	40.18	31.53	71.71
E 4	41.61	32.67	74.28
E 5	43.13	33.85	76.98
E 6	45.44	35.67	81.11
E 7	44.33	34.80	79.13
E 8	44.51	34.94	79.45

COMPLETE CHEMICAL ANALYSES SAMPLES E 2 THROUGH E 8

Raw, 110° Centigrade		Calcined	
Ignition loss	36.21		
Silica, SiO_2	11.21	SiO_2	17.60
Alumina, Al_2O_3	4.18	Al_2O_3	6.56
Iron oxide, Fe_2O_3	1.96	Fe_2O_3	3.08
Titania, TiO_2	0.30	TiO_2	0.47
Lime, CaO	44.90	CaO	70.49
Magnesia, MgO	0.48	MgO	0.75
Manganese, MnO_2	Trace	MnO_2	-------
Alkalies, Na_2O, K_2O	0.48	Na_2O, K_2O	0.75
Carbon dioxide, CO_2	34.61		
Sulfur, SO_3	0.49		

Analyst, H. S. Emigh

The Sample 9 series was taken from the southwest wall of the valley of Busfaloba Creek 1.5 miles southeast of Belden, about half a mile north of U. S. Highway 78 and the Frisco Railroad, and some 150 yards north of a local public road. The bluff at this place (SE. 1/4, NW.1/4, Sec.15, T.9S., R.5E.) is bare chalk from its base to within 5 to 10 feet of its top. Sample 9, the guide sample, was dug from a 2-foot interval of a small outcrop about 75 yards north of the local road and a few feet below the top of the bluff. The 17 samples of the No. 9 series, lettered "a" to "q" inclusive to correspond with the succession of intervals, in ascending order, from which they were taken, represent a continuous 32-foot section from the base of the exposure, 5 feet above the valley flat, almost to the top of the bluff, every sample containing material from a 2-foot interval except the two uppermost (9p and 9q), each of which is from a 1-foot interval.

LIME CONTENT OF SAMPLES OF NO. 9 SERIES

Sample	CaO	CO_2	$CaCO_3$
9	45.38	32.49	77.87
9a	40.68	31.92	72.60
9b	38.49	29.02	67.51
9c	38.02	29.85	67.87
9d	43.82	34.39	78.21
9e	43.19	33.92	77.11
9f	42.24	33.16	75.40
9g	43.40	34.05	77.45
9h	37.02	29.05	66.07
9i	37.28	29.26	66.54
9j	37.17	29.17	66.34
9k	39.62	31.09	70.71
9l	40.59	31.86	72.45
9m	43.93	34.46	78.39
9n	44.82	35.19	80.01
9o	43.65	34.25	77.90
9p	44.09	34.61	78.70
9q	45.92	36.05	81.97

Three complete analyses of samples of the No. 9 series were made: The first, of a composite of all samples in the section; the second, of a composite from which the low-lime samples 9b and 9c were omitted; and the third, a composite of Samples 9k to 9q only, comprising the uppermost 12 feet.

COMPLETE CHEMICAL ANALYSES

Samples 9a through 9q

Raw, 110° Centigrade		Calcined	
Ignition loss	34.38		
Silica, SiO_2	13.16	SiO_2	20.05
Alumina, Al_2O_3	5.16	Al_2O_3	7.86
Iron, Fe_2O_3	1.90	Fe_2O_3	2.89
Titania, TiO_2	0.25	TiO_2	0.38
Lime, CaO	44.63	CaO	68.01
Magnesia, MgO	0.90	MgO	1.37
Manganese, MnO_2	0.01	MnO_2	0.02
Alkalies, Na_2O, K_2O	0.33	Na_2O, K_2O	0.50
Carbon dioxide, CO_2	32.51		
Sulfur, SO_3	0.95		

Analyst, H. S. Emigh

Samples 9d through 9q

Raw, 110° Centigrade		Calcined	
Ignition loss	34.66		
Silica, SiO_2	12.86	SiO_2	19.68
Alumina, Al_2O_3	4.94	Al_2O_3	7.56
Iron, Fe_2O_3	1.91	Fe_2O_3	2.92
Titania, TiO_2	0.25	TiO_2	0.38
Lime, CaO	44.40	CaO	67.94
Magnesia, MgO	0.90	MgO	1.37
Manganese, MnO_2	0.01	MnO_2	0.02
Alkalies, Na_2O, K_2O	0.21	Na_2O, K_2O	0.32
Carbon dioxide, CO_2	32.99		
Sulfur, SO_3	1.05		

Analyst, H. S. Emigh

Samples 9k through 9q

Raw, 110° Centigrade		Calcined	
Ignition loss	35.74		
Silica, SiO_2	11.74	SiO_2	18.27
Alumina, Al_2O_3	4.36	Al_2O_3	6.78
Iron, Fe_2O_3	1.93	Fe_2O_3	3.00
Titania, TiO_2	0.25	TiO_2	0.38
Lime, CaO	45.41	CaO	70.68
Magnesia, MgO	0.81	MgO	1.26
Manganese, MnO_2	0.01	MnO_2	0.02
Alkalies, Na_2O, K_2O	0.22	Na_2O, K_2O	0.34
Carbon dioxide, CO_2	34.03		
Sulfur, SO_3	0.80		

Analyst, H. S. Emigh

The composite analyses show that omission of the five samples which contained less than 70 percent of $CaCO_3$ made a difference of only 1 to 2 percent in the relative quantities of the components. So far as composition is concerned, then, it appears that pit-run material would be about as satisfactory as that obtained by selective methods.

A few samples were collected by the present survey from outcrops smaller than those described, at places between or near the larger showings, in order to have a roughly uniform distribution of localities sampled. Sample A, dug from a small exposure (SW. Cor., Sec.35, T.11S., R.5E.) on the north side of the road on the southern boundary of the county a mile west of U. S. Highway 45, was found by analysis to contain 42.84 percent of CaO, 33.62 of Co_2, and 76.46 of $CaCO_3$ (Analyst, B. F. Mandlebaum). On the gentle slopes of the broad, low divide between Coonewah Creek and Kings Creek are many small chalk outcrops. From two of these, near the head of a small tributary of Coonewah Creek, and on the east side of a local road 1.5 miles west of Highway 45, Samples H, H 2, and H 3 were taken (NE.1/4, Sec.11, T.10S., R.5E.). Samples H and H 2 consist of material from a 5-foot interval, ranging from about 5 feet above the level of the road bridge to 10 feet above; H 3 is material from an interval extending from about bridge level to 5 feet higher.

LIME CONTENT OF SAMPLES OF H SERIES

Sample	CaO	CO_2	$CaCO_3$
H	44.09	34.60	78.69
H 2	42.40	33.31	75.71
H 3	42.31	33.24	75.55

Analyst, H. S. Emigh

Along the same divide about 1.5 miles farther northwest, on the north side of Mississippi Highway 6, 2.5 miles west of Tupelo, are several outcrops of chalk in open, rolling country. Samples N 1 and N 2 were taken from one of these bald spots some 100 yards north of the highway, from contiguous 1-foot intervals, and Samples N 3 and N 4 from 2-foot intervals of a similar small exposure (SE.1/4, Sec.34, T.9S., R.5E.) about 100 yards farther east at approximately the same altitude.

LIME CONTENT OF SAMPLES OF N SERIES

Sample	CaO	CO_2	$CaCO_3$
N 1	44.19	34.68	78.87
N 2	45.83	35.97	81.80
N 3	43.89	34.46	78.35
N 4	43.30	33.99	77.29

Analyst, H. S. Emigh

At Belden, on the Frisco Railroad and U. S. Highway 78, 5.5 to 6.0 miles northwest of Tupelo, at least 40 feet of chalk are exposed on the northeast side of the highway, and an equal thickness on the southwest side, in the southwest wall of the valley of Busfaloba Creek. The location is admirable for an industry which could use the chalk, but analyses of several samples of chalk from here showed considerable difference in the lime content of different intervals, and unfortunately the best material is the lowest interval. As stated in the discussion of agricultural limestone, Mellen recognized at this place a lower 9-foot high-lime interval, and an upper 30-foot sandy lime interval.[15] Samples IV, 8a, 8b, and 8c of the present survey were taken from the Belden outcrop on the southwest side of the highway at a place (NW.1/4, SW.1/4, Sec.9, T.9S., R.5E.) three-tenths of a mile southeast of a bridge and the intersection of the highway with a local public road leading to Belden. Sample IV was dug from the interval extending from highway level to 5 feet above it; Sample 8a from the interval between a lower limit 0.5-foot above the highway and an upper limit 4.0 feet higher; Sample 8b, from the top of the Sample 8a interval to 7.0 feet above the pavement, and Sample 8c through a 2-foot interval superjacent to that of 8b. Thus, Samples IV and 8a were from essentially the same interval, and they, together with 8b, were included by Mellen's high-calcium zone.[15] Sample 8c apparently was above that zone, as indicated by the analyses records:

LIME CONTENT OF SAMPLES OF BELDEN SERIES, SOUTH OF HIGHWAY

Sample	CaO	CO_2	$CaCO_3$
IV (Raw)	45.31	29.68	74.99
(Calcined)	66.20		
8a	41.09	32.26	73.35
8b	40.92	33.49	74.41
8c	37.49	29.43	66.92

Analyst: Sample IV, B. F. Mandlebaum; others H. S. Emigh

COMPLETE CHEMICAL ANALYSES

Sample IV

Raw		Calcined	
Ignition loss	31.58		
Silica, SiO_2	14.03	SiO_2	20.05
Alumina, Al_2O_3	5.64	Al_2O_3	8.26
Iron, Fe_2O_3	1.54	CaO	66.20
Titania, TiO_2	0.47		
Lime, CaO	45.31		
Magnesia MgO	0.13		
Alkalies, K_2O, Na_2O	0.63		
Carbon dioxide, CO_2	29.68		
Sulfur, SO_3	0.46		

Analyst, B. F. Mandlebaum

Sample III, taken from the lower 6-foot interval of an exposure (SW.1/4, SE.1/4, Sec.9, T.9S., R.5E.) on the Clark Adams property a few rods north of Highway 78 about a quarter of a mile east of Belden, showed by analyses:

COMPLETE CHEMICAL ANALYSES

Sample III

Raw		Calcined	
Ignition loss	34.40		
Silica, SiO_2	10.95	SiO_2	16.7
Alumina, Al_2O_3	4.77	Al_2O_3	7.3
Iron, Fe_2O_3	1.52	CaO	71.0
Titania, TiO_2	0.56		
Lime, CaO	46.54		
Magnesia, MgO	0.23		
Alkalies, K_2O, Na_2O	0.88		
Carbon dioxide, CO_2	29.40		
Sulfur, SO_3	0.46		

Analyst, B. F. Mandlebaum

Logan[16] refers to a sample from the G. W. Ritter land, half a mile east of Belden, which sample yielded on analysis, CaO, 44.80; $CaCO_3$, 83.27.

Mellen's sample from the W. E. Stephenson property (NE.1/4, SE.1/4, Sec.9, T.9S., R.5E.) also was taken from an outcrop east of Belden. It was found to contain 80.06 percent $CaCO_3$.[15]

Inasmuch as eastwards is up the dip of the strata, the high-lime interval at Belden probably is the same as that of Sample III and the Ritter and Stephenson samples, as well as of the uppermost few intervals of the No. 9 series. Some of the purer beds farther south may belong to the same zone.

Samples 7 and 8, taken from the bluff face on the northeast side of the highway about 200 yards southeast of the Sample IV site, and 10 to 30 feet higher, contained only 68.00 and 63.04 percent of $CaCO_3$, respectively. (Analyst, B. F. Mandlebaum.) Both their stratigraphic position and their analyses records suggest that they belong with Sample 8c, in the upper, more sandy interval of the bluff.

The data obtained by field and laboratory study, reviewed in the foregoing pages, prove that the Demopolis chalk of southwestern Lee County includes, somewhere near its middle, a relatively thick interval of high-lime rock. Although more or less indefinite, varying of course with the topography as well as with the composition of the chalk, the position of the eastern border of the belt of outcrop of this high-calcium zone ranges in general from 1.5 to 3.5 miles west of the Gulf, Mobile & Ohio Railroad, and from 1 mile to 3 miles west of U. S. Highway 45. All samples were taken from near public roads, but as stated, outcrops are extensive and almost continuous for long distances; faces of 25 to 30 feet could be opened in many places above ground-water level. Considerable areas have no overburden, and where overburden is present it is uniformly thin, a thickness of 15 feet being a near maximum. Specific figures on workable thicknesses of chalk may provide a clearer picture of conditions: The bluff of Tubbalubba Creek Valley at the place where the Sample 3 series was taken reaches to 40 feet above the valley flat, and chalk is exposed through 20 to 25 feet. The Chiwapa Creek bluff at the site of the Sample 4 series reaches a maximum height above the flat of 60 feet in a distance of half a mile. The southwest wall of Coonewah Creek Valley at the place where the sample 5 series was collected has an altitude of 40 feet above the base of the exposure and probably 55 to 60 feet above the creek flat. The bluff of the same valley at the E series location is 20 to 25 feet in height, and chalk is exposed from bottom to top except for the uppermost 3 feet or so. The bluff of Busfaloba Creek Valley at the site of, the No. 9 series is 45 to 55 feet high, of which some 35 feet are bare chalk.

These almost inexhaustible quantities of high-lime chalk are in general easy of access. Six or seven graveled roads extend westward from U. S. Highway 45 and the Gulf, Mobile & Ohio Railroad to and beyond the lime cliffs—roads which are in fair condition and which could easily be conditioned for heavy traffic. As already stated, the nearest railroad stations are Shannon, Verona, Tupelo, and Belden.

The chalk varies in degree of consolidation. In the mass, unweathered, it is tough and resistant when moist, brittle when dry, and probably could be quarried without too much difficulty by the use of small charges of explosive. It should crush easily, too, although perhaps the softer rock might require a special type of crusher. All the chalk contains clay and sand in varying percentages, and the overlying residuum of sand, clay, and silt could be drawn on as a source of the additional aluminous and siliceous material required. If this should be insufficient, or unsatisfactory, the necessary components to mix with the lime can be obtained from the clay phases of the Coffee sand member of the Selma, or from the Porters Creek clay which crops out in the counties bordering Lee on the west.

By way of summary, it can be said that the quantity of chalk of the proper grade available should be adequate for the operation of a large plant for an indefinite period, and that other conditions, physical and economic, are reasonably favorable: overburden absent or thin, unconsolidated, and hence easily removable; good graveled roads at hand; topography of low relief, favoring use of vehicles and construction of roads or spur railroad; drainage adequate and water supply sufficient; railroad and pavement highway only 3 to 4 miles distant; Tupelo, one of the leading shipping centers of the state, only 12 miles away; electric power transmission lines near the region of highest-grade material. Fuel requirements could be met by Alabama coal which is mined not farther than 50 miles east of Tupelo. If the proposed Tennessee-Tombigbee waterway should be opened, it, too, might be of some value as a commercial route, and the building of dams and locks would require large quantities of cement. Also, the extension of the highway systems of Mississippi and bordering states would necessitate the use of enormous quantities of Portland cement.

Use of Selma chalk for the manufacture of Portland cement has been considered at different times, and numbers of samples taken for analysis from places widely distributed over the belt of outcrop, but nowhere except at Demopolis, Alabama, has this chalk actually been used for cement manufacture. Two analyses of the chalk used at Demopolis showed:[12]

	1	2
Silica (SiO_2)	12.50	9.88
Alumina (Al_2O_3) and Iron oxide (Fe_2O_3)	2.76	6.20
Lime carbonate ($CaCO_3$)	80.71	77.12
Magnesium oxide (MgO)	1.05	1.08
Sulphur trioxide (SO_3)	1.62	n. d.
Water	1.36	5.72

NATURAL CEMENT

The Lee County chalk should be well adapted to use in the manufacture of natural cements, which do not require so high a percentage of lime, and allow of more latitude in the lime-silica-alumina-iron ratio. Natural cements are made by calcining limestones which contain from 15 to 40 percent of clayey material, and may vary widely in their content of other compounds. They are closely related to hydraulic lime, but differ from it in that, containing no free lime, they will not slake unless ground very fine.[11] The burning reaches a temperature between 1800° and 2000° F., a little higher than that used for burning lime, which is a temperature just high enough to bring about decarbonation.[11] Natural cement, then, is a mixture of calcium silicates, aluminates, and ferrites. It is lighter of weight than Portland cement, is burned at a lower temperature, and may vary much more widely in composition. The ground material, when mixed with water, sets or hardens rapidly. Although natural cement was the first hydraulic cement made in the United States and was for many years the leading cement produced, at present it comprises a very small percentage of the total output.[18] However, natural cements are very good for certain types of construction, and are much less expensive than Portland cement.[11]

As indicated by the analyses records, a large part of the Lee County chalk would be suitable for the manufacture of natural cement, insofar as its chemical composition is concerned.

Sample I, Mooreville chalk, was taken from the type locality (NE.1/4, SW.1/4, Sec.29, T.9S., R.7E.) of the Mooreville tongue of the Selma formation, three quarters of a mile west of Mooreville, through a 10-foot interval 30 to 40 feet below the Coffee sand, from the bottom and walls of a ravine on the north side of U. S. Highway 78.

Sample II, Mooreville chalk, was taken from the same locality as Sample I, from a 2-foot interval of the bottom of the ravine, 5 feet below the Sample I interval.

Sample V, Demopolis chalk, was from the lowest 5-foot interval of an exposure (NE.1/4, NW.1/4, Sec.10, T.8S., R.5E.) in the east-facing bluff of Little Dry Creek Valley, on the south side of the road, a short distance east of a road intersection, about 5 miles northwest of Saltillo.

Sample VI, Demopolis chalk, was taken through a 6-foot interval from the wall of the Reed and Fields lime pit (NE.1/4, SE.1/4, Sec.6, T.10S., R.5E.) (Figure 8) in the west wall of Coonewah Creek Valley, on the north side of Highway 6, about 6 miles west of Tupelo.

ANALYSES OF SAMPLES I, II, V, AND VI

Raw

	I	II	V	VI
Ignition loss	16.50	18.63	31.06	33.44
Silica (SiO_2)	47.71	43.58	17.62	14.21
Alumina (Al_2O_3)	11.28	9.85	8.25	6.84
Iron (Fe_2O_3)	3.00	2.60	2.16	2.24
Titania (TiO_2)	0.98	0.73	0.18	0.64
Lime (CaO)	17.73	23.68	39.68	40.81

Magnesia (MgO)	0.59	0.32	0.11	0.32
Alkalies (K_2O, Na_2O)	0.48	0.41	0.69	0.78
Sulfur (SO_3)	0.10	0.58	0.56	0.48
Carbon dioxide (CO_2)	10.52	14.33	26.16	28.15
Calcined				
Silica (SiO_2)	57.2	54.8	25.6	21.2
Alumina (Al_2O_3)	13.5	12.1	12.0	10.25
Lime (CaO)	21.2	28.7	57.6	61.4

Analyst, B. F. Mandlebaum

Sample B, Demopolis chalk, was taken from an outcrop (SE.1/4, Sec.22, T.11S., R.5E.) at the road on the north side, about 2.5 miles southwest of Shannon, and a short distance southeast of a schoolhouse.

Sample C, Demopolis chalk, was from the bottom of a gully (SW.1/4, Sec.9, T.11S., R.5E.) some 20 yards south of the road, and a quarter of a mile east of a road intersection triangle.

Sample D, Demopolis chalk, was dug from a gully (Eastern part, Sec.16, T.11S., R.5E.) at the base of a low terrace on the west side of the road a little south of a bridge.

Samples G and G 1, Demopolis chalk, were taken from an exposure (NW.1/4, Sec.24, T.10S., R.5E.) a mile west of Verona, and a few yards east of the road some 60 yards south of an intersection; G 1 was dug from an interval extending from road level to 3.5 feet above it.

Sample I, Demopolis chalk, was from a road cut (NE.1/4, SW. 1/4, Sec.29, T.8S., R.5E.) in the southwest wall of Busfaloba Creek Valley, about half a mile southwest of a community at a road triangle.

Sample J, Demopolis chalk, was taken from the west wall of the valley of Flat Creek on the south side of the road (SW.1/4, Sec.1, T.8 S., R.5E.), about 3 miles northwest of Saltillo.

Sample K, Demopolis chalk, was taken from a roadside outcrop (SW. Cor., Sec.22, T.7S., R.5E.) in the west wall of the valley of Shell Creek about a mile and a quarter south of Corrona and less than a quarter of a mile east of a road intersection.

Sample L, Demopolis chalk, was dug from the bottom of a gully (SE.1/4, NW.1/4, Sec.15, T.7S., R.5E.) on the west side of the road, a quarter of a mile or less north of Corrona.

Sample M, Demopolis chalk, was taken from a large mass which had fallen from the vertical wall (Figure 10) of the channel of Dry

Creek at the Bethany road bridge (NE.1/4, Sec.11, T.7S., R.5E.), almost on the Union County line a mile or a little more southwest of Bethany.

LIME CONTENT OF SAMPLES B, C, D, G, G 1, I, J, K, L, M

Sample	CaO	CO_2	$CaCO_3$
B	41.16	32.32	73.48
C	37.26	29.24	66.50
D	39.57	31.05	70.62
G	37.05	29.08	66.13
G 1	35.63	27.97	63.60
I	33.23	26.08	59.31
J	40.79	32.02	72.81
K	36.22	28.40	64.62
L	34.94	27.42	62.36
M	32.60	25.61	58.21

Analysts: Sample C, B. F. Mandlebaum; all others, H. S. Emigh.

Analyses of two samples of Demopolis chalk, as published by Crider, [12] are given below:

ANALYSIS OF SELMA LIMESTONE 2.5 MILES SOUTH OF TUPELO

Silica (SiO_2)	22.76
Alumina (Al_2O_3)	4.56
Iron oxide (Fe_2O_3)	6.46
Lime (CaO)	34.31
Magnesia (MgO)	0.05
Carbon dioxide (CO_2)	28.25
Sulphur trioxide (SO_3)	0.43
Moisture	2.10

ANALYSIS OF SELMA LIMESTONE 1 MILE WEST OF TUPELO

Silica (SiO_2)	14.84
Alumina (Al_2O_3)	15.59
Iron oxide (Fe_2O_3)	4.50
Lime (CaO)	32.89
Magnesia (MgO)	0.41
Carbon dioxide (CO_2)	27.10
Sulphur trioxide (SO_3)	3.30
Moisture	1.08

The sample from south of Tupelo was stated to have been from the roadside. Possibly the location was along old Highway 45. The sample from west of Tupelo was taken "on the Tupelo and Pontotoc road."

Some samples of which analyses were given in the discussion of agricultural limestone, wool rock, and Portland cement, contained too much lime for wool rock and too little for agricultural limestone or Portland cement, but should be satisfactory raw material for the manufacture of natural cement. Such were the Baldwyn sample referred to by Logan; and Samples 11 and 12 of the wool rock series. Also, of the Portland cement materials, Samples 4e, 5d, E 3, 9b, 9c, 9h, 9i, and 9j, and Samples 7, 8, and 8c.

CERAMIC CLAYS

Some clay is present in each of the formations of Lee County, but almost, if not quite, everywhere, it is intimately associated with sand, silt, and other impurities, especially iron compounds.

The unweathered Selma Chalk is clayey, sandy, and silty, but contains no clay bodies sufficiently pure for ceramic uses. The lime content is too great, even if the effect of other non-clayey substances could be overcome. However, deep weathering of the chalk has left a dominantly clayey residuum over the entire Selma outcrop area, except where it has been removed by erosion. Most of the lime has been leached from it. Impure clay, of a thickness ranging from almost nothing up to 20 feet, averaging less than 10 feet, overlies the chalk almost everywhere. It has a considerable range of colors, chiefly due to the different degrees of oxidation of the iron, but whitish, bluish, and shades of gray, brown, and yellow predominate. Mottling of gray and brown is common, indeed almost the rule towards the bottom of the residual mantle. This Selma-derived clay may contain small aggregates or lumps and disseminated coatings of lime, also iron sulphide concretions, aggregates of limonite, a very little manganiferous material, "gravel" of limonite-cemented or manganese-cemented sand, a little crystallized gypsum, and other resistant substances, all which lessen any value it might have for ceramic purposes. In some places washing of the clay has left so many of these small bodies on the surface that they form an almost solid layer.

In the Mooreville tongue area and south of it, the residual clay commonly has a greenish-gray cast not unlike that of bentonite, and contains crumbs and coatings of lime, crystals of gypsum, and ferruginous "gravel." Where the Coffee sand is absent, the overburden is slight, and large quantities of the clay could be dug from any one of a number of exposures. One of the most favorable areas for working this clay is the strip of territory which borders U. S. Highway 78 on the north, west of Mooreville and east of Tulip Creek, especially Secs.25 and 26, T.9S., R.6E. Specifically, near the center of Section 25, in a pasture west and southwest of a local road junction, very plastic gray and greenish-gray clay several feet thick, containing abundant lime concretions and disseminated lime, is well exposed by gullies in a low slope.

In the western part of the county the residuum is thickest on the broad flat to low rolling divides between the major stream valleys, where it is near U. S. Highway 78, State Highway 6, and several good local roads, as well as the Frisco Railroad. The wide extent and uniform character of the clay, and the rolling topography, provide many places favorable for development: light overburden, easy transportation, normally low water-table, and so on.

The residual clay of the chalk areas may be suitable here and there for the manufacture of low-grade or medium-grade brick, but not for stoneware. The relatively high lime content of much of it, and the iron sulphide disseminated through it, tend to make it unfit for ceramic purposes.

The clay of the unweathered Coffee member of the Selma is in the form of laminae or thin beds or thicker beds or irregular bodies, inter-laminated or interbedded with sand, and the clay itself is invariably sandy and silty. In few if any places could a large quantity of clay even relatively free from sand be dug out. The fresh clay is, as a rule, slate-gray to bluish-gray to black, and so compact in places as to approach a clay shale. It contains a considerable quantity of carbonaceous matter, and at many exposures many iron sulphide nodules or concretions and rusty masses. The weathered phases of the Coffee clay are grayish to blackish sandy masses, very sticky when wet.

A prominent clay horizon of the Coffee in Lee County is immediately above the Mooreville tongue of the Selma chalk, and scattered outcrops show considerable clay at higher levels. The basal clayey zone is well exposed near the type locality of the Mooreville, on both sides of U. S. Highway 78 some three-quarters of a mile west of Mooreville (Sec.29, T.9S., R.7E.); also near the base of the west wall of West Tulip Creek Valley on the Highway 78-Auburn School road almost on the western boundary of Sec.26, T.9S., R.6E.; and at a few other places. Of the localities where higher clay beds of the Coffee show, one of the best is along the Eggville road (Secs. 6 and 7, T.9S., R.7E).

Possibly the clay of the Coffee member would be suitable for the making of common brick or tile, provided it could be separated from the sand beds, although the other impurities would be a serious hindrance. The Highway 78 location would have the advantage of access to both Coffee and Mooreville clays, as well as to the highway itself. The overburden, too, is almost nothing in a large area of Mooreville here, and is not excessive in a sizeable area of the Coffee.

Sample C 5 was dug from the south wall of the Highway 78 cut (Eastern part, SW.1/4, Sec.29, T.9S., R.7E.) about three-quarters of a mile west of Mooreville, through a 3-foot interval of the basal clay of the Coffee sand member, extending from 5 feet above the highway to 8 feet above it. The clay is gray to black, contains considerable silt and sand and carbonaceous matter, and breaks out of the deposit in lumps, many of which are rounded and show conchoidal fracture. Like the Porters Creek clay, which it resembles, it has some of the characteristics of bentonite, and probably is bentonitic. Laboratory tests showed that this Coffee clay takes up so much water when ground fine that it can not be molded satisfactorily except by being ground coarse and handled quickly, that is, by methods which result in a rough product. It can be used for making poor or medium quality brick by the plastic or stiff-mud process, or dry press brick (8 percent to 10 percent moisture), but is one of the least desirable clays so far tested for brick making. Its weight is a crucial factor: not small enough for light-weight brick, nor great enough for dense brick.

The Coffee clay probably would be suitable for mixing with lime in the manufacture of cement, or it might be used for light-weight aggregate.

No doubt bodies of transported clay of greater or less purity exist in the alluvium under the flood plains; in fact, deeply cut channels have exposed some of them, and wells have penetrated clay beds. In general, development of such deposits would be impracticable, even if the properties of the clay were such as to make the material satisfactory for ceramics, because of the low altitude, which would create water problems; but the Tupelo Brick and Tile Company uses such a clay bed.

The extensive terraces are composed of sand, silt, and clay, and here and there include sizeable bodies of clay of various degrees of purity. The brick plant which was in operation at Nettleton many years ago used clay from the terrace on which the town stands. As described by Logan,[19] the materials belonged to a surface deposit consisting at the bottom of a fat, jointed clay containing sandy streaks; above, a sandy layer, and at the top a yellowish loam. The total thickness of the deposit was about 20 feet, but the plant pits did not reach that depth. No particulars were given concerning the chemical composition of the clay and its behavior when fired.

At one time or another, brick plants were in operation at Verona and Saltillo, but no brick are being made at either of these places at present. At Verona a lower plastic clay was mixed with an upper red sandy clay; the materials are either terrace or Selma chalk residuum. According to Logan,[19] the Saltillo plant manufactured red brick from a mixture of clay from a lower bed immediately overlying the chalk, and an upper sandy red clay lying on a sandstone. The lower clay was too plastic, or too "tight" to be used alone. The brick from the Saltillo plant were used locally, and can be seen today in the walls of the older buildings of the town.

The Tupelo Brick and Tile Company plant is in the southwest part of Tupelo (SW.1/4, Sec.31, T.9S., R.6E.), within a few rods of the corporate limits, between U. S. Highway 45 and the Frisco Railroad. The plant consists of a main building, fourteen drying sheds, three beehive kilns, and an office building. Each drying shed is about 175 feet long, 20 feet wide, and 10 feet high; each kiln is some 30 feet in diameter and 15 feet high inside, and is fired from ten grates.

The clay used underlies the flood plain of Kings Creek; in fact, the creek has cut through it, exposing a thickness of 10 to 15 feet in the walls of the channel. The present pit, extending southeast from the plant almost to Kings Creek, is about 100 yards long, but only about 35 feet wide. The east wall of the pit shows a face of 8 feet average height, of which the lower 5.5 feet consist of dark-gray sandy and silty clay somewhat mottled and streaked with iron rust, and the upper 2.5 feet of a lighter gray to dark tan and more sandy clay which dries a light tan to light yellow (Figure 19). The subsoil and most of the soil are included in the material used; only a little of the top soil is skimmed off and rejected. The pit does not reach the bottom of the clay bed: as stated, Kings Creek channel exposes a greater thickness, and borings in the floodplain have found a still greater thickness and defined an areal extent of 100 acres at least.

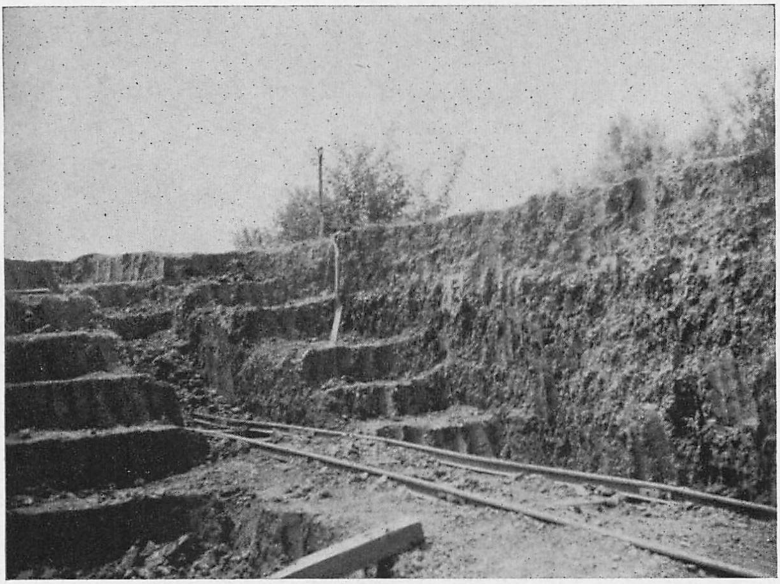


Figure 19.—South end of the Tupelo Brick and Tile Company clay pit, Tupelo. August 12, 1945.

The plant can turn out about 40,000 bricks in an 8-hour day. Each kiln has a capacity of around 120,000 brick. Gas is the fuel used. At present sixteen men are employed. Only one grade of brick is made, and no tile have been made for several years. The finished brick commonly are brick-red, but may be darker red or purplish or mottled, and are notably heavy. Many are coated with a white substance, probably lime, and a considerable proportion is spotted with black, probably from iron sulphide.

SAND[17]

On the basis of industrial uses, sand includes several classes, of which the chief are: (1) Structural sand, (2) Molding sand, and (3) Glass sand. Structural sand is used in all forms of concrete, mortars, and plasters; molding sand is used for molds in the steel and other metal industries; glass sand is used in the manufacture of glass.

Structural sand comprises two groups: Building sands, used in engineering and architectural structures, mortar, and plaster; and paving sands, used in all forms of road and pavement construction. Each kind of structural sand has different requirements as to maximum grain size, quantity of fines grading from coarse to fine, and allowable impurities, but certain general characteristics are common to all grades. The sand must be clean and reasonably free from clay-coated grains, lumps of clay, flat or elongated grains, vegetable or other organic matter, and iron sulphide; also it should have a minimum of disseminated clay, silt, or loam. The upper limit of size of the coarser sands is 1/4-inch to 3/8-inch. In grading size, material retained on a 100-mesh screen is called sand; that which passes the 100-mesh is known as silt, clay, or loam. Material removed by sedimentation or elutriation (silt) commonly is specified not to exceed 3 percent for all grades. The sand should grade uniformly from coarse to fine, and not contain an undue proportion of any one size. The shape of the grains may be either round or angular.

Molding sand consists of two classes: one, sand which contains a natural bond, and the other, sand which does not contain a natural bond. By sand with natural bond, is meant sand which, when removed from the bank, contains enough clay, loam, or other foreign material to bond it sufficiently when it is tamped into place around the pattern. Sand of the second class must have some bond, such as a refractory clay or an organic binder, mixed with it. The first class sometimes is called "foundry sand," "iron molding sand," or just "molding sand"; the second class may be referred to as "silica sand" or "steel molding sand." These names are applied because the sand which contains natural bond is used primarily for molding cast iron and the non-ferrous metals or alloys, such as brass, whereas the silica sand is high in silica and for that reason is used in steel molding, where high refractoriness is necessary.

The value of a sand for foundry purposes depends on (1) bond, or cohesiveness; (2) permeability; (3) grain size; (4) refractoriness; and (5) durability. (1) A well-bonded sand is soft and smooth and can be compressed in the hand; each quartz grain should be covered with a thin film of the bonding material, which commonly is clay, but may contain other mineral substances, especially hydrated oxide of iron (iron rust). (2) Permeability, the property of permitting the flow of gases through the mold, depends on the grading of the sand from coarse to fine, the average grain size, the amount of the bonding material, and in large measure the shape of the grains. Obviously a coarse sand is more permeable than a fine sand, and angular-grained sand is more permeable than rounded-grained. "In general, a sand of good permeability is not uniformly graded from coarse to fine, but comprises grains of fairly uniform size that represents the texture or average and enough fines or clay to make the bond; such a sand lacks intermediate sizes between these." (3) Grain size affects the permeability and determines the use of the sand. Very coarse material is used for the heaviest work, and fine-grained sands for light work and for smooth castings, as in stove plate. (4) The refractoriness of a molding sand is governed to a great extent by its chemical and mineralogical composition: in general, sands high in silica are most refractory, and those which contain a high percentage of alkalies are least refractory. Steel-molding sands commonly contain more than 96 percent of silica before the addition of artificial bond; most naturally-bonded sands contain 75 to 90 percent total silica, but some run as low as 57 percent. (5) The durability of a sand is determined by the number of times the sand can be used. It depends chiefly on the bond. Inadequate durability is due to loss of bond by dehydration or breaking down by high temperature.

The specifications for a glass sand are controlled by the kind of glass for which it is intended. Sand intended for use in the manufacture of optical glass, flint glass for fine table ware, and plate glass which is to be ground and polished, must be high-grade, consisting of 98 to 99 plus percent pure silica; but sand intended to be used in the manufacture of lower grades of glass, such as third quality flint glass, fifth quality sheet glass and window glass, seventh quality green glass, and ninth quality amber, need not contain so high a percentage of silica. Sand to be used for green glass and for different grades of amber glass may contain much more iron oxide and slightly less silica than material for the higher grades of glass requires. However, no sand can properly be classed as a glass sand unless it contains at least 95 percent of silica. Only a small percentage of iron oxide is allowable; for example, the upper limit for window glass is about 0.35 percent. All glass sand must be screened to remove oversize particles, and should pass a No. 20 sieve. In general, much fine material (material which will pass a 100-mesh sieve) is objectionable. The shape of the grains is not important.

Other classes are: Engine sand, abrasive sand, filter sand, fire or furnace sand, and several of minor rank. The specifications for each class differ in some particulars from those for any other class, but are the same in requiring freedom from rubbish, organic matter, clay lumps, oversize particles, and other impurities. In general the specifications are not very rigid, and the differences may center about the tenacity of the sand, its chemical purity, and the percentage of fines allowable.

The Coffee sand member of the Selma formation and the small part of the Tombigbee member of the Eutaw comprise by far the greater part of the sand of Lee County. The Coffee is, directly and indirectly, the great source of sand in the county. The alluvium of the flood plains, and also the stream terraces, include sizeable bodies of relatively pure sand, re-worked from the older formations.

The results of analyses by T. E. McCutcheon, Ceramic Engineer, Mississippi State Geological Survey Ceramics Laboratory, of four samples of the Coffee sand, are given below. Naturally, the samples were taken from locations which are easily accessible and favorable with relation to the highways and railroads, and to Tupelo, but they may be considered typical of the Coffee sand as a body.

Samples C 1 and C 2 were taken from the type locality of the Tupelo tongue, in East Tupelo, the north wall of a cut for the old Fulton road, at the top of the first hill (SE.1/4, NW.1/4, Sec.33, T.9S., R.6E.) (Figure 12). Sample C 1 is gray sand, from an interval ranging from road-level to about 3 feet above.

SCREEN ANALYSIS, SAND C 1

Gross weight, dry sample at 110° C., 100 grams
Caught on Screen 28, 1.0 gram of iron siltstone and glauconite
Through Screen 28, caught on Screen 60, 3.0 grams of iron siltstone, quartz sand, mica, and glauconite
Through Screen 60, caught on Screen 100, 8.4 grams of iron siltstone, quartz sand, mica, and glauconite
Through Screen 100, caught on Screen 150, 44.1 grams of quartz sand, mica, and glauconite
Through Screen 150, caught on Screen 200, 24.8 grams of quartz sand, mica, and glauconite
Through Screen 200, by difference, 18.7 grams of clay and silt.

Sample C 2 was taken from the 5-foot interval superjacent to C 1, that is, from 3 feet above road-level to 8 feet above it.

The sample is yellow and brown sand.

SCREEN ANALYSIS, SAND C 2

Gross weight, dry sample at 110° C., 100 grams
Caught on Screen 28, 0.0 grams
Through Screen 28, caught on Screen 60, 1.6 grams of quartz sand, mica, and glauconite

Through Screen 60, caught on Screen 100, 21.0 grams of quartz sand, mica, and glauconite

Through Screen 100, caught on Screen 150, 42.9 grams of quartz sand, a little mica, and glauconite

Through Screen 150, caught on Screen 200, 12.5 grams of quartz sand, a little mica, and glauconite

Through Screen 200, by difference, 12.0 grams of silt and clay and glauconite.

Sample C 3 was taken from the west wall of a cut (Figure 14) for U. S. Highway 45 about 1.5 miles by highway north from the limits of Tupelo. The interval ranges from 13.0 feet above the flat of Old Town Creek to 17.5 feet above it, near the base of the exposure. The sample is gray sand.

Screen Analysis, Sand C 3

Gross weight, dry sample at 110° C., 100 grams

Caught on Screen 28, 1.3 grams of siltstone and glauconite

Through Screen 28, caught on Screen 60, 10.0 grams of quartz, siltstone, mica, and glauconite

Through Screen 60, caught on Screen 100, 22.9 grams of quartz, siltstone, mica, and glauconite

Through Screen 100, caught on Screen 150, 27.6 grams of quartz, siltstone, mica, and glauconite

Through Screen 150, caught on Screen 200, 14.5 grams of quartz, siltstone, mica, and glauconite

Through Screen 200, by difference, 13.7 grams of quartz, siltstone, mica, clay, and glauconite.

Sample C 4 was taken from a small sand pit in the west wall of a shallow cut for U. S. Highway 45 (center of northern part, Sec.19, T.9S., R.6E.), about 1.2 miles north of the northern boundary of Tupelo. It was dug from a 2-foot interval at the base of the exposure, 45 feet above the flat of Old Town Creek, and about 10 feet below the Coffee-Demopolis contact. Shells from the basal shell bed of the Demopolis are scattered through the sand and soil near the top of the pit wall. Sample C 4 is dull-white to light-yellow sand.

Screen Analysis, Sand C 4

Gross weight, dry sample at 110° C., 100 grams

Caught on Screen 28, 0.0 grams

Through Screen 28, caught on Screen 60, 31.0 grams of quartz sand and glauconite

Through Screen 60, caught on Screen 100, 56.6 grams of quartz sand and glauconite

Through Screen 100, caught on Screen 150, 4.0 grams of quartz sand and glauconite

Through Screen 150, caught on Screen 200, 0.7 gram of quartz sand and glauconite

Through Screen 200, by difference, 7.7 grams of clay and silt and glauconite.

PROXIMATE ANALYSIS, SAND C 4

Ignition loss	0.72
Silica (SiO_2)	94.77
Alumina (Al_2O_3)	3.17
Iron oxide (Fe_2O_3)	0.80
Titania (TiO_2)	0.25
Lime (CaO)	0.13
Magnesia (MgO)	0.36
Manganese (MnO_2)	0.02
Alkalies (Na_2O, K_2O)	0.38
Sulphur as SO_3	None

Analyst, H. S. Emigh

The analyses show that Sands C 1, C 2, and C 3 contain too much clay and silt and mica to be suitable for use in concrete, or in mortar and plaster, unless after processing which probably would be economically impracticable. Sand C 4, after the clay and other impurities have been washed out, would be a valuable addition to coarse sand in concrete mixtures, by supplying the fine sand which the ordinary run of concrete sand commonly lacks. The proportions might be something like 2 parts of the coarser sand to 1 part of the finer (Coffee). Also, sand such as that of Sample C 4, washed and mixed with coarser sand, possibly in a 2 to 1 ratio, should be a suitable component of mortar and plaster, for the same reason. The clay content is too high to permit use of the material in construction which must be in compliance with somewhat rigid specifications, as that of state highways.

In its natural state, the Coffee sand, as represented by the samples, is not suitable for molding sand, and probably at present no economic advantage would be derived from treating it in order to use it for molding. Impurities, such as silt, mica, pyrite, and lime, form too large a percentage of the whole, and treating would be more expensive than would be warranted.

The question, whether or not a particular sand has the properties necessary to make it suitable for a certain use, must be determined by tests. In several industries which use sand, specifications are commonly not very rigid, but are adjusted to fit supplies of sand available in the locality concerned.[17] This is particularly true of structural sand. Possibly, too, certain local sands could by processing be made to serve purposes which require material having special properties, but in few cases would such processing be economically feasible. Some Lee County sand has been and is being used for structural purposes—building and paving. At Saltillo local sand has been used in making mortar and concrete, and at Tupelo also as a component of building materials.[18] Obviously it is satisfactory for such uses, or at least can be made to serve.

Logan reported about 35 years ago that building sand for local use was obtained in Tupelo west of the lake and southwest of the fertilizer factory, from pockets of white and yellow sands near the top of a range of low hills.[18] Probably these sands are terrace, or wash from the higher Coffee sand hills to the west. Logan gives the record of granularmetric analyses of two samples from this place: Sample No. 1, from the low range of hills, and No. 2 from the sand washed down from the hills into a small creek valley:[18]

GRANULARMETRIC ANALYSIS OF TUPELO SAND

	Sample 1		Sample 2	
Sand	Retained, percent	Passed, percent	Retained, percent	Passed, percent
16-mesh	00.1	99.9	00.1	99.9
20-mesh	00.2	99.7	00.3	99.6
40-mesh	6.6	93.1	34.9	64.7
60-mesh	68.2	24.9	50.7	14.0
80-mesh	20.6	4.3	11.8	2.2
100-mesh	00.1	4.2	00.1	2.1

The following additional data were given: Percentage of voids, 41; weight per cubic foot, 91 pounds; specific gravity, 1.46. The result of a test of tensile strength of a mixture of 1 to 3 with standard cement was: No. 1 briquette, 256; No. 2 briquette, 201; No. 3 briquette, 201; No. 3 briquette, 265; average, 240.[18]

Some 35 to 40 years ago, sand of the same general character as much of that of Lee County was used at Aberdeen, Monroe County, in the manufacture of sand-lime brick, but the lime was imported, not derived from the Selma chalk.[19]

Sand is very abundant in the county, but no considerable commercial development can be hoped for unless a large deposit of very high-grade sand usable for some special purpose, should be discovered. Although close observation has been made in connection with the general geological and mineral resources survey, no such body of sand has been located, and in view of the character of the rock formations, and their mode of genesis, probably does not exist. No clean silica sand has been found, and none of the sand yet seen is sufficiently pure for use in the manufacture of fine glass; however, possibly some of it could be used for making green or amber glass of low grade.[17] The proximate analysis of Sand C 4 indicates a content of almost 95 percent of silica, which is sufficiently high, but the alumina (3.17) is almost as high as the limit allowable, and the iron oxide (0.80) is beyond the limit.

A limited, more or less local utilization of the sand of the county is, then, the best that can be reasonably anticipated.

BENTONITE

The only bentonite found in Lee County is at a place 2 to 3 miles west of Itawamba County and 4.5 to 5.0 miles east of Saltillo. Here (SE.1/4, Sec.18, T.8S., R.7E.) a 0.5-foot bed of bentonite, consisting of blocks and angular pebbles, shows in a roadside ditch on an eastward-facing slope some 10 feet above the flood plain of Patch Creek.[7] A mile or so farther east on the Saltillo-Mantachie road, bentonite crops out in the walls of the road cut in the south wall of Puncheon Creek valley (eastern part, Sec.17, T.8S., R.7E.); the bed consists of 8 inches of blue bentonite below, and 4 inches of cream-colored bentonite above. A few holes in the area found the clay on four farms. South of the road outcrop about three-quarters of a mile is another small exposure in an old road cut near a creek. Yet another outcrop appears in a road bank about a mile from the Section 17 showing mentioned above, north of it, and east across the valley of Puncheon Creek (NE.1/4, Sec.16, T.8S., R.7E.). On the Dave C. Cates farm near by are several outcrops, and large masses showing conchoidal fracture; however, a number of holes drilled on the 200-acre farm proved the clay too thin to be of commercial importance, although the maximum overburden is less than 16 feet and the bed has a considerable area. Prospecting in the Sections 16 and 17 area likewise showed the bentonite bed there to be too thin and sandy for commercial development.[20]

According to Stephenson and Monroe, the Patch Creek bentonite appears to be at approximately the same stratigraphic position as the bentonite east of Booneville, Prentiss County, and both may be a few feet above the Arcola limestone.[7] It has been suggested, too, that the

Lee County bentonite can be correlated with the John Duncan deposits in Prentiss County.[20]

The Coffee sand region of Lee County has been thoroughly explored by the writers of this report and by prospectors for private interests. However, so commonly is bentonite concealed by plant debris, or buried by landslides, soil creep, or slope wash, or disguised by weathering, that the search so far made may have failed to find all that is present, and further prospecting may bring to light an additional deposit or two. Nevertheless, the discovery of any large body of bentonite in Lee County is improbable.

MISCELLANEOUS MINERALS

Small quantities of a few common mineral substances are scattered through the Lee County formations, but none is of industrial importance, and they are mentioned here only because of the interest taken in them by certain people, many of whom have erroneous ideas concerning the value of these widely and sparsely disseminated minerals.

Iron pyrites is present generally in the form of small nodules or concretions of a great variety of shapes, which are relatively abundant at some horizons, as noted in the discussion of stratigraphy. Iron pyrites is a compound of iron and sulphur, and may be a silvery white heavy metallic mineral known as marcasite, or a yellow metallic mineral named pyrite; also the names "white iron pyrites," and "yellow iron pyrites" are used. The iron sulphide of the sand and chalk in Lee County is almost entirely marcasite. These iron minerals do not have much value, even in large quantities, but the basis of their claim to attention is revealed in the designations "fool's silver" and "fool's gold," applied to them because of the many instances of uninformed people mistaking them for silver and gold.

Oxidation of the iron of the iron pyrites results in the formation of limonite, or "iron rust," which is a hydrated oxide of iron—that is, a compound of iron and oxygen containing water. In a few places the residuum from the weathering of the chalk contains numbers of lumps of limonite: for example, near the top of the west wall of Old Town Creek valley southeast of Tupelo and northwest of the Verona-Plantersville road; and southwest of Guntown (Sec.28, T.7S., R.6E.). These limonite masses may have been formed by deposition of iron rust from surface or subsurface water.

Another iron mineral, which is present as scattered lumps, commonly small and flattish, or nodules or concretions of irregular shape, is siderite, a carbonate of iron ($FeCO_3$). These nodules, which are likely to be more numerous where organic material is present—that is, in lignitic sands and clays—commonly are of rusty appearance because of the oxidation of the iron at and near the surface, but the surfaces made by a fresh fracture show the original material to be dark-gray to light-gray to almost white. The iron content of pure siderite is 48.2 percent, which is sufficient for good ore, but the siderite of Lee County, in addition to being impure, is too small in quantity to be of importance.

As has been stated in the discussion of stratigraphy, lime phosphate nodules and molds of fossils are abundant in certain places, and in three distinct zones. The lime phosphate is of no importance commercially.

Calcite ($CaCO_3$) and gypsum ($CaSO_4.2H_2O$) are disseminated in insignificant quantities through the sand, clay, and chalk, as interstitial crystals, or in veins, or as small bodies. The gypsum is commonly in the form of selenite.

In a few places very small quantities of manganese mixed with iron rust give a black color to the sands or clays. Commonly the manganese acts as a cement, forming a resistant layer which may project from the general level of the outcrop. It may be in the form of pyrolusite (MnO_2) or wad (a mixture of oxides).

Fragments of lignitized wood are numerous in some places in the Coffee sand and clay. Also many large and small masses of silicified wood have been found in the Eutaw formation and the Coffee member of the Selma. None of these substances is of commercial importance.

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LABORATORY PROCEDURE

(Herbert Safford Emigh, M.S.)

Grinding: Samples were ground to pass a 100-mesh screen.

Ignition loss: 0.5000-gram samples were heated in a platinum crucible at full heat of a blast burner for one hour.

Silica: Ignited samples were fused with 3 to 5 times their weight of pure anhydrous sodium carbonate and the fused mass dissolved in dilute hydrochloric acid in which they were double dehydrated. The silica was filtered onto an ashless filter paper, washed, ignited, weighed, volatilized with hydrofluoric acid and reweighed. The loss in weight represents the pure SiO_2 in the sample.

Alumina: Alumina, iron, and titania were precipitated together by ammonium hydroxide in the presence of ammonium chloride. The mixed hydroxides were filtered onto ashless filter paper, washed, ignited, weighed as R_2O_3. The mixed oxides were fused with sodium pyrosulfate, dissolved in very dilute sulfuric acid and made to volume in a 250 ml volumetric flask.

Iron: An aliquot of the volumetric solution was reduced by the stannous chloride method, and the resulting ferrous solution subsequently titrated with standard dichromate solution. The iron was calculated as Fe_2O_3.

Titania: An aliquot of the volumetric solution was placed in a Schreiner type colorimeter tube after adding a small amount of hydrogen peroxide solution. The color developed in the solution due to the presence of titanium was compared with that of a standard titania solution. The titania was reported as TiO_2. The alumina was determined by difference from the following expression,

$$Al_2O_3\ R_2O_3 — (Fe_2O_3 + TiO_2)$$

Lime: Lime was determined from the filtrate of the R_2O_3 determination by precipitation as the oxalate in a slightly alkaline solution. It was weighed as CaO.

Magnesia: Magnesia was determined from the lime filtrate by precipitation with ammonium phosphate in an alkaline solution. The precipitate was washed, ignited to magnesium pyrophosphate from which the MgO was calculated.

Manganese: Manganese is present in such small amounts that it is determined colorimetrically, using a 0.500-gram sample. The sample is decomposed in a platinum crucible with hydrofluoric acid. The manganese is then dissolved as manganese sulfate, and the resulting solution treated with potassium periodate. The color developed is compared with a standard solution using the Schreiner colorimeter. It is reported as MnO_2.

Alkalies: Alkalies were determined by decomposing a 0.5000-gram sample in the platinum crucible with hydrofluoric and sulfuric acids. The decomposed mass was taken up in hot water and the alkalies determined as outlined in Scott °Standard Methods of Chemical Analysis.° Sodium and potassium were not separated but reported as combined oxides.

Sulfur: Sulfur was determined by fusion of a 0.5000-gram sample with a 10:1 mixture of pure anhydrous sodium carbonate and potassium chiorate. Solution of the fused mass was accomplished with very dilute hydrochloric acid and the resulting SO_4 ion precipitated with 10% barium chloride solution. From the weight of barium sulfate obtained the SO_3 was calculated.

Carbon dioxide: Carbon dioxide was determined by the use of a Hempel gas apparatus in which the volume of carbon dioxide gas was measured (under observed temperature and barometric pressure) after being liberated from a 0.2500-gram sample by its action with dilute phosphoric acid. From the volume of carbon dioxide liberated the weight percent of carbon dioxide in the sample was calculated.

All of the samples were analyzed according to the procedures just given except that for samples 9a through 9q, the titania and manganese were determined by use of the Lumetron Photoelectric Colorimeter, Model 400. The accuracy of determination with this instrument is greatly increased over that of the Schreiner tube method. The time saved by using the instrument is also worthy of note, especially when a number of determinations are in the process of analysis.

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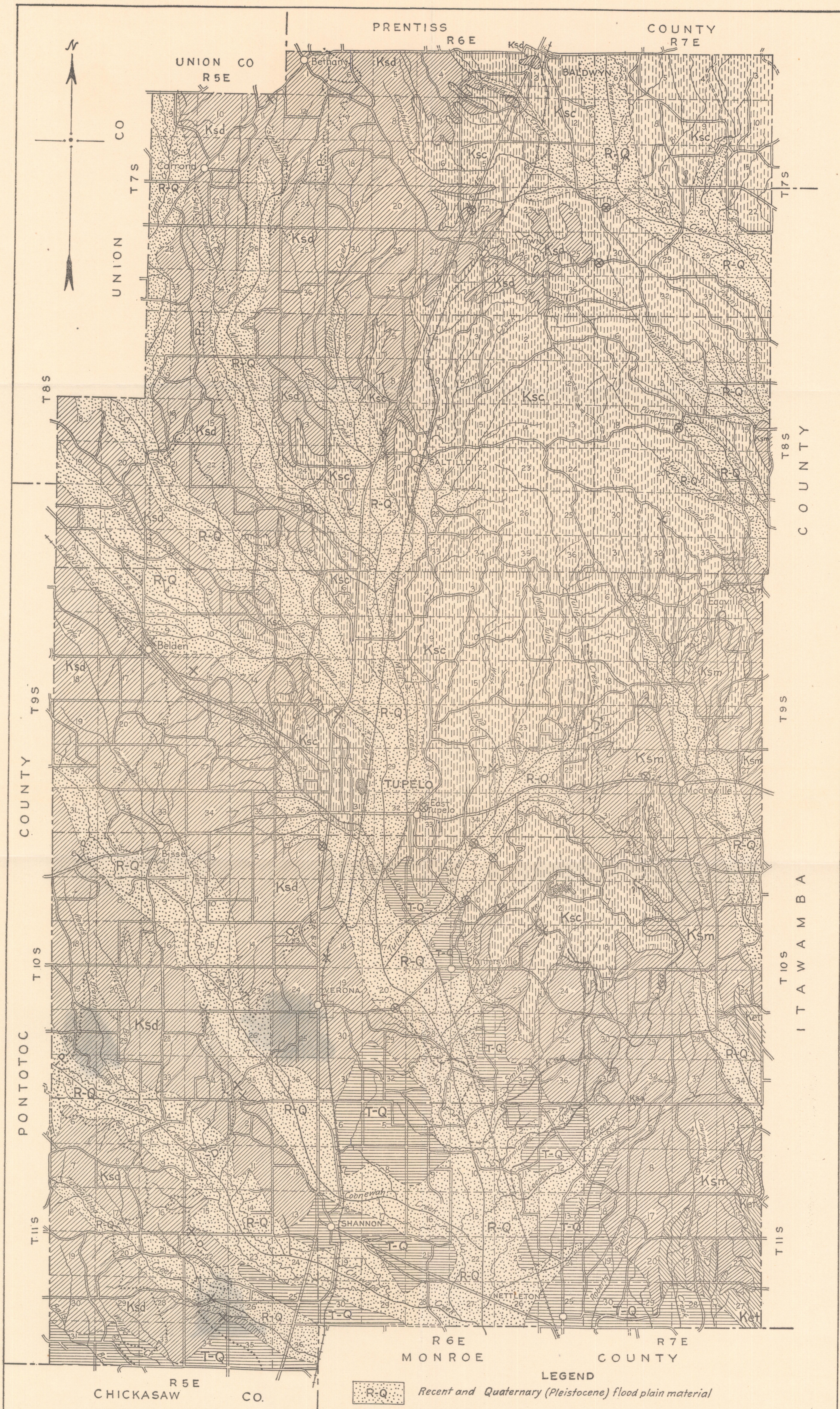

GEOLOGIC MAP OF
LEE COUNTY, MISSISSIPPI
By Harlan Richard Bergquist and Franklin Earl Vestal

0 1 2 3 miles

- --D-- *Diploschiza cretacea* zone
- --P-- Approximate position of the top of the *Exogyra ponderosa* zone and the base of the *Exogyra costata* zone
- ⊗ Prominent outcrops, locations of stratigraphic sections described in text
- X Other prominent outcrops

LEGEND

- R-Q: Recent and Quaternary (Pleistocene) flood plain material
- T-Q: Tertiary (Pliocene)? and Quaternary (Pleistocene) material, chiefly terrace deposits

Great unconformity

- Ksd, Ksa, Ksc, Ksm: Cretaceous system, Selma formation: Ksd, Demopolis member, chalk of wide range of sand and clay content; Ksa, Arcola member, thin, hard to white pure limestone; Ksc, Coffee member, chiefly light-gray cross-bedded glauconitic sand, but includes ledges of calcareous sandstone and sandy clay; Ksm, Mooreville member or tongue, clayey and sandy chalk or chalky clay

Unconformity

- Ket: Cretaceous system, Eutaw formation, Tombigbee member: Ket, Massive fine gray to greenish-gray glauconitic sand