PRELIMINARY REPORT

ON THE

GEOLOGY AND AGRICULTURE

OF THE

STATE OF MISSISSIPPI,

BY

L. HARPER, LL. D.,

CORRESPONDENT OF THE IMPERIAL MUSEUM FOR NAT. SCIENCE OF FRANCE, ETC.

STATE GEOLOGIST OF MISSISSIPPI.

BY ORDER OF THE LEGISLATURE OF MISSISSIPPI.

E. BARKSDALE, STATE PRINTER,

JACKSON.

1857.

AUTHORIZATION.

EXTRACT

Of an Act to provide for the Printing of the Second Annual Report of the Agricultural and Geological Survey of the State, and for other purposes.

SECTION 1. Be it enacted by the Legislature of the State of Mississippi, That so much of "An Act to further endow the University of Mississippi," approved March 5th, 1850, as appropriates out of the treasury three thousand dollars per annum to aid in making an agricultural and geological survey of the State, and also so much of said Act as connects the said survey in any manner whatever with the University, be, and the same is hereby, repealed.

SEC. 2. Be it further enacted, That the agricultural and geological survey of the State shall be prosecuted to completion, according to the provisions of the above recited Act, and of an Act entitled "An Act to authorize the printing of the First Annual Report of the Agricultural and Geological Survey of the State," approved March 1st, 1854, by a State Geologist, to be appointed by the Governor.

SEC. 3. Be it further enacted, That the State Geologist shall keep his office in the City of Jackson, etc.

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SEC. 6. Be it further enacted, That five thousand copies of Professor Harper's Report be printed, under the direction of the Governor, to be bound in boards, with such plates, charts, and wood-cuts therein, as his Excellency may deem appropriate, and necessary for its illustration.

SEC. 7. Be it further enacted, That when said Report shall be printed and bound, it shall be distributed according to the provisions of the last recited Act.

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SEC. 10. Be it further enacted, That the State Geologist to be appointed under the provisions of this Act, shall enter upon the discharge of the duties of his office on the first Monday in March, 1857, and this Act shall go into effect from and after its passage.

WILLIAM BARRY,
Speaker of the House of Representatives.

JOHN J. PETTUS,
President of the Senate.

Approved January 31st, 1857.
JOHN J. McRAE.

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DEDICATED

TO

HIS EXCELLENCY, J. J. McRAE,

THE

Popular Governor of the State of Mississippi,

AS

A TOKEN OF HIGH RESPECT AND ESTEEM,

BY HIS DEVOTED FRIEND,

THE AUTHOR.

PREFACE.

To His Excellency, J. J. McRae,
Governor of the State of Mississippi.

Sir :—When, separated as I was from the geological survey of the State since the first of November, it devolved upon the representation of the sovereign people of Mississippi to make arrangements for the appointment of a State Geologist, to complete the survey, after the separation of the office from the State University, our enlightened Legislature left it to you to appoint the officer, although their confidence and favor seemed to honor the humble author; I can, therefore, not do less, than dedicate this, my first report, written in retirement, to you, who, on account of your just and equitable administration, and bold defence of our commonwealth, stand foremost in the heart of every Mississippian, from whatever party he may be, and who have since called me back to the field of my labors.

Allow me then, Sir, to beg you to receive this hurried report as the humble expression of my high and unfeigned esteem and my admiration for your generally satisfactory administration, and the high stand which you have taken among the defenders of our Southern Home.

The report I have the honor of presenting to you herewith, can only be called a hurried and preliminary one, and, even as such, I have to claim for it your indulgence and forbearance. The circumstances under which I have had hitherto to make the survey, and especially to write this report, were, indeed, *the most unfavorable.*

You will be kind enough to remember, Sir, it was only in

February, 1854, that I was called by the Trustees of the University of Mississippi, and by you, among them, to the chair of Geology, Agriculture, and Analytical Chemistry, and the direction and execution of the Geological Survey of the State, ordered by the Legislature of our State in the year 1850, and then already in progress since several years.

The arrangement was made that I should lecture in the University on Geology and Agriculture during six months of the academic year, make the analyses for the State, direct the Assistant Geologist, and, during four months, go myself into the field and survey the State.

It was only on the 24th of October, 1854, that I was enabled to set out on a geological tour, in order to ascertain the general geological features of the State, which had not been ascertained up to that time.

I repeated my journeys whenever it was possible; but, until I commenced to write the following report, it had been impossible for me to spend more than about ten months in the State Survey, and through the assistance afforded me I received no other material useful for my report, besides my field-notes, but *one* report and *one* analysis from the last Assistant Geologist.

Under such circumstances, your Excellency will certainly excuse that my report is not more particular and complete. I have attempted to embrace the whole State in the work, in order to render it interesting to the citizens of every part of it.

This report would have been, nevertheless, more definite and particular, had I not, during the time of my writing it, been separated from all resources; not only from the geological and palaeontological specimens, but also from *any* library, even from the largest part of my own.

Before I withdrew from the Survey of the State, I directed the Assistant Geologist to the north-eastern part of the State, especially to Itawamba county, in order to examine a geological formation, intermediate between the carboniferous and cretaceous formations, which reaches the State from Alabama, to enable me to complete the geological map of the State. He returned, after the expiration of the term fixed by myself for my withdrawal from the University and the Survey, and his report came not to my hands, as it ought to have done, in order to be enabled to admit its contents into my report. Having separated the specimens and fossils belonging to the Survey from the collections of the University of Mississippi, and arranged them in separate rooms, the Assistant Geologist left the State, without giving me the necessary information respecting his last examination, made according to my direction.

When my report was written and ordered to be printed by the Legislature, and when I was re-appointed State Geologist, I desired to have access to those rooms containing the specimens and fossils belonging exclusively to the Survey, and consequently to the State of Mississippi, in order to avail myself of the last report of the late Assistant Geologist, if any was made, to compare my report once more with the geological specimens and fossils, and to take some specimens of the large deposits of silica and kaolin, discovered in the State, along to the large northern cities, where I was compelled to go to purchase an apparatus for an analytical laboratory for the State, and to have the diagrams and maps accompanying my report engraved, etc., in order to draw the attention of the manufacturers of glass and porcelain ware to those valuable deposits, to the great advantage of the State.

I had, indeed, no doubt that my request would be granted immediately, especially as the collections for the Survey were entirely separated from those of the University; but where I expected willingness, and even the desire of promoting the interest of the State, I found the contrary.

My request was refused. I repeated it to the Secretary of the Board of Trustees, and as I found there the same difficulty, I addressed a petition to the Executive Committee, in which I showed that, according to the law (of the 5th of March, 1850,) the report of the Assistant Geologist belonged incontrovertibly to the State, and the specimens and fossils certainly first to the State, and then to the University. I received the answer from the Secretary "that my petition should be laid before the Executive Committee of the University of Mississippi at their next meeting."

I waited nearly a fortnight for an answer, but received none. Longer it was not in my power to wait; I then left Oxford, and have never since received an answer.

I am far from making complaint on account of the refusal of a request which seems to me not only in accordance with the law, but the granting of which would have promoted the interest of the State, without the least inconvenience or loss to the University, but my views may be wrong, but *it is my duty* to state those facts, in order to exculpate myself.

That under such most grievous and unfortunate circumstances, my report cannot be more complete and particular, and but a preliminary one, needs no further demonstration. It was impossible for me to make specific determinations of fossils not already made on the spot where they were found, or even to review and correct generic determinations.

It is also very much to be regretted that, under these circumstances, the gap in the geological chart of the State could not be filled up.

My report on the Geology of the State, Sir, is not the first one; another has been published previously, in the year 1854. I have no connection whatever with that report, and am far from claiming any of its merits. Its contents were entirely unknown to me before its publication, and even long afterwards.

Concerning the plan followed in my report, I have to remark, that, as the State of Mississippi is an entirely agricultural one, I have deemed it necessary to adopt a peculiar plan in order to enhance its usefulness. I have always considered that I had not so much to write for learned geologists as for an agricultural public; I have therefore attempted to write a popular work, not only tending to exhibit those resources, which have been discovered in the State, but to be instructive in such matters as are not generally known, to give reasons for my assertions and conclusions, and interest the people generally. That such a report cannot and ought not to be written entirely without scientific disquisitions and terminology is very evident, but the glossary added to it will give the necessary explanations to render it generally intelligible. I hope, also, that the scientific world may find in the report something interesting concerning the geology of a State hitherto very little known, preliminary and incomplete as it only can be.

Desiring particularly, Sir, that this report of a part of the geological survey of your State, made entirely under your popular administration, may be of some interest and satisfaction to you,

I have the honor of being,

With high respect and esteem,

Your Excellency's humble and obedient servant,

L. HARPER.

College Hill, Lafayette Co., Mississippi, March, 1857.

INTRODUCTION.

Geological surveys of States have hitherto been very little appreciated among the mass of the people, and it has been customary for geologists to introduce their reports by an enumeration of all the advantages of a geological survey of a State.

Such an introduction appears to me unnecessary, where a survey has developed such important resources as has been the case in Mississippi. This State is a merely agricultural one, favored with such fertile lands as only a few other States contain, and with such an abundance of them as only few other States can exhibit. There is, perhaps, no country in the world which has four and a half millions of acres of such alluvial lands as our Mississippi bottom contains; an alluvial plain, in a mild and happy climate, level as the surface of the ocean, and of inexhaustible fertility, every acre of which is able to produce from sixty to eighty bushels of corn, and from one and a half to two bales of cotton, which will therefore, perhaps, after the lapse of half a century, produce as much cotton as all the Southern States together now produce and, perhaps, much more. A country of which we have said in the proper place: "It is still a wilderness, the retreat of the bear, wolf, and panther. The prejudice of its unfitness for cultivation has only lately been removed from the minds of the inhabitants of our own and other States, and the axe of the woodman scarcely begun its ravages; but, after the lapse of another century, whatever the Delta of the Nile once may have been, will only be a shadow of what the alluvial plain of the Mississippi river then will be. Cities like Memphis, Thebes, Andropolis, Busiris, Mendes, and Heliopolis, once more will spring up. It will be the centre-point

—the garden-spot of the North-American Continent; the scene of action of the busy activity of a free and happy agricultural nation, where wealth and prosperity will culminate."

And this alluvial plain is only a small part of the fertile lands of the State of Mississippi. The rich table-lands of North Mississippi; the splendid loamy lands along the bluff of the alluvial plain and the banks of the Mississippi river, in the southern part of the State; the dark and heavy prairie lands of the eastern part of the State; the productive alluvial bottoms of the rivers and creeks of the interior of the State, and the large quantity of good and productive lands of the tertiary formations, are not of less importance.

Agriculture will then be by far the principal source of wealth and prosperity of this State. But lands, which are cultivated for the support of man and his domestic animals, decrease in fertility, and become exhausted at last, however fertile and productive they may be; and it is very difficult, in our Southern climate, to provide for artificial manure; herbage for feeding our domestic animals, keeping them stabled, for the collection of sufficient manure, does not succeed here, and other artificial manures are too expensive. Their application would much decrease the profit from our agriculture. What more precious articles, then, could have been discovered, by an examination of the resources of our State, than natural manures—more effective than artificial manures, to restore the fertility of exhausted lands—to keep the originally fertile lands in fertility, and render those soils productive, which have hitherto been entirely neglected on account of their inferiority to other lands?

This has been done. Marl-beds have been discovered north and south in our State, which have scarcely their equal, in quantity and quality, anywhere in the known world. We refer to the concerning part of our report. The marl deposits, in South Mississippi, in the eocene formation commence in Clarke and Wayne counties, near the State line of Mississippi and Alabama, and extend from there westward, in a wide belt through the whole State, to the alluvial plain of the Mississippi, near Satartia, in Yazoo county.

They underlie more than 2,000 square miles of the State; are from a few inches to more than 100 feet in thickness, and contain, as the analyses in another part of this report show, as fine and rich a marl as ever has been found anywhere—a shell-marl mixed in some places with lime, in others with clay, and adapted for all kinds of soils—a marl which is far superior to any manure which our agriculturists could prepare themselves, and, indeed, superior to the so much extolled guano, as it really improves the soil, and lasts for a number of years; whereas guano is only effective for one year, and its influence scarcely perceptible the next.

Such marl has not only been found in the southern part of Mississippi, just where it is most needed, on account of the inferior quality of the lands, near the coast of the Gulf of Mexico, but also in the northern part, in Tippah, Tishamingo, and Pontotoc counties. Also there it underlies a large extent of country, as the particular charts of those counties exhibit, and is in some places, as in the northern part of Tishamingo county, above the little town of Corinth, more than 100 feet in thickness, and of superior quality.

These marl-beds are of an incalculable value for the State—indeed, much more so than mines of precious metals, and they enhance the wealth and prosperity of the whole State, having immediate influence upon that human occupation which is the foundation of all greatness and prosperity. The precious metals would affect comparatively only a small part of its population; the marls confirm our agricultural population in their most useful occupation, facilitate it, and render it more lucrative—in an occupation which fosters their moral and religious character, their patriarchal simplicity and hospitality; they corrupt manners and morals, lead to extravagance, dishonesty, and vice, and call an undesirable population into the State.

Invaluable as these resources appear, they are not all which the geological survey has disclosed. Others have been discovered, which excite mechanical industry, and give our citizens an opportunity of excelling in a branch of human occupation, for which a few countries only yield the precious material. To these belong the immense deposits of the finest kaolin or porcelain clay, which, in size, as well as fineness of their material, have not their equal in the territory of our Confederacy. To these belongs the important deposit of nearly pure silica for the fabrication of the finest glass-ware.

Both of these deposits have been discovered in a part of our State, where native fuel is very abundant, where mineral fuel from other States is quite contiguous, where a large river navigable the whole year, and considerable creeks navigable a part of the year, at least, are in the immediate vicinity, and which is crossed by the Charleston and Memphis railroad, where, consequently, all facilities for the establishment of porcelain and glass manufactures are afforded.

If such resources have been discovered, it is, indeed, not necessary to enter into a long discussion concerning the usefulness of a geological survey. It has been practically demonstrated, and already acknowledged by our intelligent and wise State authorities. The printing of the report has not only been ordered, after a careful examination, but the geological survey has been rendered more effective by its separation from the State University, and its continuation to completion been decided. Let us, then, acknowledge the laudable ardor of our State authorities, with which they try to promote the welfare and prosperity of our commonwealth, blessed before many others with a most productive soil, and ample means to maintain, and even increase its productiveness, and request them to go now a step farther, and make the necessary provisions for a prudent and correct cultivation of our fertile lands, and the immediate resort to those resources which the geological survey has disclosed.

The question obtrudes itself here: How can it be done?

Agriculture—nobody will deny it—is the foundation of all national greatness and prosperity; and if that be in general so, it must, indeed, be especially so in our State, which is a *merely* agricultural one. Our national greatness and prosperity must, consequently, depend exclusively upon agriculture, and our highest interest demands that we should spare no sacrifice to elevate this scientific art to its highest standard.

Agriculture has hitherto not kept pace among us with all the other arts and sciences. Whilst, after an existence of scarcely eighty years of our great Union, we excite the admiration of the whole civilized world with respect to our progress in all other arts and sciences; whilst our discoveries and inventions astonish our contemporaries in other parts of the world; whilst our telegraphs, our railroads, our steamboats and fast-sailing vessels, our weapons of defence, excite the jealousy and emulation of old Europe; whilst our commerce extends from one pole to the other, *our agriculture lags behind.*

I intend, by no means, to indicate that our agriculture does not provide for our wants. It does much more than that. Our Indian corn, our wheat, our flour, is exported to all parts of the world, and our cotton clothes the whole civilized world; but we gain those articles *too much at the expense of our soil, not of our labor and industry.* Our agriculture is not a correct, a natural, and scientific one. We exhaust our lands, abandon them, and resort to others; we remedy, by the abundance of our lands, what we ought to prevent by our skill and science, and, after a longer continuation of such an agriculture, our States must be exhausted, and their inhabitants reduced to poverty.

Scarcely ten years ago, our agriculturists were still obstinate in their cultivation of the soil. They thought that agriculture was only a correct one, which observed rigidly the manners and customs of their forefathers. All innovations and scientific principles applied to agriculture were called "book-farming," and deemed utter nonsense. In their opinion, agriculture could only be learned by practice. By such principles the customs of their fathers were sanctioned, and rendered unchangeable.

The fields were in continual cultivation, without any change or rotation of the crops. Thus, cotton or corn was planted in the same field for fifteen or twenty years in succession, without manuring, or even fallowing them, and, of course, one farm or plantation after the other became exhausted; and thus it happened, that whole States, originally of great fertility, became sterile deserts. This was, indeed, the case with Virginia, South Carolina, Georgia, and other States. They were completely or partly exhausted, and annually deserted by a large portion of their population, who emigrated to other States, westward, in order to find other lands still in their primitive fertility, where they could renew their agricultural ravages. It was only, then, when this state of affairs increased to an alarming extent, that the eyes of the people were opened, and that they listened to better advice. Fortunately, our agriculturists see now everywhere that the old custom of cultivating the soil is wrong and injurious, that it is against their own interest, and undermines the welfare of our States. As much as they condemned "book-farming" formerly, just as ready are they now to resort to such "book-farming;" but, unfortunately, the instruction in arts and sciences that were abhorred formerly has not been provided for, and therefore the necessary intelligence for a correct agriculture is beyond the reach of our agricultural population.

Thus it is, then, that in all these arts and sciences, which are dependent for their very existence upon agriculture, our youth can find instruction in our States; more than that, we provide for instruction, which is, indeed, as yet, perfectly unnecessary; build observatories where we have no students who study astronomy to such an extent as to need observatories, nor professors to teach it to such an extent, or make astronomical observations useful for the promotion of science; and we neglect *the very basis of all arts and sciences, of all national wealth and prosperity—the only* *source from which we can derive the means to erect and maintain literary institutions for the promotion of science*—Agriculture!

Let me not be understood to oppose the erection of observatories. By no means. I am fully aware of the usefulness, and even necessity of such scientific institutions; but am of the opinion, *that the necessary must be done first.* The national prosperity must first be secured; the instruction in sciences must first be introduced, which are absolutely necessary for that purpose. Our colleges and universities must first advance to such a standard that observatories are necessary; *then, and only then,* it is time to erect them, and provide them with scientific men able to direct them.

Before we go one step farther, and build towering edifices, let us fortify the foundation; otherwise they might appear as *castles in the air.* Let us provide for the promotion of agriculture. This is, indeed, nowhere easier than in our blessed State of Mississippi. We have not only the fertile lands, we have also the materials in abundance to keep them in a continual state of fertility, and nothing is wanting but the knowledge of their correct application.

The question will be asked: How can we promote agriculture?

There is only one correct way to do this speedily and effectually, and that is by establishing in our State, *a Central Authority for the promotion of Agriculture,* whose sole and exclusive business it is to have that end continually in view, and pursue it with untiring ardor; to provide that central authority with able and competent agriculturalists, endow it with ample means, and entrust to it the management of all agricultural affairs under the immediate superintendence of the State Legislature, and most especially to allow it a *considerable influence* upon the education of the youth of this merely—nay, *exclusively* agricultural State.

It is, indeed, of the highest importance that the sons of our agriculturists who devote their life to agricultural pursuits, should be equally well educated for their pursuit in life as the lawyer, the physician, the theologian, the teacher; and only when this is the case, agriculture, the first and most important of human sciences, can have an adequate representation in our Legislatures and National Congress, and occupy that rank among human sciences which is due to it.

The institution of an agricultural authority is not a new one; if we cast a glance around us we will find it in all well-organized States on this and other continents, even in those where agriculture is not the exclusive resource of the country, as it is the case in our State.

France, Prussia, Austria, Russia, have their Secretary or Minister of Agriculture in the cabinets of their monarchs, who promote agriculture in every respect, excite emulation, direct the agricultural education, provide for the importation of useful domestic animals, fruit trees, seeds, &c., and assist the agriculturist in the knowledge of his soil, and the application of the most suitable fertilizers.

In our Central Government at Washington, the Patent Office has hitherto performed the duties of an Agricultural Bureau, but recently arrangements have been proposed to employ a Secretary of Agriculture, who takes charge of the agricultural interests of our Union.

Even in most of our older States, such agricultural authorities have existed for a long time, and have proved to be eminently useful.

The idea of the establishment of such an Agricultural Bureau, even in our State, is not a new one. A prominent and most active and useful member of our Legislature, Hon. Thos. J. Hudson, of Marshall county, has carefully prepared a bill for the establishment of so necessary an institution. It has been read twice in our Legislature, and referred to the House Committee on agriculture; it will, without doubt, be brought forward, during the next session of our Legislature, for final legislative action; let us then unanimously request our enlightened Representatives to lose no time in passing the bill, and the most beneficial influence of that Bureau upon the agriculture of our State, and consequently its wealth and prosperity, will soon be visible.

Another very effective means for the improvement of agriculture is the establishment of a good agricultural journal in our own State.

Since the author first took charge of the geological survey of this State, he has made several attempts to establish such an agricultural journal, offering willingly his gratuitous co-operation in order to benefit the agricultural public, and elevate agriculture; but all of them failed.

Two patriotic gentlemen, Messrs. Elliott & Williams, have recently come forward and established such a most desirable journal in our capital—Jackson itself. They have requested the author to take the direction of the journal in order to render it, by his knowledge of the State, its geology and agriculture, as useful as possible, and he has most eagerly seized upon the kind offer.

The journal appears monthly, under the title of "The Mississippi Planter and Mechanic," and will be the medium of communication of the undersigned, State Geologist, with the agricultural public. It would be superfluous to publish another report before the completion of the geological and agricultural survey, and all interesting discoveries and communications will be published in the agricultural journal. The attention of the agricultural and mechanical public is therefore respectfully called upon for that journal, and they are requested to enable the patriotic publishers, by their liberal patronage, to accomplish their design, and elevate it to one of the best agricultural and mechanical journals in our country.

There are a great many excellent agricultural periodicals in existence in our Union, and even in our Southren States, and it would appear as if the addition of another one was not necessary, but that is evidently a mistake.

Agriculture is not like other sciences, the same in all countries and climates; on the contrary, it differs in every climate and every country, even on every different soil; it is, therefore, most desirable that, at least, every State should have its own journal of agriculture, which is certainly much preferable for its population than the agricultural journals of other States.

A very sure means of improving the agriculture of our State, is, lastly, the application of the fine marls which have been discovered in the State. These marls are the more valuable for our agriculturists the more difficult it is to procure a sufficient quantity of fertilizing matter. Our warm climate is not adapted for the cultivation of herbage for stabling our domestic animals during the winter; we have scarcely dry herbs enough for the food of our horses; the collection of a sufficient quantity of stable manure is, therefore, impossible. The artificial manures are extremely expensive; the guano costs now more than $60 a ton, and without natural manure our agriculturists would scarcely be able to carry on an extensive and remunerating cultivation of their lands without exhausting them. But that want of manure is abundantly supplied in our State by the immense beds of the finest shell-marl. May our agriculturists, then, avail themselves of that most excellent manure, which is far superior to any stable-manure, and a correct application of which will not only keep the lands in continual fertility, but render them more and more fertile.

Nature has furnished that fine fertilizer in this State in such abundance, that its application will never cause any other expense than that of its transportation; and as soon as the effect of the marl upon the land is sufficiently known, there is no doubt the advantages of its application, as a manure, will be a sufficient inducement for the construction of railroads to the rich deposits of those marls.

The application of marl as a manure, is still very little known in our State; the author has, therefore, endeavored to increase the usefulness of his report by adding to it, in an Appendix, an essay "On the Use of Marl as a Manure."

GEOGRAPHICAL DESCRIPTION

OF THE

STATE OF MISSISSIPPI.

THE State of Mississippi is bounded, North, by Tennessee; the boundary line, which separates it from the latter State, agrees with the 35th degree of N. lat. It commences W. on the Mississippi river, long. 90° 18′, divides Horn lake in two parts, leaving only a part of its southern arm in the State of Mississippi, and comes out of the lake exactly below a ridge of hills, reaching the lake from the E.

From there, that boundary line continues to the Tennessee river, striking this river under the 88° 13′, of long. from Greenwich. From there to the mouth of Big Bear creek, under the 88° 7′, the Tennessee river forms the boundary line of Mississippi, leaving a small corner within the square of the State, between it and Tennessee, to the State of Alabama.

From the mouth of Big Bear creek, from the 88° 7′ of long. from Greenwich, the State is bounded E. by Alabama, the boundary line going from that point in a direction of about S. S. W., or more exactly S. 15° W., to a point under lat. 32° 8′, long. 88° 38′, from which point it turns again a little E., and goes S. 15° E. to the Gulf of Mexico, which it reaches in lat. 30° 25′, long. 88° 18′.

From the latter point to the mouth of Pearl river, lat. 30° 13′, long. 90° 25′, the Gulf of Mexico forms the boundary of the continental part of the State; not excluding, nevertheless, a number of islands, of which Round, Horn, Ship, Deer, Cat, and Aupied islands are the principal.

From the latter point, lat. 30° 13′, long. 88° 18′, in the mouth of Pearl river, this river makes the W. boundary of the southern part of Mississippi, to lat. 31°, long. 88° 45′, separating the State from that of Louisiana.

From the latter point on Pearl river, lat. 31°, long. 89° 45′, the southern boundary line, which separates Mississippi from Louisiana, corresponds with the 31° of N. lat. to the Mississippi river, in long. 91° 41′.

From this point, in lat. 31°, long. 91° 41′, to the line of Tennessee, in lat. 35°, long. 90° 18′, the principal channel of the Mississippi river forms the western boundary line of the State, and separates its southern part from the State of Louisiana, and its northern part from Arkansas.

The territory, on whose geology I have the honor of reporting to the legislative body of the State, extends, therefore, according to the above geographical description, from the 35° of N. lat. to lat. 30° 13′, and measures, in its greatest latitudinal extent, 287 geographical, or 331.65 statute miles.

In longitude it extends under the 31° of N. lat. from the Alabama line, in long. 88° 23′ to long. 91° 41′, on the Mississippi river, and measures, in its greatest longitudinal extent, 198 geographical, or 227.7 statute miles.

The State has the smallest latitudinal extent west of Pearl river, where the southern boundary line follows the 31° of N. lat. It measures there in length 4 degrees, from the 31st to the 35th, or 230 geographical, or 276 statute miles; and in width, from long. 88° 23′ on the Alabama line to long. 89° 45′ on Pearl river; extending over 1° 11′, or 71 geographical, or 81.65 statute miles.

The area comprehended in the territory of the State of Mississippi, comprises, according to a careful calculation, about 45,468 square miles, or 29,099,520 acres of ground, which is divided as follows among the different geological formations of the State:

Formation.	Square Miles.	Acres.
1 Carboniferous	729	466,560
2 Cretaceous	5,040	3,225,600
3 Eocene	20,736	13,271,040
4 Miocene	10,692	6,842,880
5 Postpliocene	927	593,280
6 Alluvium, of the Mississippi	7,092	4,538,880
7 Other Alluvium	252	161,280
Total	45,468	29,099,520

REMARK.—Mr. B. L. C. Wailes, in his report on the agriculture and geology of the State of Mississippi, says, on pages 18 and 125: "The State embraces an area of 55,500 square miles, or 35,520,000 acres." There is consequently a great discrepancy between his and the above statement. Efforts were made to get official statements concerning the area of the State of Mississippi from the State archives, but there are none, and it cannot be ascertained where Mr. Wailes has found his data. The author of this report has endeavored to ascertain the area of all the different geological formations of the State according to the sections, townships and ranges into which they are divided, and has reason to believe that his statement comes nearer to the truth than any other. It is certain that the area of 55,500 square miles does not agree with the length and breadth of the State, as stated by Mr. Wailes. He says on page 18 of his above quoted report:

"The width of the State, along the northern boundary, is 120 miles; on the seashore, 78 miles The greatest length from north to south, is 330 miles."

The average width of the State of Mississippi would, accordingly, be 99 miles; admitted now, which is, nevertheless, by no means the case, the length of the State was in all its parts 330 miles, this would only give an area of 32,670 square miles, or 20,908,800 acres.

It is unquestionable that the State of Mississippi has not an area of 55,500 square miles; it cannot have more than 47,156 square miles, as admitted by T. H. Colton, but the statement of the author of this report is probably more correct than that.

It must be added that the above remark has not been made in order to detract from the merits of the report of Mr. Wailes in the slightest degree, but the author deemed it to be his duty to clear up, as much as possible, the errors in the statistical notices concerning this State, and come as near to the truth as possible.

Admitted now that the whole area of the State consists in about 20,099,520 acres, of which, according to the census of 1850, as much as 10,490,000 are held by individuals (of which 3,440,000 are in cultivation), the unimproved lands would amount to 25,655,520 acres, and those still held by the Government of the United States and that of the State of Mississippi to 18,609,520. But this state of affairs has changed much since 1850, and it can, with safety, be admitted that since that time nearly half of those Government lands has passed into the hands of private individuals or companies, and much more land has been improved, especially in the Mississippi bottom.

GEOLOGICAL GEOGRAPHY

OF THE

STATE OF MISSISSIPPI.

THE State of Mississippi is not, like its neighboring States N. and E., very varied with respect to its geological formation; by far the largest part of it is occupied by the newer, and a large portion even by the newest formations.

Mississippi, unlike Tennessee, Alabama, and Georgia, has no representatives of the azoic formations (1); none of the transition formations (2); the whole immense primary fossiliferous or palaeozoic period of our earth is only very feebly represented in this large State; not more than a small corner of Tishamingo county, in the N. E. corner of Mississippi—not more than at most one third of that county—is occupied by the lower portion of the carboniferous formation, as the geological chart indicates.

The secondary or mesozoic period is better represented in Missisisppi, nevertheless only by its upper formation, the cretaceous rocks (3), which enter the State from Alabama, and run, as a narrow belt only, along the carboniferous formation, and the N. E. boundary line, into the State of Tennessee. It does not extend farther W. than the line of Chickasaw county, and runs near the towns of Pontotoc in Pontotoc county, and Ripley in Tippah county, upwards, towards the Tennessee line.

It is sufficiently ascertained, and a settled principle in geology, that all stratified formations of our globe have been formed by deposition from water; not only the very stratification, but also the fossil remains of plants and animals, found in most of them, prove that satisfactorily. It is then evident that during that period, in which a certain class of rocks are in the process of formation, that portion of our globe, where those rocks occupy the surface, must have been submerged under the water of the sea, if the formations be marine—under fresh water, if they be lacustrine or fluviatile.

It follows, then, that during the whole of the primary fossiliferous period, whilst Georgia, Alabama and Tennessee were already partly above the surface of the ocean, the whole territory of the State of Mississippi, with the exception of a very small portion of Tishamingo county, was still, for many years, the bottom of the ocean, and the tumbling-place of the immense monsters of the deep, which it then harbored in its lap; being then, if not the only, at least the principal seat of animal life.

This state of things continued even to the very end of the secondary or mesozoic age. Of all the secondary rocks, only the uppermost portion of the cretaceous, or upper secondary formation, is found in Mississippi. It also extends over a very small portion of the State, as the geological chart exhibits. It enters the State from Alabama, in the corners of Lauderdale and Kemper counties; its western line runs E. of Dekalb, a little W. of Macon and Starkville, along the line of Calhoun and Chickasaw counties to Pontatoc, from there by Ripley, in Tippah county, into Tennessee. This, then, is the only part of the territory of the State of Mississippi, which, at the very end of the secondary age, became elevated above the surface of the ocean. It is not impossible that other parts may have been elevated and re-submerged, but improbable.

The whole Mississippi valley, the whole of Florida, the southern parts of Georgia and Alabama included, the whole western part of Tennessee, the whole of Louisiana, and a part of Arkansas, were then, at the close of the secondary age, and even during the first part of the tertiary age, still submerged by the waters of the ocean. The only primeval coasts in the territory now occupied by Mississippi, run along the line of the cretaceous formation, as it is laid down in the accompanying geological map.

It was only after the lapse of the first part of the tertiary age of our globe, after the eocene period, that another more considerable portion of the State of Mississippi became elevated above the level of the ocean, and converted into dry land. At this time most probably the whole, or very nearly the whole, of the area of the State, not already elevated above the level of the ocean, was heaved up; the appearance of a small portion of the eocene formation, in ranges

1, 2 and 3, townships 1, 2, 3, 4, 5 and 6, in Tippah county, seems to warrant that opinion. If so, a re-depression took place at the time of the end of the eocene or commencement of the miocene period, which submerged first the N. W. part of the State, from the 33° of N. lat. upwards, the territory now occupied by the miocene formation, where both of the miocene groups, the lower lignite and the upper orange sand groups, are found. This re-depression must have extended from W. to E., and been much more intense W. than E., because a portion of the eocene was left elevated eastward, along the cretaceous formation. (Longitudinal Section, Tab. III., sec. I., from *a* to *b*.)

An inland sea seems then to have been formed, again extending, on the Latitudinal Section No. II., of Table II., from *b* to *d*—on the Longitudinal Section, Tab. III., sec. No. I., from *a* westward; whereas the country from *a* to *b*, nearest to the present Gulf of Mexico, was not re-depressed.

It is also possible that a large portion of the area now occupied by the miocene formation was not elevated above the level of the sea, at the time when the territory of the eocene formation was raised. The upheaved portion was then that of the State nearest to the ocean, and an inland sea remained where now the the miocene formation is situated.

During the latter part of the tertiary age, the dry land of the present territory of the State of Mississippi was confined to the north-eastern and southern part; from the line of the eocene, indicated on the geological chart, upward, and from the line of the cretaceous formation, westward, there was still an arm of the sea, extending into the land (from *b* to *d* on the same section). Whether this part of the sea, extending into Mississippi, and cut off, south, by the upheaved eocene formation, from the present Gulf of Mexico, was only a small estuary, or a larger bay or gulf of a western sea, will only be known when the States of Louisiana, Texas, and Arkansas are also surveyed.

The present Gulf of Mexico, with its many islands, was certainly, at, comparatively, not a very remote period of our globe, a part of a continent. It is possible that the change from dry land to sea occurred totally, or at least partly, as late as after the miocene, or middle tertiary period (3), and that before that time, a large sea, or large bay, existed, which occupied perhaps the whole of Louisiana, a part of Texas and of Arkansas; also that part of the State of Mississippi N. of its eocene, and W. of its cretaceous formations, and even a considerable part of western Tennessee.

It is then evident that the Mississippi river, immense as it is, could not yet have been in existence, at least in its present condition, during a time when all the dry land on its eastern and western shores, from Kentucky down to the Gulf of Mexico, was not yet upheaved above the level of the ocean. The earliest existence which the geology of Mississippi allows it, is after the upheaval of the miocene rocks, towards the end of the tertiary age (4). Its existence at a very early period of the quaternary or human period is certain, and can be proven by its deposits in Mississippi, and especially in Louisiana (5). This subject will be later discussed, when treating of the singular fluviatile formation found, especially in the southern part of Mississippi, from Vicksburg down to the line of Louisiana (6).

At the period of the miocene, or middle tertiary rocks, especially at the end of this period, the whole of the territory now occupied by the State of Mississippi must have been in a state of subsidence and gradually depressed below the surface of the ocean, for it can hardly be otherwise explained how it happens that the newer tertiary rocks overlie every one of the older formations, from the carboniferous upwards to the eocene, as it really is the case. All the older rocks must have been again upheaved at the end of the miocene formation, for a newer decidedly marine formation has not been found overlying them.

After the appearance of the miocene, or middle tertiary rocks, above the level of the sea, the configuration of the territory of the State of Mississippi was nearly the same as we find it now. It contained, in its northern, eastern and southern parts, a great many ponds and lakes, which were afterwards filled up, and converted into lacustrine formations; as, for instance, the prairies in the southern and eastern part of the State, parts of the fertile table-lands in Marshall, Tippah, and other counties, etc.

Besides, the Mississippi river—large as it is, and always has been—is as unsteady in its bed as a river can possibly be. It has shifted from one side to the other, and produced a great many changes in its territory, and produces them continually. We will discuss those changes more amply in connection with the alluvial formations of the State.

The different geological formations within the State of Mississippi are, then, as we have above stated, and as the Table No. I. shows at a glance:

1. Of the primary fossiliferous, or palaeozoic age, a small portion of the lower carboniferous formation. (7).
2. Of the secondary, or mesozoic age, the upper secondary or cretaceous formation.
3. Of the tertiary, or kainozoic age, the eocene and miocene, (perhaps, also, the pliocene and pleistocene—a continuation of the survey will settle the question.)
4. Of the quaternary age, or human period, the postpliocene and alluvium.

All of which have been marked out on the geological map; and the stratigraphical situations of them, among the formations of the globe, are represented in Table I.

LIMITS OF THE DIFFERENT GEOLOGICAL FORMATIONS IN MISSISSIPPI.—(8.)

1.—CARBONIFEROUS FORMATION.—(9.)

The oldest formation in the State is the lower part of the carboniferous, consisting of a portion of the mountain limestone, which extends into Mississippi from the State of Alabama.

The last report of the Assistant Geologist not having been received, the point where the carboniferous formation enters the State cannot be exactly indicated. It is most probably in township 8 or 7, range 11, east, in Itawamba county; it goes in T. 6, R. 9, sec. 32, into Tishamingo county, strikes in T. 5, R. 9, the head-waters of the Tombigby river, on the W. side of which it runs nearly in a N. direction, crosses T. 4, R. 9, nearly in the middle, turns then a little E. of N. after entering T. 3, R. 9, to the N. E. corner of that township, running along Crippled Deer creek. It crosses Yellow creek in T. 2, near the division line of ranges 9 and 10, runs along that line, and goes into the State of Tennessee through the W. part of T. 1, R. 9.

The territory E. of this line is taken up by the carboniferous formation, but this is, in its W. part, along that line, so thickly overlaid by tertiary rocks, that it is scarcely, if at all, perceptible. (10). This territory of the carbonaceous formation in Mississippi is a very small one; it does not extend over more than about 792 square miles, and contains not more than about 466,560 acres of ground. However small it is, in a national-economical point of view, it is a very important one.

2.—THE CRETACEOUS FORMATION.

The eastern boundary line of this formation, next in age to the carboniferous, in the State of Mississippi, is, from reasons above stated, not known from the line of Alabama to Tishamingo county; from there it coincides with that of the latter formation (11), from where it enters Tishamingo county to where it passes into the State of Tennessee. The western boundary line of the cretaceous formation crosses the State line between Alabama and Mississippi, under the 32° 35′ of N. lat., and 88° 23′ of long.; it extends from there in a N. N. W. direction, through T. 9, R. 18; T. 10 and 11, R. 17; T. 12, R. 16, in Kemper county, and through Townships 13, 14, 15, R. 16; T. 16, R. 15, in Noxubee county; from there it crosses Ocktibbeha county in a diagonal line through Townships 17, 18, 19, 20. In T. 21, R. 3, it leaves Ocktibbeha, and enters Chickasaw county, extends thence in the same direction through T. 22, R. 3; takes from there a due N. course, going nearly along the line between Chickasaw and Calhoun counties to T. 26, R. 2, in Pontotoc county; from there it crosses T. 10, R. 2, in a N. E. direction towards the town of Pontotoc, T. 10, R. 3, leaving this town inside of the cretaceous formation. West of Pontotoc the line of the cretaceous formation takes again a due N. course, extending very nearly along the line between the Ranges 2 and 3, to T. 4, R. 3, in Tippah county; from near Ripley, it inclines again slightly E., remaining, nevertheless, in R. 3, and extending through townships 3, 2, and 1, to the line of Tennessee, where it arrives nearly exactly under 89° of long. Within this territory, bordered W. and S. by the line just described, N. by the State of Tennessee, and E. by the boundary lines of the carboniferous formation and the State of Alabama, is contained an area of about 5,040 square miles, or 3,225,600 acres of ground.

3.—THE EOCENE FORMATION.—(12.)

The formation next in age is, as will be seen on Table No. 1, the eocene of the tertiary age. It extends over a larger part of the State of Mississippi than any other formation. It is bounded N. by a line commencing about a mile below the town of Satartia, in Yazoo county, where the first outcrop in the bluff about a mile from the Yazoo river was found. From there it extends due E. nearly along the line between Townships 9 and 10 to R. 3, in Madison county; from there it takes a southerly course through townships 3, 4, and 5, R. 9, in Madison county. In Scott county, it passes through Ranges 6, 7, 8, 9, T. 8. In R, 10, T. 8, in Newtown county, it declines again a little N. of E., and enters Neshoba county, in T. 11, R. 9, crosses there ranges 12, 13, 14, 15, T 9, enters Lauderdale county in R. 15, T. 8, and extends through Ranges 16, 17, 18, T. 8, to the line of Alabama, which forms the boundary of the eocene in *Mississippi*, down to the Gulf of Mexico. (13.)

Along the Gulf of Mexico the eocene is either bounded by this or the alluvium of the Gulf. (14.) At the mouth of Pearl river, the boundary of that formation falls again, together with the boundary line of the State, passes consequently in Pearl river N. to 31° of latitude; from there, W. along that degree of N. lat. to where it reaches the loëss or bluff, or postpliocene formation on the Mississippi river, in Wilkinson county, about ten miles from the river, in Range 3. From that point it passes N. through Wilkinson, Adams, Jefferson, Clayborne, and Warren counties, at an average distance of about ten miles from the Mississippi river. From Vicksburg to the mouth of the Yazoo river, it forms the eastern banks of the Mississipi river, extends along the southern arm of the Yazoo river, through ranges 4, 5, 6, townships 7, 8, and 9, to a mile below Satartia. Which line, from Vicksburg to Satartia, separates it from the alluvium of the Mississippi river, and may be considered as correct. The territory circumscribed by the above boundary lines, has an area of about 20,376 square miles, or 7,040,640 acres of ground.

The eocene formation within the State of Mississippi is not entirely limited to the southern part; a small portion of it is found in the northern part of the State. It extends, as the geological chart indicates, from the upper part of T. 1, Ranges 1 and 2, in Pontotoc county, where it takes a western course from the line of the cretaceous formation northwards, in R. 1, from the line of Lafayette county, to the Tippah creek, in T. 4, R. 1, Marshal county; from there it takes a north-western direction, and runs through T.'s 4 and 3, R. 1; T.'s 3 and 2, R. 2; T.'s 2 and 1, R. 3, into the State of Tennessee. From about a mile west from the mouth of Mudd creek, it runs along the boundary line of the cretaceous formation to the southern line of Tippah county, in T. 6, on the line between R.'s 2 and 3. Its area amounts to about 360 square miles, and 230,400 acres of ground.

4.—THE NEWER TERTIARY, OR MIOCENE FORMATION.—(15.)

The middle portion of the upper or northern part of the Mississippi is taken up by the newer tertiary, or, most probably, the miocene formation. On the eastern side, through the counties of Kemper, Noxubee, Ocktibbeha, Chickasaw, and Pontotoc, the boundary line coincides with that of the cretaceous formation; from T. 6, R. 3, in Tippah county, the line runs westerly towards Lafayette county, around the eocene of Tippah; it turns then N., runs up in R. 1, W. of Marshal county, enters into R. 1, E. in T. 4 of Tippah, continuing N. E. through T. 3, R. 1, E.; T. 2, R. 2; T. 1, R 3, E., where it strikes the line of Tennessee, which cuts off its continuation in the State of Tennessee, to where it meets the alluvium of the Mississippi river, near the dividing line of R.'s 8 and 9 W.

From this point, to about one mile below Satartia, the miocene runs along the alluvium of the Mississippi, Yazoo, and Cold Water rivers. It turns first S., near the dividing line of the R.'s 8 and 9, W., to T. 4, R. 8, W.; passes there around a projection of the bottom of Cold Water river. From the division line of T.'s 4 and 5, R. 9, W., in De Soto county, it runs again in a southern direction to T. 29, R. 8, W., in Panola county; there it runs around a projection of the bottom of the Tallahatchie river. From T. 28, R. 8, W, in Panola county, the line between the miocene and the alluvium of the Mississippi takes again a southern course towards Charleston, in Tallahatchie county, and passes, about a mile W. of that town, through T.'s 25, 24, 23, R. 2, E.; from there it runs around a projection of the alluvium of the Yallabusha river. From the line of Tallahatchie county, T. 22, R. 2, E., it turns again S., down in R. 2 E., through the townships 21, 20, 19, 18, 17, in Carroll, and T.'s 16 & 15, in Holmes county. From there it takes a S. W. direction towards the S. W. corner of T. 14, R. 1, E., in Holmes county; continues in that direction to Yazoo city, where the bluff comes within a very short distance of the Yazoo river; thence it passes through ranges 8 and 7, E., townships 11 and 10, to a mile below Satartia, which is its most southern point.

The miocene meets there the eocene, and turns, consequently, eastwards, through the counties of Yazoo, Madison, Scott, Newton Neshoba, Kemper, and Lauderdale, along the northern boundary line of the eocene, as before stated. The superposition of the miocene formation is elucidated by the longitudinal sections on Tab. III., under Nos. 2 and 3. The area comprised in these boundaries contains about 10,692 square miles, or 6,842,880 acres of ground.

5.—THE POSTPLIOCENE FORMATION.

This formation consists, in Mississippi, principally of the loëss or lehm, or bluff formation, of the Mississippi river, which is found all along the bluff bordering the alluvium of the Mississippi. It appears first on the W. side of Horn lake; farther down in De Soto, Panola, and Tallahatchie counties; in Carroll county, especially opposite the town of Greenwood; in T. 19, R. 2, where the road to Greenwood crosses the bluff; in Holmes county, and again in Yazoo county, especially W. of Yazoo city, and in several other places in that county; but these places are not continuous, and their area cannot be estimated. A very considerable deposit of this loëss, or bluff formation, is found beginning at the city of Vicksburg, and extending all along the Mississippi river, at an average distance of about ten miles from that river to the line of Louisiana. It extends there over an area of about 972 square miles, or 593,280 acres of ground. The prairies of Mississippi, as well those overlying the cretaceous formation in Pontotoc, Itawamba, Chickasaw, Monroe, Lowndes, Ocktibbeha, and Noxubee counties, as those of less importance overlying the eocene in Clarke, Wayne, Jasper, Smith, and Scott counties, belong to this formation, as will later be shown; but they are so little continuous, that their area cannot well be estimated separately; it has therefore been estimated with those formations which they overlie.

6.—THE ALLUVIAL FORMATIONS OF THE MISSISSIPPI.

The most important of these alluvial formations is that of the Mississippi river, under which name the bottoms of the Yazoo and Cold Water rivers are also comprised.

The alluvium of the Mississippi river commences in the State of Mississippi, on the southern part of Horn lake. Its eastern boundary line coincides with that of the miocene, or newer tertiary, which has been traced under that head. From Satartia, where the miocene formation ends, the alluvium is bounded by the eocene formation, the boundary line running through T. 19, R. 6, W., in

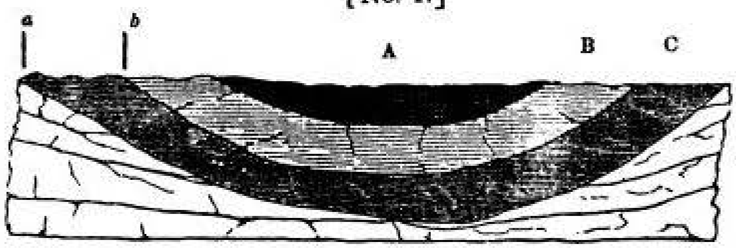
Yazoo county, and through T.'s 18 & 17, ranges 5 and 4, W., in Warren county, to Vicksburg, along the Yazoo river. From there upwards to Horn lake, the Mississippi river is the boundary line in this State. The area comprehended in those limits amounts to 7,092 square miles, and 4,338,880 acres of ground. There is more alluvium in the State; every river, every considerable creek, has its alluvial territory. There is also some more alluvial formation along the Mississippi river, from Vicksburg to the line of Louisiana, and, most probably, an alluvial edge along the Gulf of Mexico; but it is too unimportant, and too little continuous, to estimate its area, and circumscribe it. The other alluvium along the Mississippi river, from Vicksburg to Louisiana, and along the Gulf of Mexico, contains about 252 square miles, with 161,280 acres of ground, and the whole area of the State of Mississippi must therefore be estimated, as it has been done above, to contain 45,468 square miles, and 29,099,520 acres of ground, provided the surface of Mississippi were a level plain; but the undulation, or its hills and valleys, which cannot be estimated, must considerably increase those numbers.

LITHOLOGICAL AND PALAEONTOLOGICAL DESCRIPTION OF THE CARBONIFEROUS FORMATION.—(16.)

1.—THE CARBONIFEROUS FORMATION.

The carboniferous formation belongs, as the table on Plate I. shows, to the primary fossiliferous, or palæozoic age of our globe, and lies immediately above the two transition formations, the silurian, and devonian. It consists of three distinct divisions, the mountain limestone, the millstone grit, and the coal measures, which overlie each other, as the following diagram shows:

[No. 1.]



Underlying rocks.

A. Coal measures. B. Millstone grit. C. Mountain limestone.

The carboniferous formation appears generally like a large basin, as it were, on the bottom of which lies always the mountain limestone; then follows the millstone grit, and the upper part of it forms the coal measures, which alone, of the whole formation, contain the coal, in distinct layers of variable thickness, from that of some inches to many feet. Many of such layers lie generally over each other. It is, therefore, only in such countries as contain the upper stratum of the carboniferous formation, that coal can be found.

The carboniferous formation extends from Alabama, or from E. to W., into the State of Mississippi, and only that portion contained between the perpendicular lines, *a b*, the mountain limestone, extends into Mississippi; consequently there cannot be any coal in this State—the coal measures belonging to that formation must terminate farther E., and so they do.

There are large coal fields in Alabama belonging to the same formation, which has its western terminus in Mississippi.

The carboniferous formation in Mississippi consists especially of massive lime and sandstones. The end of this formation seems to consist entirely of sandstone. The most southern outcrop is in T. 10, Sec. 30; T. 11, Sec. 6, R. 9, in Itawamba county; it crops out again about twenty miles N. of Fulton; and a very conspicuous outcrop is about four miles from there, at Graham's mills; it appears here in gigantic masses and picturesque beauty.

The same sandstone crops out again in Tishamingo county, T. 5, R. 11, E., Sections 29 and 30. It was at this place that the sandstone was carefully examined. The outcrop is about half a mile long, and from forty to fifty feet high. A little creek, a tributary to Big Bear creek, runs through the middle of it; and small as the creek appears, its waters have had a powerful effect upon the huge sandstone ledges: they are all broken off, fallen down, and lie scattered and overturned about—scarcely one of the ledges near the creek is in situ (in its original place); and if such ledges, lying nearly horizontally in their original place, were not found in the bottom of the creek, the scattering and breaking down of the ledges, some of them measuring more than twenty feet in diameter, could have been attributed to a powerful catastrophe.

The dip of the sandstone was indeed very difficult to determine, the ledges of rock having been all removed from their original place. At last a large ledge of rock having been found in situ, especially at the bottom of the creek, it was ascertained that their dip was from N. N. W. to S. S. E., or more accurately, S. 15° E.; they strike consequently at right angles. The scenery on this little creek is decidedly, if not the most, at least one of the most picturesque in the State of Mississippi, reminding of some of the prettiest sceneries in the Alleghanies and White Mountains; and if the scantiness of the apparatus had not been an insurmountable obstacle, it would have made a frontispiece of this little volume and exhibited a picturesque beauty which nobody would have sought in this State.

It was at first, indeed, difficult to determine, whether the sandstone, which is very similar in its petrographic character to the Medina sandstone of the Niagara group of Western New York, belonged to the silurian or carboniferous formation, as it is perfectly destitute of fossil remains, except some indistinct fucoids, which could as well be silurian as carboniferous.

It was only later, when that sandstone was found alternating with the characteristic mountain limestone, that all doubt was removed.

The sandstone is compact and fine-grained, of a light gray color, and of different hardness, which seems to increase from exposure to the atmospheric influence ; it is differently jointed and laminated, and easily quarried in the shape of flag-stones, and the heaviest building-stones. The fossil fucoids are especially found on the planes of the joints and cleavage.

On the right or east side of Big Bear creek, in R. 11, T.'s 6 and 5, a range of hills comes from Alabama, extending from S. S. W. to N. N. E. ; all the hills contain the sandstone, which, in a small rivulet or branch, appeared about one hundred feet thick, and finely laminated. The limestone overlies here the sandstone, and contains a great many fossils. Stems of crinoids, spirifer, orthis, productus, and terebratula, are the most prominent of them.

Other outcrops of the carboniferous sandstone are in T. 6, R.'s 9 and 10, E., especially in Sec. 14, T. 6, R. 9, E., near Grisholm's mill. The stone exhibits here the same character. In T. 5, R. 10, E., Sec. 36, there is an outcrop of the sandstone, which presents vertical walls on both sides of a valley of a little branch, from fifteen to twenty feet high. Here also the little branch has caused ravages which could be attributed to a powerful catastrophe, were it not that the ledges of sandstone in situ show an undisturbed position, which could not be the case if such a catastrophe had taken place. The hillsides of the little valley are strewn with blocks of sandstone of various sizes. The sandstone is here distinctly stratified, and may be quarried in any size ; it is also of different hardness ; in some parts it may be broken and crumbled between the fingers, in others it is suitable for grindstones.

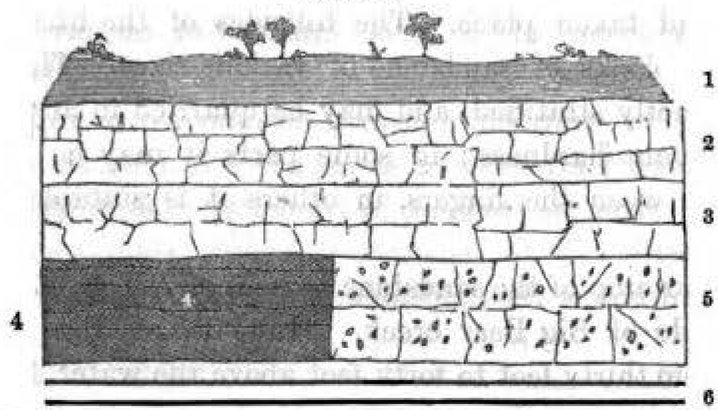
Another outcrop of the sandstone is in Sec. 7, T. 6, R. 11, E., on the right side of Big Bear creek. Huge ledges rise here to the height of from thirty feet to forty feet above the water, forming also a beautiful scenery. The stone here is of an excellent quality, and admirably fitted for grindstones.

In some places the sandstone alternates with hornstone, this is the case in T. 4, R. 11, E., Sec. 15 ; the sandstone is here in part transformed into flinty hornstone, and contains characteristic carboniferous fossils; for instance, fenestella, cyathophyllum, pentatrematites, terebratula and leptaena.

Another outcrop of the carboniferous sandstone is on Cedar creek, T. 6, R. 11, E. Its dip is here exactly as before mentioned, S. 15° E. The carboniferous limestone crops out N. of Cedar creek; it has the same dip as the sandstone, and it appears here clearly that both rocks are co-ordinate, or in juxtaposition, alternating with each other, and not over, nor underlying each other.

This fact is confirmed on the plantation of Mr. Suddard, in T. 5, R. 11, Sec. 20. The carboniferous sandstone crops here out, and yields fine grindstones of different hardness. It is in some places nearly hard enough for mill-stones. Not far from the outcrop of the sandstone, the mountain limestone appears above ground all along the hills. On one hill, nevertheless, the sandstone was found on the brow of the hill, and not far from it, in a little creek or branch, the limestone appeared at the bottom of the creek, which rendered it again somewhat doubtful whether the limestone was subordinate to the sandstone or not. This question being an important one, as in the case of the subordination of the limestone, the sandstone might belong to the millstone grit of the carboniferous formation, I went to a deep cut on the railroad, in Buzzard-roost valley, in Alabama, where both sandstone and limestone were said to have been cut through. The annexed diagram represents the situation of the different carboniferous rocks of that locality:

[No. 2.]

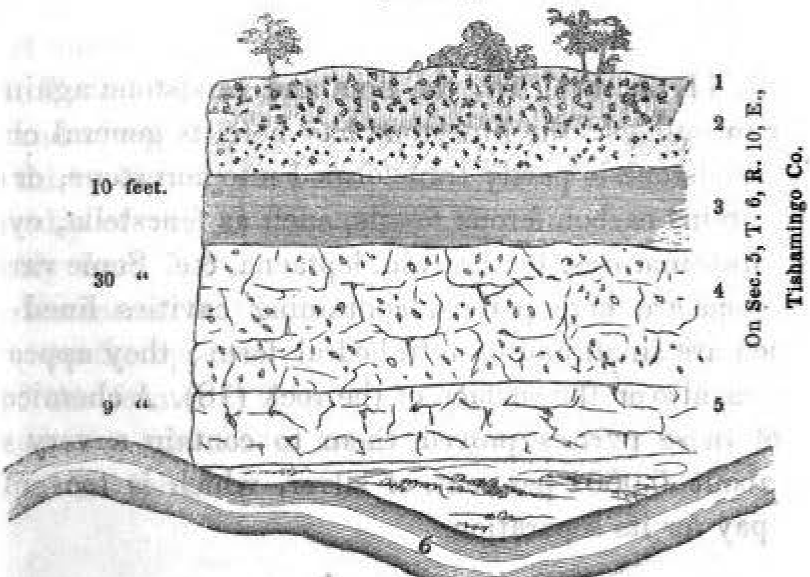


1. Red sandy clay, of the tertiary age, 6 feet thick.
2. Gray sandstone, smaller jointed, 10 feet thick } Without fossils.
3. Sandstone of the same color, 10 feet thick. } Without fossils.
4. Soft and brittle schistose aluminous slate. } Without fossils.
5. Mountain limestone, with many fossils, as terebratula, spirifer, orthis, and crinoids, of different genera and species, especially the stems of them are numerous.
6. Memphis and Charleston Railroad.

The sandstone lying here only in small ledges over the limestone, it appears doubtless that both alternate, especially as at another outcrop on Sec. 5, T. 6, R. 10, E., in Tishamingo county, the latter overlies. There, on a creek, an indurate black schistose slaty clay, with distinct stratification lines of a whitish yellow color (doubtless the same schistose aluminous slate found at Buzzard-roost, and represented in the foregoing diagram), lies at the bottom of the creek. Above this stratum of clay or slate, softened by water standing over it, there is a layer of yellowish or reddish hard sandstone, which cleaves easily in irregularly shaped flags, of from ½ to 1½ inches in thickness, with an uneven surface, and impressions of indistinct and nearly indiscernible fossils, among which seem to be those of crinoidal stems, and pentatrematites.

This layer of sandstone is about 9 feet thick; above it appears the mountain limestone, of a grayish color and very crystaline in its structure. It is some 30 feet thick, and not of the same texture in all its parts; in some places it is more loose, and not impenetrable to the atmospheric precipitations, which wash it, therefore, on such places, and detach the fossils, of which it contains a great many, consisting chiefly of pentatrematites, cyathophyllum, fenestella, leptaena, orthis, spirifer, and the terebratula, &c. The following diagram exhibits the appearance of this most interesting outcrop, which settles the question of the position of the different rocks and of the quality of the sandstone, as a simple alternate of the limestone, and a member of the mountain limestone formation, definitely, as the limestone found in Buzzard-roost underlying the sandstone, overlies the latter here:

[No. 3.]



The stratum No. 1, represents the conglomerate stone of oxide of iron and sand lying on the top; then follows No. 2, orange sand, containing pebbles of hornstone, or chert, jasper, &c. No. 3 represents a stratum of black schistose clay, about 10 feet thick. These three upper strata are evidently of tertiary origin, belonging to the orange sand group, which will later be mentioned and discussed; then follows, in a descending order, the fossiliferous limestone, in No. 4. No. 5 is this sandstone underlying limestone, and No. 6 is the bed of the creek, containing, as a foundation, the schistose clay; the latter is most probably not fossiliferous as the aluminous schistose slate at Buzzard roost.

On Big Bear creek, on the S. E. quarter of Sec. 18, T. 5, R. 11, E., the mountain limestone crops out, and continues along the little creeks which empty into a pond near Bear creek. It shows here the character of yielding to the action of water, as it generally does in all formations where it is found. The Assistant Geologist, Dr. Hilgard, gives in his field notes the following interesting description:

"One of the little creeks emptying into Cypress pond, after flowing for some distance in a narrow channel, which it has excavated into the rock, disappears entirely beneath it, flowing in a tunnel from 18 to 24 inches wide, by three feet high. I followed it up for some 20 yards; it narrows occasionally, but could be followed up still farther. Several small channels of similar nature empty into it—all washed by water. The appearance of the surface of the rock is strikingly like that of the ice in glacier vaults, all scooped out into rounded cavities, adjoining to each other, like the cells in a honey-comb. The projecting angles of this cornice work serving as points for the drops of water to fall off from, after having exercised the solvent action on the mass. Yet there are no stalactites. The fetid bituminous smell of the limestone pervades the whole cave and also the water of the branch, rendering it undrinkable."

On T. 4, R. 11, E., Sec. 15, the lime and sandstone again crop out together in gulleys; the limestone has here its general character, but the sandstone is partly transformed into hornstone, or chert (17). It contains carboniferous fossils, such as fenestella, cyathophyllum, pentatrematites, terebratula, leptaena, &c. Some varieties of the hornstone are here porous, containing cavities lined with pyrites, which are small and of tetrahedral form; they appear, in some instances, also on the surface of the rock (18). A chemical examination of these pyrites proved them to contain a very small proportion, about 0.0001 per cent. of silver, which is too small a quantity to pay for its separation.

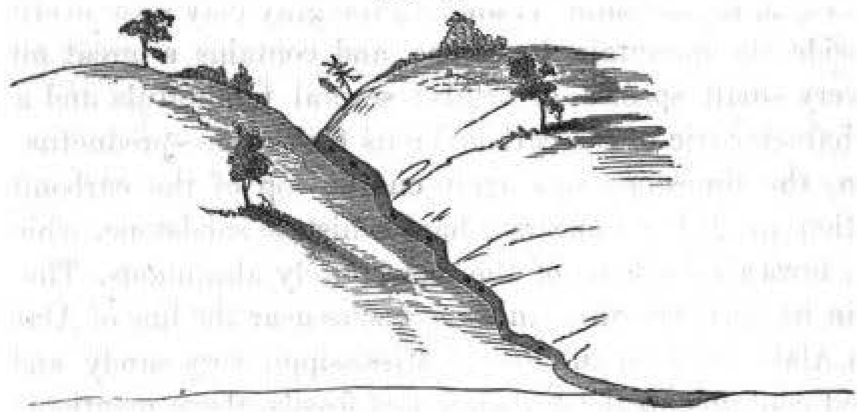
On Sec. 9, of the same T. and R., the gray clay slate overlies on a hill-side the mountain limestone, and contains a great number of a very small species of orthis; several terebratula and a shell very characteristic of the carboniferous formation—productus. Farther on, the limestone lies again on the top of the carboniferous formation and below appears a hard schistose sandstone, which becomes, towards the basis of the rock, purely aluminous. The limestone in its turn becomes, in some places near the line of Alabama, and in Alabama, near the line of Mississippi, very sandy and friable, and contains all the carboniferous fossils above mentioned, except orthis. On Yellow creek, T. 2, R. 10, E., near Turner's Mill, the hornstone appears in a position which shows distinctly that it alternates with the mountain limestone, showing, nevertheless, transition into sandstone. Near the mouth of Yellow creek, nearly on the line of Mississippi, a slaty limestone crops out about 5 feet above the level of the creek: it is sandy, and becomes, by degrees, really calcareous sandstone; it does not split easily, and is, therefore, unlike the aluminous and slaty limestone at Eastport, which will be mentioned below.

The examples above quoted, have, I believe, sufficiently shown that the carboniferous formation, or rather its lowest member, the *mountain limestone*, does not only consist of limestone, but also of sandstone, hornstone, and a soft schistose clay slate, and that these different rocks are not subordinate to each other, but co-ordinate, and occur in juxtaposition. Another most interesting outcrop of massy rocks, in which all the above rocks are blended in an admirable manner, will corroborate that conclusion.

This outcrop occurs on a hill N. N. W. of the town of Eastport, R. 11, T. 2. It is only a few hundred yards distant from Eastport, and about the same distance from the Tennessee river, and from thirty to forty feet under the brow of the hill.

The dip of the rock is most difficult to determine; it is most probably from N. N. W. to S. S. E. On the east side of the hill the aluminous linestone approaches the road to the Tennessee river; on the opposite side another hill rises, half way from the top of the former hill, and a little rivulet or brook falls down between the two hills, from terrace to terrace, as the annexed diagram exhibits:

[No. 4.]

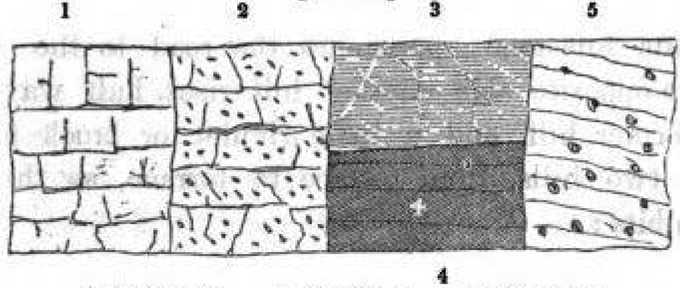


Upon some of the terraces the water has scooped out smooth round or oblong basins, which are filled with water, and appear as if formed by art. The aluminous limestone appears here from forty to sixty feet thick. It is generally of a bluish color; in some places lighter, in others darker, varying also in hardness, as the basins scooped out in the above terrace prove. It appears destitute of fossils. All the different rocks of the mountain limestone above mentioned, are blended in this limestone. It is a mixture of the aluminous schistose slate, and of the original limestone, having retained the slaty form of the former. In it are found a great many cherty nodules; some more sandy, others more flinty, representing the horn and sandstone; often the nucleus of these nodules consists of a small pyrite. These nodules are much harder than the slaty limestone, and form knotty protuberances on its surfaces. The limestone, when broken, or struck with a hammer, or rubbed, emits a nauseous and offensive odor.

There is an outcrop of the same kind of limestone on Yellow creek. Another outcrop of the same aluminous limestone is about half a mile W. of Eastport.

According to the above description of the mountain limestone group, as found in the N. E. corner of the State of Mississippi, it must be represented as in the following diagram:

[No. 5.]



1. Sandstone. 2. Limestone. 3. Hornstone.
4. Aluminous schistose slate. 5. Slaty aluminous limestone.

All the different members of the mountain limestone, where they occur in their simple state, seem to be fossiliferous, and the real limestone is certainly most so; where they are blended in the slaty aluminous limestone, I have never been able to discover any fossils.

The carboniferous fossils found in the mountain limestone group are:

1. Fucoides (cellular plants).
2. Fenestella (polyp. bryozoa).
3. Cyathophyllum (polyp. anthozoa).
4. Pentatrematites (radiata).
5. Terebratula,
6. Leptaenae,
7. Orthis,
8. Spirifer,
9. Productus (19).

} Acephalous molluscs. (5–9)

To these may be added, 10. Gorgonia (polyp. anthozoa), which was found on a hill in Eastport.

The above enumerated rocks are all those found in the N. E. part of our State, which can be admitted to belong to the carboniferous formation; but these rocks crop out only in, comparatively, very few places. They are generally covered, and, in many places, especially towards their western limits, very thickly covered.

It will be most suitable first to consider and examine the different materials of the geological formation overlying the mountain limestone group, and then try to account for their origin, and determine their geological character and comparative age.

2.—ROCKS OVERLYING THE CARBONIFEROUS FORMATION.

The rocks overlying the mountain limestone group of the carboniferous formation of the N. E. part of the State of Mississippi are not uniform, but of a great variety, and exhibit very distinctly their double origin from disintegration of older rocks and importation from abroad.

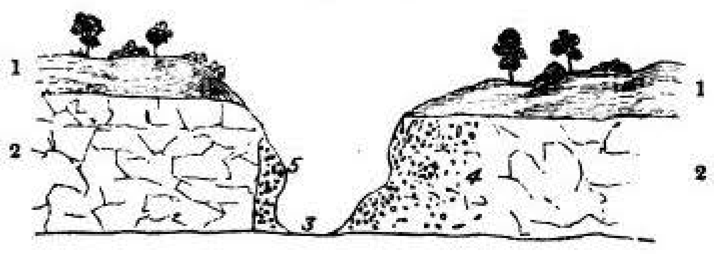
The most general cover of the carboniferous, as well as of the adjacent cretaceous rocks, consists of coarse red sand (20), which is most generally of an orange color, but sometimes of different shades.

This orange sand is found in T. 5, R. 10, on Sec. 6. It overlies the ground about eight or ten feet thick ; it changes then to a greenish and yellowish color, and extends fifty feet and more downwards. It is interstratified with pebbles, consisting of jasper, hornstone, flint, agate, and other species of quartz, crystalline quartz being nevertheless scarce. These pebbles are frequently, and also in this locality, cemented together with a strong cement of brown iron ore, and appear as pudding-stone. On Sec. 5, T. 6, R. 10, E., the pebble strata are very conspicuous, and the pebbles are found now and then to be very large. The pebbles, as well as the iron conglomerate are contained in the orange sand.

Below the orange sand is a stratum of black schistose clay, also evidently of tertiary origin. I refer here to Diagram No. 3, which exhibits, in No.'s 1, 2, 3, the strata here mentioned. The place where the outcrop is found is marked in the chart of Tishamingo county, 3.

A very interesting locality is found on Sec. 34, T. 5, R. 10, E. A little creek runs here from N. to S., between two hills E. and W. On the hill on the E. side the white silicious sandstone crops out at

[No. 6.]



1. Orange sand.
2. Carboniferous sandstone.
3. Bed of the creek.
4. Pebbles belonging to the orange sand.
5. Outlier of the pebbles cut off by the creek.

2, while on the W. side the opposite hill consists entirely of the pebble conglomerate. As on the E. side, the pebbles extend below the sandstones down to the bed of the creek ; it appears, at first sight, as if the pebble conglomerate were actually overlaid by that carboniferous structure; but the creek, which flows exactly in the dividing line, where the carboniferous sandstone extends no farther, has evidently excavated its bed through the pebble stratum, and left a portion of it as an outlier on the E. side.

All about in this township the hills are capped with the common orange sand formation ; in many places the pebble stratum appears, and here and there the pebbles are cemented with oxide of iron, and transformed into pudding-stone. In some places this orange sand stratum is underlaid by clay of different colors; so for instance in Sec. 4, T. 6, R. 10, E., in the bed of a little creek or branch, appears under the pebble stratum a yellowish white clay, varying much in its composition, from clayey sand to sandy clay; in some places it exists as a nearly pure white plastic clay. It belongs, evidently, to the tertiary strata. The pebbles above it consist of every variety of quartz. Even on the other side of Big Bear creek, in Range 11, the orange sand group is nearly everywhere found overlying the carboniferous formation, and contains in many places the pebbles; in other places they are transformed into pudding-stone: this, for instance, is the case on Sections 7, 8, 9, T. 5, R. 11, E. In Section 8 these pudding-stone strata are found in every state of hardness and quality, from the common iron sandstone to the hard pudding-stone, which forms here what is called by the German geologists "nagelfluh," a formation so very characteristic to the miocene (or molasse formation of Bronn) in Germany, and especially in Switzerland.

In the above described manner, the orange sand group appears all over the carboniferous formation, but its members are not always the same, only the sand seems very general, although it adopts different colors in different places.

On Sec. 8, T. 5, R. 11, E., between Big Bear and Cedar creeks, a well was dug in the S. E. part of the section. For about 30 feet the diggers penetrated only orange sand and pebbles, but at this depth they struck a layer, which they called "*white chalk*," a stratum of the highest importance for the county of Tishamingo, and, indeed, for the whole State of Mississippi. This white chalk proved to be, on examination by the Assistant Geologist, Dr. Hilgard, the same kaolin, or *porcelain* clay already found nearer to Eastport by the author, in 1853. It appears here like true kaolin, free from sand, and, when dry, of a pure white. The well-diggers dug from 20 to 30 feet in this stratum of kaolin without penetrating it. Every section in which this kaolin has been found is marked in the chart of Tishamingo county with +, and the district is enclosed in a dotted line.

On Sec. 7, in the S. E. portion of the county, the kaolin crops out on the hill side, and a spring issues from its surface. It is here not quite as pure as on Sec. 8. It is in contact with the pudding-stone, and of course the oxide of iron, contained in abundance in this stone, has been imparted to it; it contains, therefore, here, red veins. Farther W., or rather S. W., at the head of the little creek tributary to Cedar creek, the surface consists entirely of schistose clay, and it appears as if the kaolin deposit terminates here, not extending farther S. nor W.

That slaty clay underlies in various places the sand and pebble stratum, and appears to be lower than the former. An outcrop of it is found on Sec. 9, T. 5, R. 9, E.; it comes here from under the orange sand, in the bed of a creek tributary to Mackay's creek. A large piece of fossil wood was found in the bed of this creek.

Upward, towards the N. in this range, the orange sand is found everywhere overlying the older formation; it contains frequently the ferruginous sandstone, and assumes, in some places, a greenish yellow color, from an admixture of glauconite (21).

On Sec. 33, T. 5, R. 9, E., wells havs been dug 80 feet deep, and the orange sand has not been entirely penetrated.

The black schistose clay of the overlying tertiary formation crops out also on Sec. 15, T. 4, R. 9, E.

On Sec. 4, T. 4, R. 10, E., a well was dug 93 feet, and the tertiary cover of the carboniferous formation not penetrated; at 30 feet the slaty clay was struck, this was only 10 feet thick, for the rest of the depth of the well, about 53 feet, a greenish yellow sand was dug into. The surface of the schistose clay contains the iron pyrites, so common in the lignite group.

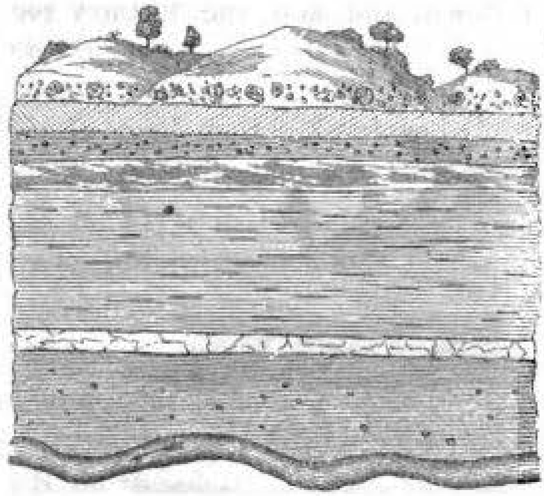
On Sec. 18, T. 4, R. 11, E., the kaolin crops out on Crippled Deer creek. It is here perfectly white, but contains some grit and pebbles. A mile from there the kaolin was found about 28 feet below the surface; here, also, it appeared gravelly or gritty.

Another outcrop of the kaolin is on Sec. 8, of the T. and R. It appears here in the bluff of a creek, a tributary to Big Bear creek, about 10 feet above the bed of the creek, underneath a stratum of the pudding-stone. The upper part of the kaolin is perfectly white but gritty; farther down it is of an excellent quality; it has been used for whitewashing (22). A mile farther E., on Sec. 7, the kaolin appears at a spring, and is also of good quality.

All along the Alabama line the orange sand caps the hill; it overlies the mountain limestone group, and contains here and there pebbles and pudding-stone. On Sec. 33, T. 3, R. 11, E., the kaolin has been found in the Memphis & Charleston Railroad, only five feet below the surface. It appears here very white, containing only now and then red veins, and sometimes large, deep red lumps, but it is gritty.

Another outcrop of the kaolin, or "white chalk," as it is called by the inhabitants of Tishamingo county, or of the kaolin district only, is on Sec. 24, T. 3, R. 10, E., on a creek tributary to the Tennessee river. The outcrop is represented on diagram No. 7 here below:

[No. 7.]



No. 1 of the diagram is a layer of the pudding-stone. It caps the surface.

No. 2 is a layer of loose white sand, 10 inches thick.

No. 3 is a stratum of loose pebbles imbedded in clay, about 14 inches thick.

No. 4 is a layer of clay of variegated appearance, principally red and blue, about 10 inches thick.

No. 5 is the stratum of kaolin. It is white, with red streaks; hard and indurate above, more soft and sandy, and of a reddish tint, below; it is 8 feet thick.

No. 6 is a seam of ferruginous conglomerate, 6 inches in thickness.

No. 7 is again a layer of yellowish sandy clay, containing loose pebbles.

No. 8 is the bed of the creek.

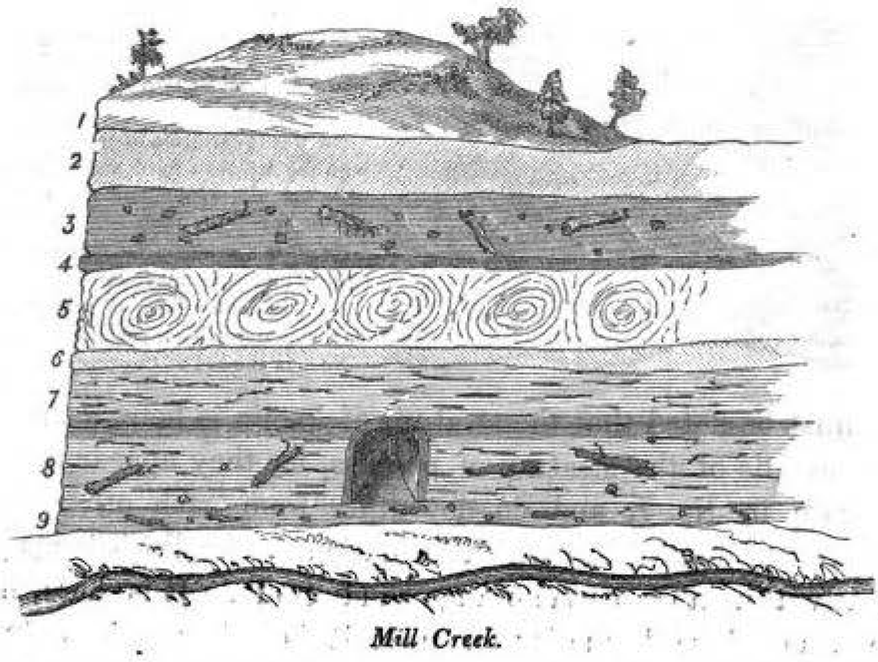
It must be noted that the stratum of kaolin is here, as it were, in the middle of the stratum of pebbles, for they appear in No. 3, and again in No. 7, and do not differ from each other. It is, therefore, not doubtful to which formation the kaolin belongs; it is evidently a member of the orange sand group. It is here, nevertheless, not of good quality for use; it is gritty and sandy, and full of red ferruginous veins.

Other outcrops of the kaolin are on Secs. 24 and 25, T. 6, R. 11, E.; but, as they are in Alabama, they can only serve to indicate the line of the kaolin district, which has, therefore, been marked out with red on the accompanying chart of the county of Tishamingo.

On Sec. 22, T. 3, R. 11, E., in the midst of the hills overgrown with pines and capped with the pebble stratum, there occurs *brown iron ore*, in veins and layers, in the ferruginous sandstone, which would be useful if the quantity were not insufficient, containing about 55 per cent. of iron. This ore is evidently a member of the sand group; the sand in which it occurs is the orange sand, assuming here a yellow color, and it is mixed with grains of cairngorm stone (a light yellow and pellucid variety of quartz-crystal, also called false topaz) and turmaline, or shorl and mica (23).

A fine view of the tertiary rocks, overlying the carboniferous here very thickly, affords the section of a hill, near Warren's mill, in T. 4, R. 9, E., where some young Georgians, only a short time before my arrival there, had mined for copper ore, and dug a gallery in a high hill. Diagram No. 8 represents the hill, a large part of which had slid down, and laid the tertiary rocks bare.

[No. 8.]



No. 1 of the diagram represents the top of the hill, overgrown with shrubbery and trees which had not slid down; it consists, necessarily, of the same orange sand as No. 2.

No. 3 contains the same sand, but filled with oxide of iron, conglomerate, lignite and sulphuret of iron or pyrites, both together, about eight feet thick.

No. 4 is a seam of ferruginous conglomerate and lignite, from six to eight inches thick.

No. 5 is a stratum of greenish clay, with most singular contortions, which indicate that when this clay was deposited by the water, there must have been a whirlpool, and the water consequently have had a considerable depth.

No. 6 is a seam of yellowish green sand, increasing in thickness towards the right side to about two feet.

Nos. 7 and 8 are two strata of blue and purple clay, in some places of a beautiful color, interstratified with red and green sand of very lively colors.

No. 9 is a seam of hard rocks, abounding in lignite, and sulphuret of iron.

No. 10 is the entrance of the gallery, dug by the above mentioned Georgians to the depth of more than thirty feet; it runs S. S. E. (24.)

All the different strata lie perfectly conformably upon each other, and it does not appear that any considerable interval existed between the deposition of all of them. This circumstance, then, alone renders it in the highest degree probable that all the different strata, as they appear there, belong to the same geological period; and it will be shown, later, that that fact is beyond all doubt. South of Eastport the hills are mostly capped by the pebble stratum; but by degrees large fragments of hornstone begin to appear, increasing eastwards.

In the neighborhood of Eastport the angular fragments of hornstone are frequently cemented together by oxide of iron, and form a breccia (25). The hornstone originates evidently from the carboniferous formation itself, and may have come either from below, or been carried there from Tennessee or Alabama, where that formation is much better developed than in Mississippi.

The breccia appears in a very conspicuous manner on Sec. 26, T. 2, R. 11, a little more than a mile from Eastport. It is here extremely hard, and would be useful for ornamental purposes, if it were not for its unevenness.

About two miles from Eastport, on Secs. 26 and 23, T. 2, R. 11, E., very near Big Bear creek and the line of Alabama, from forty to fifty feet under the brow of a hill (the locality is marked with an S. on the chart of Tishamingo), there is an outcrop of a white substance, called, in Eastport and the neighborhood, "chalk," and frequently used as such for writing or marking. At first appearance this looks exactly like another outcrop of the kaolin. The outcrop is about five feet above the water of a little rivulet running below the hill, which has washed away a part of the foot of the hill, and caused a portion of the latter to slide down.

As the kaolin appears below the pudding-stone, so this white "chalk" appears below the breccia. The layers of hornstone above it are from two to six inches thick; they consist of broken and angular pieces. The "white chalk" is hard and indurate in many places, and exhibits every stage of transition, from hard quartz into a soft mass, its softest part being in the middle portion of the stratum.

A specimen of the "chalk" was taken along to the laboratory, and, after a careful quantitative analysis, found to be not kaolin, as I at first sight suspected, but nearly pure silica (26).

The deposit is inexhaustible; any quantity of the silica can be obtained by a very easy process. The deposit is even not confined to the hill under which it crops out; by digging a well in Eastport, on the hill whereupon stands the Academy, to the depth of one hundred and sixty feet, a stratum of ten feet of this silica was found underlying a layer of breccia, and it may extend even farther than that.

We have now to decide to which formation this stratum of silica belongs. We have seen it is found under a stratum of hornstone; and were this rock in situ (or in its original place), there could not be the slightest doubt, according to a geological law, "that the lower of two strata, in situ and undistorted, is the older," it must be a member of the mountain-limestone group; but the stratum of hornstone under which the silica is found is evidently not in situ; it is a detrital agglomeration, consisting merely of angular pieces of that rock which has been broken up, removed by aqueous agency, and re-deposited where we find it now overlying the silica; and of the same origin is the silica, which most probably is nothing but a detritus of the quartzose hornstone.

The existence of such a detritus in the solid mass of hornstone, protected by the overlying stratum from the influence of the atmosphere, would be a most unaccountable fact, but the silica, in the shape of quartz-rock, has probably first been removed from its original place by aqueous agency; it has been for a long time, perhaps, exposed to two different agencies, the aqueous and atmospheric, transformed from quartz into silica, and then re-covered by a new stratum of detritus of hornstone, and later by sand, and in this state we find it now.

The question, to what formation it belongs, is, therefore, not difficult to decide. It belongs to a formation of that time in which the agencies, that reduced the silica to the state in which we find it now, were active. We shall see later that this must have been during the tertiary period, and the silica is, therefore, unquestionably a deposit and rock of that age. The same is the case with the kaolin, but the question where this has to be located in the chronological table of geology, is much less difficult to decide.

Kaolin cannot be the detritus of hornstone, as we shall see later, the material from which it originates, either feldspar or feldspathic rocks, are even not found in its vicinity; the material must, therefore, have been transported thither by aqueous agency; it is, besides, found under water-worn pebbles, *shingle*, as we may well call them, and in one place even in the midst of such shingle, and cannot but belong to that tertiary formation of which the pebble stratum of the State of Mississippi, one of its most interesting formations, is a member; and this we have to discuss in a particular essay—meanwhile we will consider it as a member of the orange sand formation.

From Eastport, west, and south westward, the surface formation is very changeable; in some places the ground is covered with angular pieces of hornstone, in others, only a few hundred yards off, with pudding-stones. In some instances, hornstone fragments cover the lower part of the hills, and above them, near the top of the hills, appears the pudding-stone, not unfrequently in large blocks, forming a true "nagelfluh" of Switzerland.

Sometimes the angular fragments of hornstone are of considerable thickness, hornstone on one side, sandstone on the other; and a porous mass like tufa or pumice-stone in the middle, which is sometimes full of carboniferous fossils. The breccia of Eastport appears confined to the vicinity of Big Bear creek and the line of Alabama.

On Sec. 30, T. 2, R. 11, E., there is another interesting and not unimportant outcrop of "chalk," as it is termed by the inhabitants of the vicinity, who appear to call every friable earth which will make a mark, "chalk." The outcrop is on a hill capped above with pebbles, about 15 feet above a small rivulet winding along the hill. It consists of solid red clay, perfectly free from grit, and indeed hard enough to serve as "chalk," but not white chalk; it is perfectly red, and in fact a fine and valuable *terra sigillata*. (The outcrop is marked in the chart of Tishamingo county, T.)

This deposit of terra sigillata is traversed by stripes and layers, or rather lenticular masses and nodules of white clay, which, although, with respect to its quality, it would be useful for fine pottery, is insufficient in quantity.

There is a sufficiency of this red clay, which is of great importance with respect to national economy.

The deposit of terra sigillata, or red clay, as it may well be termed, being below the deposit of pebbles and pudding-stone, is evidently in the same position as the kaolin, and must, therefore, be deemed its equivalent, and consequently a member of the orange sand group (27.)

We have seen the mountain limestone group of the carboniferous formation, which, alone of this formation, is found in Mississippi, crops out only in comparatively a few places; towards its western and southern limits, it does not crop out at all; it is thickly overlaid by much newer rocks in nearly all its parts, but especially along its southern and western limits. We might, therefore, be tempted *not* to extend its territory entirely to the cretaceous formation, but to draw a line nearly through the middle of the carboniferous formation, as it has been marked out on the geological map, as well as on that of the county of Tishamingo, and to call the very narrow streak, west of that line, between the carboniferous and cretaceous formations, a tertiary formation, would be inadmissible, according to the nature of things, as will later be shown.

The different members of that formation, which we have found overlying the carboniferous rocks, are in a descending order:

The orange sand. It consists of rather coarse-grained sand, frequently interspersed with scales of mica, grains of cairngorm stone, turmaline, glauconite, &c., whose color is most generally orange, or even of deeper hue than that, which assumes all tints and shades, from white to deep red. It is interstratified above the carboniferous formation:

a. With layers of smooth and rounded pebbles, appearing like real shingle of the sea beach, and consisting of all the different kinds of quartz, as, jasper, hornstone, agate, chalcedony, cornelian, &c.

b. With angular fragments of hornstone, most probably the detritus of the carboniferous formation in Mississippi and the adjacent States of Tennessee and Alabama.

c. With strata of pure silica derived probably from the disintegration of quartz of the overlying hornstone.

d. With breccia and pudding-stone; the first the product of a cementation of the pebbles, the second of the angular pieces of hornstone by oxide of iron.

e. With clays of different kinds and color, among which the most valuable are kaolin and the terra sigillata.

All these different rocks are evidently deposited together, or rather alternately with the orange sand, as we have seen from their situation; we will therefore call them the *orange sand group.*

Where the carboniferous formation is very thickly covered along its southern and western limits, there this orange sand group rests upon another basis, earlier deposited, but not belonging to an earlier period. This group is represented in diagram No. 8, to which I here refer.

The strata represented under Nos. 1 and 2, consist of the common orange sand; No. 1 contains pebbles.

The stratum No. 3, consists of the same orange sand, but instead of pebbles, it contains ferruginous concretions, lignite and sulphuret of iron, the same material with which all the lower strata abound, especially the lowest ones, those represented in Nos. 8 and 9.

The stratum No. 3 is, therefore, a *real transition* stratum, from the orange sand group to the lower group, showing most obviously a continuance of the same period during the deposition of the orange sand group, in which the lower group had been deposited, and only a change of the material which constitutes the different rocks. Floating wood, which gave origin to the lignite as well as to the sulphuret of iron, which appears all collected in and around lignite, is the most characteristic ingredient of the lower group. If we now add to the above very striking proof, that *of the perfect conformability of the different strata, from the lowest to the highest*, there cannot remain a shadow of doubt that all the strata, from the top to the bottom, belong to the same geological period.

It is undeniable that some of the strata, from No. 4 downwards, bear very much the lithological character of the eocene clays and sands in Tippah, Clark, and Wayne counties of this State, but even the identity of the petrographic character is no proof at all, if not supported by others, as, for instance, the palaeontological character; and besides, the clays and sands overlying and underlying the lignite in Lafayette, Calhoun, Carroll, Panola, Marshall, and other counties, bear exactly the same petrographic character; but even were it a proof, it must here necessarily give way to far more striking and conclusive ones (28).

The lower strata of sand and clay—those from No. 5 downwards—bear not only the same petrographic or lithological character as the lignite group in the counties above mentioned, which there lies also below the orange sand group, but are perfectly identical with it and belong to it, without the slightest doubt.

These strata are not only found at Warren's mill, T. 4, R. 9, E., but the slaty clay is also met with, by digging wells, in R.

11, T. 7, in Itawamba county, after the orange sand has been dug through. The same crops also out on Mackay's creek, forming there abrupt bluffs.

Another outcrop of the slaty clay is on Sec. 15, T. 4, R. 9, E., immediately E. of Cartersville. On Sec. 7, T. 5, R. 11, E., the bed of a little branch, tributary to Cypress pond, and running there under a rock, consists entirely of the schistose clay of the lignite group. Not far from it, on the same branch, in the same section, the kaolin crops out, and both are here probably equivalent and alternating.

The diagram No. 7, to which I refer here, shows in the stratum No. 3 a layer of the schistose clay, which underlies here, in regular order, the orange sand and the pebbles. The same is the case on Sec. 8, T. 5, R. 10, E.; the greenish sand stratum is there struck at a depth of from fifteen to twenty feet, by digging wells. On Sec. 33, T. 4, R. 9, E., the schistose miocene clay is again found, and is there of a very dark, nearly black color, corresponding in its appearance very much to a stratum of black clay of the eocene formation, in Greene county, of which it is, nevertheless, by no means a contemporary. It agrees also, in its petrographical character, perfectly with a black stratum of clay over the lignite in Calhoun and Winston counties, with which it really is coeval.

The substratum of the orange sand group consists, then, as we have seen:

1. Of sand of different colors and quality: frequently it is interspersed with scales of mica, glauconite, etc.; it is sometimes fine-grained, sometimes coarse, and varies much in color; frequently it is of a greenish hue, but often yellowish, red, and ferruginous, and full of lignite and sulphuret of iron.

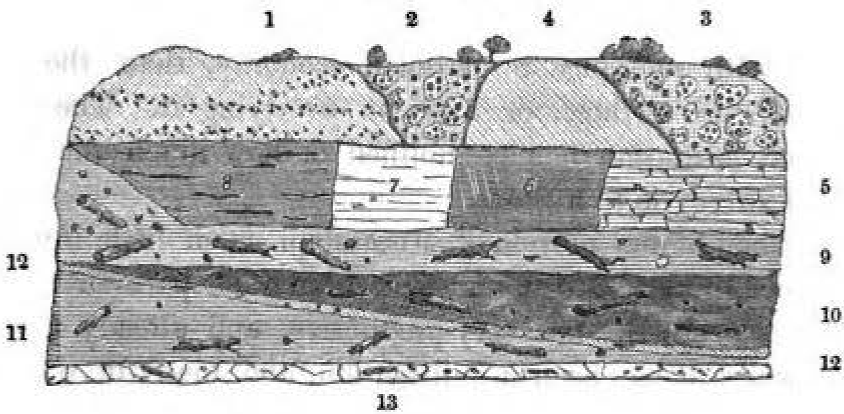
2. Of massy strata of clay: generally of a dark color, nearly black, but often mostly red, yellow, greenish, and gray; also frequently full of sulphuret of iron and lignite.

3. Of entire strata of ferruginous conglomerate and lignite. The diagram No. 8 affords the best view of these rocks. These strata are frequently found in different positions. Sometimes the sand is the upper stratum, sometimes the clay; they are, therefore, alternating and in juxtaposition. The seams of ferruginous conglomerate make generally the dividing line.

The character of these rocks agrees perfectly with that of the molasse of Switzerland, and the lignite formation in northern Germany, and, so far as I am now able to judge, I deem it coeval with these formations, and of miocene age; but this subject will be later more extensively discussed.

This formation, the orange sand group, as well as its substratum, the *lignite group*, must be represented as it has been done in the following diagram.

[No. 9.]



ORANGE SAND GROUP.

1. Orange sand, with pebbles.
2. Orange sand, with breccia.
3. " " with pudding-stone.
4. " " in its pure state.
5. Kaolin.
6. Terra sigillata
7. Silica.
8. White clay, with red stripes.
9. Orange sand, with lignite, sulphuret of iron, and ferruginous conglomerate.

LIGNITE GROUP.

10. Clay of different colors, with lignite, etc.
11. Sand of different colors, with lignite, etc.
12. A seam of ferruginous sand, with lignite and sulphuret of iron.
13. A seam of ferruginous conglomerate, with lignite and sulphuret of iron.

The whole of the formation overlying the mountain limestone group in this State, has one characteristic in common: *the absence of all zoogene fossils*, or of fossils which are of animal origin; its fossils are all *phytogene*, or of vegetable origin. They consist of silicified wood, or wood petrified by silica, and scattered or sporadic pieces of lignite in the orange sand group, and lignite or carbonized wood in considerable layers, and in scattered pieces in the lignite group (29).

THE CARBONIFEROUS FORMATION OF MISSISSIPPI, CONSIDERED IN A NATIONAL, ECONOMICAL, AND AGRICULTURAL POINT OF VIEW.

None of the geological formations of the State is of greater importance, with reference to national economy, than the carboniferous and the tertiary, or miocene overlying it. The exploration of that formation has exemplified of how much importance a geological survey is to a State.

The carboniferous portion of Mississippi is of little importance with respect to agriculture, and far behind other parts of the State. The land is originally not very productive, and already much exhausted where it has been in cultivation, and many of the inhabitants leave it for a soil more grateful to the agriculturist. Those unwilling to leave, hoped for the discovery of small mines of precious metals, or coal, and the desire of having such mines has created many groundless rumors about gold, silver, copper, lead, and other valuable metals; but such mines have not been, and never will be discovered. The home of the more valuable metals are the azoic rocks; some metals are also found in the transition rocks; hardly any metal but lead has ever been found in the carboniferous formation, and as for coal, we have seen that only such portions of the carboniferous formation extend into Mississippi as *never* bear coal.

Although such hopes have not been realized, other resources have been opened, which are indeed more valuable, and which, after a lapse of time, and the change of the population, from an agricultural to a mechanical, must give the carboniferous district the greatest importance, not only for the State of Mississippi, but also for the United States.

This, nevertheless, requires some time; the resources discovered must first be generally known and duly appreciated; the population will then soon change, the resources be cultivated, and wealth and affluence be the result.

The resources found in the carboniferous rocks themselves, are the following:

1. Valuable stones for building and domestic economy.

Wherever the sandstone of the mountain limestone crops out, as, for instance, in T. 5, R. 11, E., Sec. 29 and 30; Sec. 14, T. 6, R. 9, E.; T. 5, R. 10, E., Sec. 36; T. 6, R. 11, E., Sec. 7; T. 6, R. 11, along Cedar creek, and in other places of Tishamingo county, there it proves to be an excellent material for building stones. It is fine-grained, compact, well cemented, withstanding well the disintegrating influence of the atmosphere, especially if worked and smoothed. It is generally of different hardness, and a selection can be made to suit different purposes (30). In some of the above named places, and many other outcrops, it is well suited for flag-stones; it is finely laminated and jointed, and very easily split into flags of all sizes, and of sufficient hardness. In some places it is hard enough for grindstones; such an outcrop, for instance, occurs in T. 5, R. 11, E., Sec. 15, along Big Bear creek. Even for millstones it is suitable, in the latter and other places, and it has already frequently been used for that purpose. An outcrop of the sandstone, excellent for grindstones and millstones, is on Sec. 7, T. 6, R. 11, E. The slabs have here the required thickness, and are easily prepared. The outcrop is marked on the chart ⊙.

2. Very fine carbonate of lime, for burning quick-lime.

Such material is afforded by the mountain limestone nearly wherever it crops out; for instance, T. 5, R. 11, E., Sec. 18; T. 6, R. 10, E., Sec. 5, and in many other places. The burning of lime for exportation to other counties, and even States, could here be made a branch of profitable industry, especially for persons of limited means, as the transport is so very easy. Not only the Charleston & Memphis railroad crosses the country, but the nearly always navigable Tennessee river touches it, and the frequently navigable Big Bear creek, along which the limestone crops out, empties into the Tennessee river, as a large stream, which is, sometimes in summer, but in winter and spring, always, navigable for flatboats and rafts (30).

3. A very fine material for making *hydraulic cement.*

The slaty aluminous limestone cropping out near Eastport is a fit material for that purpose. Such hydraulic cement or mortar is now used in our Southern States in large quantities, and is all derived, with great expense, from the Northern States. The manufacturing of such cement would be a remunerating business, especially in Eastport, where the immediate neighborhood of the Tennessee river facilitates the transport of it to all parts of the Union.

The hydraulic mortar is especially used for plastering and lining cisterns, for cementing culverts or walls exposed to the water on railroads, etc.

Only those limestones are adapted to this purpose which contain from eight to twenty-five per cent. of alumina and silica, and those of Eastport contain fully that amount (32).

RESOURCES CONTAINED IN THE TERTIARY ROCKS OVERLYING THE CARBONIFEROUS FORMATION.

1.—*The Kaolin Deposit.*

The most important discovery made in that part of the State occupied by the carboniferous rocks, is that of the kaolin, or porcelain clay; a fine clay resulting from the decomposition of orthoclas, or feldspar, and other feldspathic rocks in general, as, for instance, some kinds of granite, porphyry, porcelain-spar, and sometimes also of beryll; it is generally found in the places where those rocks occur.

This valuable clay is generally soft, very fine and friable, resembling starch; it exists in different colors, white, reddish, yellow, gray, greenish-white, etc. The rocks, from the decomposition of which it results, contain all more or less potash; the principal change which their detritus has to undergo, to be converted into kaolin, is the removal of that alkali with a portion of the silica. This is done by the water which percolates through it, and of which it then retains a portion. The kaolin is a chemical compound of silica, alumina and water, a real hydrated silicate of alumina; its normal composition is in 100 parts, 47.2 parts silica, 39.1 parts alumina, and 13.7 parts water (33).

Useful and valuable kaolin is comparatively of rare occurrence, and its mines principally confined to Europe; they are there much more valuable than mines of the precious metals, and belong to the governments or regents of the countries where they are found.

The kaolin deposit in Tishamingo county is, I believe, the most extensive in the world. It extends, in the State of Mississippi, over not less than 50 or 60 square miles, which have been marked out with a dotted line in the chart of Tishamingo county, and the outcrops of kaolin already found, with a cross.

The kaolin lying between the surface rocks is most easily mined in most of the places where it has been found. The kaolin region contains different kinds of porcelain clay, from the finest, whitest, and purest, to coarse and colored kaolin ; all kinds are useful—the finer for fine china ware, the coarser for inferior porcelain and other pottery. It is true, the really fine kaolin seems to be confined to comparatively few places, but there is enough to supply the world with china ware for many thousands of years.

The most remarkable phenomenon offered by this immense and really invaluable kaolin deposit, is its appearance on the place where it is found. The kaolin hitherto found has, according to my knowledge, all been found in the formations where those rocks, from which this clay originates, are in their original places. Thus it is in Germany, thus in France and England. Here in Mississippi, perhaps the most important kaolin deposit ever found, lies in the midst of tertiary rocks, far from the rocks from which it originates, and it can scarcely be ascertained whether it proceeds from the disintegration of feldspar, granite, porphyry, beryl, or from what other mineral.

It is indeed difficult to account satisfactorily for its appearance in such an unusual locality. It has undoubtedly been transported thither by water (34).

2.—*The Red Clay, or Terra Sigillata.*

This is also a discovery of some importance. It was found on T. 2, R. 11, E., Sec. 30, near Indian creek, which locality has been marked on the chart of Tishamingo county by T.

It appears there as a massy clay of red color, entirely free from grit, and consequently of a fine quality. It is hard enough to serve as "red chalk" for marking, for which purpose it is frequently used where it is found It seems not to be confined to that place; more of it is said to occur about six miles from Eastport.

This stratum is most evidently an alternate of the kaolin, with which it is in juxtaposition, and has the same origin, proceeding from the disintegration of older rocks, carried there by water.

The terra sigillata is of rather rare occurrence, but not as valuable now as it has been in earlier times, when it was much used for the fabrication of sealing-wax, as its name indicates. For this purpose it is now no more applied. It is a fine material for colored pottery, for which it was formerly much used, especially near Faenza, in *Italy*, where its fitness for that purpose was first discovered, during the sixteenth century. The pottery made of it received thence the name of Fayence, and is now well known under that name, and also that of *terra cotta* (35).

3.—*The Silica Deposit.*

One of the most important discoveries in the carboniferous district is that of a deposit of very fine and pure *silica*, or *silicious acid.* It was found by the author, on T. 2, R. 11, Secs. 23 and 24, near the town of Eastport, only a short distance from the mouth of Big Bear creek; it is marked in the particular chart of Tishamingo county by an S. A better material for manufacturing the finest kinds of flint and crown glass, does perhaps not exist.

The author analyzed a specimen of the silica taken from the middle of the deposit, and received the following result:

Silica	97.190	per cent.
Alumina	1.700	"
Lime	0.310	"
Oxide of iron	0.200	"
Magnesia inappreciable	....	"
Water and loss	0.600	"
	100.000	

The silica is, therefore, very nearly as pure as quartz itself; the only impurity which could have an influence against the transparency and brilliancy of the glass made of it, is the alumina and oxide of iron; but the quantities are too small to exert that influence. The lime is no impurity; it is, to some extent, a requisite of nearly all the different kinds of glass.

How valuable this material is, may be seen from the circumstance that nearly all the British glass-manufactories are supplied with sand from the same deposits, the Linn and Ryegate sand.

The Pittsburg glass-houses, in Pennsylvania, receive their silica or sand from the State of Missouri. A fine material for the fabrication of glass is found in Bohemia, in Germany, and is there one of the principal sources of wealth and prosperity. Bohemian crown glass is sold all over the face of the globe, and to a very great extent in the United States.

There are no glass-manufactories in the Southern States; and such an establishment would, therefore, prove here to be of the highest importance, and certainly very lucrative (36).

The deposit of silica, or silicious acid, is found under a stratum of disintegrated hornstone, or chert—a kind of quartz; it belongs, therefore, doubtless to the newer *tertiary*, not the carboniferous formation, and proceeds from the disintegration of the hornstone itself.

The silica, in the deposit itself, is of different quality; the upper stratum is gritty and coarse; in the middle it is very fine—a fine white powder, nevertheless harsh to the touch, and gritty under the teeth; the lower stratum is again coarser, and not quite as white; all of it can, nevertheless, be used for the purpose of making glass. The finest and purest part will, of course, make the finest glass.

This silica is also an excellent material for the fabrication of *water-glass*—a silicate of soda in a fluid state, which when dry leaves a fine enamel; it is much used for a varnish, especially upon lime-walls, and can be used for making a fire-proof coating over wood, cloth, and paper.

The deposit is a very large one, and not confined to the hill near Eastport, where it was first discovered. It has also been found by digging a well in the town of Eastport, and extends probably as far as the disintegrated pieces of hornstone, which can only be found out by digging or boring; but the deposit under the hill where it was first found, which is about six feet thick, and forms the base of that large hill, yields silica enough for the manufacture of glass for thousands of years.

MINERAL SPRINGS.

That part of the State of Mississippi which is occupied by the carboniferous formation, contains several valuable mineral springs.

There is a sulphurous chalybeate spring on Sec. 30, T. 6, R. 9, E., which has already been used to advantage. It is not a very cold spring, but the water it yields is strongly impregnated with sulphuretted hydrogen, and contains also sulphate of iron, the taste of which is obliterated by that of the sulphuretted hydrogen, but is distinctly perceptible after the partial or entire escape of the latter; it makes also a yellow sediment of hydrated peroxide of iron.

Another chalybeate spring is found on Sec. 26, T. 6, R. 9, E. It contains sulphate of iron, lime, magnesia, alumina, and some carbonic acid. The spring yields a large quantity of water, which has a fine taste.

Another chalybeate spring is on Sec. 34, T. 5, R. 10, E.; it is cold, yields a large quantity of water, and causes a strong deposit of hydrated peroxide of iron. Its principal contents are sulphate of iron, magnesia, chlorine in combination with sodium, as chloride of sodium, and a trace of lime.

Another very fine chalybeate spring is near Warren's Mill, on Mackay's creek, T. 4, R. 9, E. The spring is cold, strongly impregnated with sulphate of iron, and contains some sulphuretted hydrogen. It would be very valuable on account of the large quantity of water it yields, were it not in a swampy place. (The localities where valuable mineral springs have been found, are marked on the chart of Tishamingo county by a goblet.)

ELEVATION OF THE COUNTRY AND WATER-POWER.

The area of the carboniferous formation is of a considerable elevation; it averages, according to thermo-barometric measurement, from 400 to 600 feet above the level of the ocean; at such an elevation are the towns of Farmington and Eastport in the northern part of Tishamingo county. This county is distinguished in Mississippi for water-power. Great Bear creek, Yellow creek, Cedar creek, Mackay's creek, Indian creek, and several others, have nearly all the year water enough for mills and manufactories.

In a national economical view, there is certainly no part of the State of as much importance as the territory occupied by the carboniferous formation. Everything is united to make it a wealthy manufacturing country:—not only the natural resources, consisting in such objects as are scarce and much desired, as kaolin, for the finest kind of pottery and porcelain, silica, for the very best kind of glass and glass-ware, red clay, for colored pottery, carbonate of lime, for quick-lime, aluminous limestone, for hydraulic cement, sandstones, for flagstones, building-stones, grindstones, and even millstones; it is not only an elevated country, containing water power in every direction, and a very healthy region—but it possesses also great facilities for receiving the articles necessary for the manufacture, and sending the manufactured goods to all parts of the United States. Through the middle of the territory runs the Memphis & Charleston railroad; eastward, along the line of Alabama, runs Big Bear creek, navigable nearly the whole year, at least for flatboats and rafts; through the N. E. corner runs the large Tennessee river, always navigable for steamboats; and not very far from the country, the Mobile & Ohio railroad crosses, connecting the Ohio river with the Gulf of Mexico and Mobile.

The whole country is, besides, thickly overgrown with wood, affording fuel in abundance for a long time to come; and should there be a want of it, the terminus of the large Alleghany coal-bed in Tennessee and Alabama is very near, and any quantity can be procured with ease by transportation on the Tennessee river and the Charleston and Memphis railroad.

The town of Eastport on one side, near the Tennessee river, and on the other, near Big Bear creek, is situated in the middle of all the above enumerated resources, and will certainly, as soon as they are generally known and duly appreciated, become the emporium of a manufacturing country, and a place of much importance.

AGRICULTURE.

With respect to agriculture, the territory of Tishamingo county occupied by the carboniferous formation, is of much less importance. It is not the least fertile country in the State of Mississippi, perhaps even not in the northern part of the State, but its soil cannot be rated as an average one of the fertile state. It is decidedly the least fertile part of the county of Tishamingo, the other more westerly part of which is occupied by the cretaceous formation.

The territory of the carboniferous formation, the eastern portion of Tishamingo county, is generally hilly, too much so for agriculture; it has a great deal of poor sandy land, entirely formed from the sand strata of the orange sand group, which overlie it nearly everywhere, and in most places very thickly. The growth of forest trees of these lands consists principally of pine trees (*pinus rigida*), and black jack (*quercus nigra*), as soon as the timber is cut down, the soil is washed off from the slopes of the hills, and the land becomes very poor.

The good lands are only found along the creeks, but there only in small bodies, on account of the narrowness of the bottoms of the creeks in this region.

There are some good lands in the northeastern part of the carboniferous formation, on Yellow, Indian, and Big Bear creeks, which empty all into the large Tennessee river; but even the bottoms of these considerable creeks are narrow, owing to the circumstance, that the carboniferous formation consists mostly of hard rocks, which are not easily excavated and washed away.

Of the same character are the lands in the southern and southeastern portion of the carboniferous formation. The country is there also hilly, and the creeks only small, and consequently the bottoms still smaller; but, nevertheless, of some fertility. The principal creeks here are Brown's and Mackey's, both of which empty into the Tombigbee river.

The forest growth consists here also in the short-leaf pine tree, (*pinus rigida*), black jack (*quercus nigra*), and hickory (of different kinds, mostly *carya tumentosa*).

The soil originates, as already mentioned, principally from the orange sand group, and where it has not been sufficiently mixed with the detritus of the underlying formation, or alluvial material, it is very thin and sandy.

In places where the carboniferous limestone and schistose clay crop out, along the hills, the soil in the neighboring valleys has partly been formed from the detritus of those rocks, and is fertile; but such places are scarce.

Near Eastport, where the aluminous limestone stands near the surface, and crops out, in some places the soil is very poor, and scarcely worth cultivating.

The Tennessee river has, in the State of Mississippi, no bottom at all, and its alluvium does, consequently, not give origin to as fine a soil as on the opposite side, in the States of Tennessee and Alabama (37).

The crops of the country consist of cotton, Indian corn, wheat, and oats. An average crop of the country consists of about 800 or 1,000 pounds of cotton, (the seed included); from 20 to 25 bushels of Indian corn; from 10 to 12 bushels of wheat, and from 20 to 25 bushels of oats to an acre.

The growth of forest trees consists principally of short-leaf pine trees (*pinus rigida*), oak trees of different species, especially black jacks, post oaks (*quercus obtusiloba*), red oak (*quercus rubra*), white oak (*quercus alba*). Less frequently are found hickory (*carya*), of different kinds; poplar (*lyriodendron tulipifera*), sweet gum (*liquidamber styriciflua*), beech trees (*fagus americana;*) and in the bottoms, especially of Bear creek, cypress (*cypressus disticha*), black gum (*nyssa*), birch trees (*betula*), and others.

II.—GEOLOGICAL AND PALAEONTOLOGICAL DESCRIPTION OF THE CRETACEOUS FORMATION.

This formation is, as Plate I. exhibits, the last of the secondary or mesozoic age, and therefore often called the *upper secondary formation.* It is well developed in Mississippi, although its territory is not a large one. It consists of two distinct groups of rocks, which are most characteristically and suitably called the *glauconitic* and *calcareous*, or lime groups.

We will review them according to their position. The lowest of the two is:

A.—THE GLAUCONITIC GROUP.

The rocks of this group consist principally of stratified sand, mixed with a large proportion of silicate of iron or glauconite, which imparts to it a greenish color of different hues, and has given origin to the very appropriate name of *green sand.* This sand is of different quality, sometimes fine-grained, sometimes coarser, but never very coarse; it is most frequently mixed with a large proportion of mica scales. Its color varies from light grayish green to real sap green. It alternates frequently with other sand of different color, varying from whitish to red; most frequently of the latter color, which preserves, then, none of the characteristics of the original green sand, but a few traces of its fossils. Sometimes the green sand contains a quantity of very small and round black pebbles of black quartz, very much water-worn. In this State it has, most fortunately for the agricultural inhabitants, assumed a modification which I have never found to such an extent. It consists of very fine-grained, dusty and conglobating sand, mixed with much aluminous and calcareous matter, which makes it somewhat greasy to the touch, and is replete with a great many fragments of disintegrated shells, from whence nearly all its lime is derived, and which impart to it sometimes a whitish color; in a word, it is changed into one of the richest and best marls existing, nearly as good as the best marl of the eocene period. It contains very few or no pyrites, or nodules of conglomerates of iron. The color of this marl is most frequently greenish gray, but varies, and changes also to a bluish tinge. Again, in some places the green sand is found as a crumbling, silicious sand, greenish and gray, or whitish in streaks, devoid of fossils, but containing small pieces of lignite, especially carbonized fragments of calamites. Between these two extremes there are a great many intermediate transition forms.

The green sand alternates, also, with clays of different description; sometimes with a stiff greenish or bluish, or even black plastic clay; sometimes with a rather schistose bluish black, or black clay, finely jointed and laminated, and containing generally a large proportion of mica scales and oxide of iron. In some places the clay, found alternating with the green sand, is gray and very ferruginous. These clays are generally void of fossils.

Frequently the green sand is found indurate, and is then either cemented by lime or oxide of iron. The green sand, cemented by lime, is found in large ledges, sometimes surrounded by loose green sand, overlaid and underlaid by it, and in this case most frequently in seams of different thickness, sometimes as a large deposit of green sandstone; in either case it is of different hardness, with variable proportions of sand, clay, and lime; often very hard, so as to strike fire when struck with a hammer.

The indurate green sand is most generally remarkably full of fossils. This green sand—or better, glauconitic sandstone—is of different color, according to its composition, and the color of the principal constituent, the green sand. It proves to be often a useful building material, especially where it can be used in the rough. It approaches in this state, indeed, the *quader* of Germany, which it represents on this continent. I have seen it rolled down the bluff of the Tombigbee river, into the bed of the river, where a strong current rushes over it, without dissolving, or even softening it, in several years.

As a partial alternate of the green sand, a hard whitish limestone, of a singular structure, approaching that of bones, is found in the northern part of Mississippi, and called there the horse-bone limestone. It consists of an aluminous carbonate of lime, and is of a yellowish white color.

The green sand, cemented by oxide of iron, as a very ferruginous mass, is principally found in seams. I have never found it in Mississipi in ledges as it is found in Alabama, along the Black Warrior river.

The oxide of iron penetrates the green sand in stripes and veins, and produces the most singular concretions, often construed into the forms of relics of animals and plants, and appearing exactly as rusty iron does, having been sometime in water. Such seams of ferruginous concretions disintegrate much slower than the under or overlying material, be it green sand, clay, or other sand, and form projections; and on the banks of the rivers and creeks, even wide platforms, preserving the underlying strata; where the latter are washed away, these platforms break down, and the flags of iron conglomerate are then found paving the beds of rivers and creeks.

Characteristic of the glauconite group is a large proportion of sulphuret of iron, mostly in rounded balls of different sizes, from that of a small rifle ball to the size of a large hen egg. These pyrites are frequently found in most curious and fantastic forms of snakes, fishes, fruits, &c., and appear, indeed, to be pseudo-metamorphosed of zoogene or phytogene fossils (38). The external color of these pyrites varies from that of lead to that of copper. Internally they are radiated, the rays proceeding from a common centre. Sometimes the sulphuret of iron is found crystalized around pieces of lignite, and even in its interior, pervading it entirely.

Another characteristic consists in conglomerated nodules of oxide of iron and sand, originating from the decomposition of sulphuret of iron.

A very important characteristic of the whole glauconitic group is pieces of lignite, consisting frequently in slender stems of chondrites flattened by pressure, but perfectly recognizable; often the lignite consists of large trunks of endogenous and coniferous trees (39); among the latter, most probably cupressinea. Whole deposits, or beds of lignite, are never found in the green sand—only single pieces, stems and branches of trees which have been carried, where they are now found, as driftwood. A characteristic of most of the glauconite lignite, is its not being entirely carbonized: the woody fibres are generally preserved.

These rocks form in Mississippi the lower cretaceous formation, for which I have adopted the name of *glauconitic group*, because very few of them only are devoid of silicate of iron, and most of them are, to a large extent, composed of and colored by it.

B.—THE CALCAREOUS OR LIME GROUP.

Over the glauconitic group, forming the lower cretaceous formation, lie the rocks of the lime group. As the former is by glauconite, so is this characterized by white carbonate of lime, and even much more strongly so than the first by glauconite; there is not one member of the group of which the white carbonate of lime constitutes less than one-third of the whole rock.

The prototype of the whole group is *the white aluminous carbonate of lime*, which, wherever it is found, is of a very uniform lithological character. It is a mixture of nearly equal parts of carbonate of lime and aluminous matter, with the addition of a considerable portion of silica, some magnesia, and oxide of iron. The proportions of lime and aluminous matter vary in the different parts of the stratum; above, the first predominates; below, the latter. The color of this stratum is generally yellowish white, but varies to yellowish blue, and even blue. The upper layers are generally white or yellowish, and the lower bluish and blue; the transition from white to blue is so gradual and insensible, that no line of separation can be drawn between the white and the blue part.

I think it not difficult to account for the difference of color. Originally the whole stratum was most probably bluish, the color of the aluminous part of the stratum; but, as the blue particles are more finely divided and more soluble in water than the very little soluble carbonate of lime, the percolating water of the atmospheric precipitations has washed and swept them, by degrees, more downwards to the bottom; thence it happens that the stratum of such carbonate of lime is whiter and more calcareous in its upper layers, and becomes gradually bluer and more aluminous towards the bottom, until it is changed into a soft blue calcareous clay. The hardness also seems to decrease with the decrease of the quantity of lime. On an average it is, perhaps, a little harder than hard soap, and is easily cut with a knife, wherefore it has received the popular name of *rotten limestone*. Sometimes the strata are, nevertheless, very hard, and fossils can only be cut out of it with great difficulty, as its tenacity appears to increase with its hardness; it does not split, but has to be cut with an edged tool.

In the upper layers of this white aluminous carbonate of lime, especially on a bluff on the Tombigbee river, in Alabama, I have now and then found small nodules of chert or flint, flat and discoid in shape, not larger than a quarter of a dollar; wherefore they can easily be mistaken for fossil oyster-shells (40).

The lower portion of this stratum participates in round and uniform balls of sulphuret of iron, such as are found in the green sand; it contains, also, small pieces of lignite, generally much perforated by teredinae, which are frequently found petrified with the lignite, sometimes in large numbers.

The rotten limestone, although the principal stratum of the lime group, is not always the upper stratum; it is often overlaid by a layer of hard limestone, solid and compact, cropping out in rounded forms, and containing a much larger proportion of carbonate of lime than the rotten limestone; its color is dirty white, or yellowish; it is frequently so hard, and somewhat silicious, as to strike fire when broken with a hammer.

In some places this hard limestone appears in a singular perforated form, full of round smooth holes, and is then called *bored limestone;* and, indeed, the name is not unsuitable—the holes appear so round and smooth, as if bored with a borer or auger.

The explanation of that appearance is easy. When formed, pure soft clay remained segregrated in the calcareous masses, which was afterwards washed out by water, and left the smooth round holes. I have seen the limestone with such soft and plastic clay enclosed in the round tubes.

Those hard limestones I have always found higher, or overlying the rotten limestone. I have hesitated to separate them from the latter, thinking that they are nothing but the same carbonate of lime, separated from the largest portion of the aluminous matter by external causes, and perhaps molecular attraction; and, indeed, the bored limestone appears to confirm that opinion—but I am not certain; it requires farther examination.

The hard limestone, solid or bored, affords, wherever it is found, a good material for burning lime, and calcines quickly.

Other more local members of this lime group are:

A soft and white calcareous clay, differing somewhat in color; it consists of carbonate of lime, mixed, to a larger extent than the rotten limestone, with clay of other colors than blue.

A soft, yellowish and greenish calcareous sand, in which the carbonate of lime is mixed with a large proportion of silicious sand, of different colors; it contains, also, some glauconitic sand, whch imparts to it, where it is contained in it in larger quantity, the greenish color.

A coralline limestone of a yellowish color, in which the coralline polyps of the genus ceriopora are very predominant. It is only found in Tippah and Tishamingo counties.

Another kind of limestone, of a medium hardness and a yellowish color, being somewhat ferruginous, and containing a large quantity of cerithia—sometimes so many that it appears a conglomerate of these shells. It is also found (in Pontotoc county only, as far as I know) of a grayish green color (41).

A blue calcareous clay, containing many pyrites, and more lignite than any other member of the lime group. The lignite is, especially here, much perforated by teredina; and clusters of the petrified mollusks are found in the lignite. This clay forms the lowest stratum of the lime group.

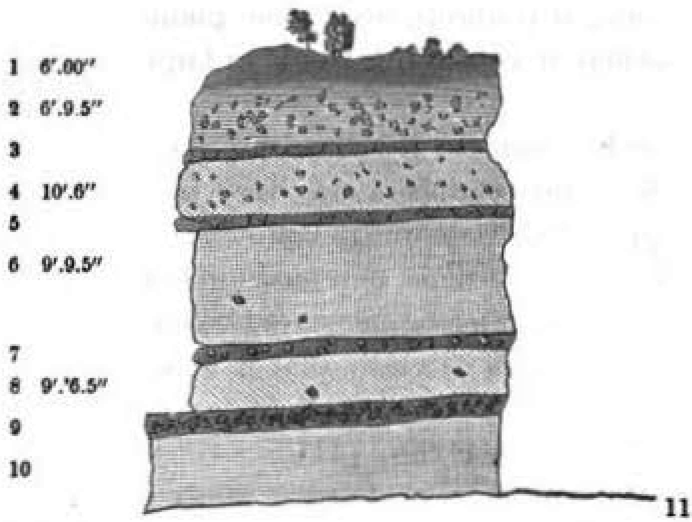
The different members of this group are frequently separated from each other, and that group from the glauconitic, by hard seams of indurate green sand, cemented by lime and silica, which contain frequently more indurate knobs.

The thickness of the lime group, or upper cretaceous formation in this State, must be estimated to from 600 to 700 feet, and is, perhaps, greater than that.

A very fine view of the superposition of the cretaceous strata, the lime group as well as the glauconitic group, is afforded by Plymouth Bluff, on the Tombigbee river, about four miles N. W. of Columbus, in Lowndes county.

The following diagram exhibits a section of it:

[No. 10.]



No. 1. A stratum of disintegrated lime, from 3 to 4 feet thick, mixed with overlying ferruginous tertiary material, and running insensibly into—

No. 2. A stratum of calcareous and sandy clay, about 12 feet thick, of bluish color, containing, as characteristic fossils, ostrea plumosa, and an inoceramus (probably barabeni).

These two strata are the representatives of the calcareous or lime group, which is much thinned out, and runs here entirely out, never to disappear again on the other side of the Tombigbee river; the largest part of the outcrop belongs, therefore, to the glauconitic group.

No. 3. Is a seam of very hard calcareous sandstone, cemented by carbonate of lime from 1 to 2 feet thick.

No. 4. Is a stratum of green sand, about 10 feet thick. Its color is light green; it contains a great many specimens of exogyra costata.

No. 5. Is again a hard seam from 1 to 2 feet thick, containing a great many apparently fucoid cellular marine plants. The sandstone of the seam, a real green sandstone, is also cemented by calcareous matter.

No. 6. A stratum of green sand, about 30 feet thick, and very nearly void of fossils; the green sand is the same as that above the seam.

No. 7. A seam of very unequal thickness, full of knolls, consisting, also, of hard green sandstone cemented by carbonate of lime.

No. 8. A stratum of green sand, about 12 feet thick, of the same quality as above

No. 9. A hard seam of more than a foot in thickness, cemented by lime and oxide of iron. It is very hard, projects, and forms a platform of different widths; it is full of inocerami, and, therefore, called the *inoceramus ledge*.

No. 10. Is again a stratum of green sand, whose thickness cannot be ascertained, as it forms the bottom of the river at No. 11. At low water it stands about 10 feet above water.

The dip or inclination of the strata at Plymouth Bluff, is from N. E. to S. W.

The seams here represented continue a long distance westward, and as they are impermeable to water, they cause the different stories of the green sand to be water-bearing. All the different strata of green sand contain pyrites in great quantity, many of which are exposed to the air, and converted into protosulphate of iron.

A great many fossils are found under this bluff; the most prominent of them are: large ammonites, some of which must, according to measurement of fragments and calculation, have been at least

12 feet in diameter; A. delawarensis, A. placenta, and others; nautilus, of different species, some of immense size, from 1 to 2 feet in diameter; among them is nautilus dekayi—several of them are yet undescribed—gryphea mutabilis, ostrea plumosa, O. cretacea, O. panda, and others; ianira quinque-costata, exogyra costata, hamites arculus and others; scaphites, baculites ovatus, B. asper, B. carinatus and others. Teredina, serpula (especially S. barbata), terebratula, inoceramus, natica petrosa, hamulus onyx, and many vertebrae, and teeth of placoid fishes; for instance, odontaspis raphiodon, corax, otodus appendiculatus, ptychodus mortoni, and others (42).

LOCALITIES OF THE CRETACEOUS GROUP.

1.—*The Glauconitic Group.*

An outcrop of the glauconitic group is to be found on Sections 11 and 12, T. 17, R. 7, E., on the left bank or on the E. side of Town creek, in Lowndes county. For several miles along the creek, the green sand forms the left bluff, which is from five to twenty feet high.

The glauconitic sand is here very fine-grained, and most excellent for manure; it is, in its petrographic or lithological character, very similar to the tertiary green sand marl, for which I really mistook it, until a gryphea mutabilis convinced me of my mistake. This green sand contains a great many pyrites, converted into protosulphate of iron by peroxidation, from exposure to the influence of the atmosphere. How thick the green sand is here, cannot be seen; only the upper part of it crops out. It is divided in two distinct strata by a seam of dark clay, the upper stratum being only a thin one.

The fossils found in the glauconitic group consist principally of exogyra costata, gryphea mutabilis, and some species of ostrea. The same kind of green sand, very fine-grained, calcareous and aluminous, and good for manure, crops out again on Spring creek, in the same county, Sec. 24, R. 7, T. 17. The stratum of green sand is here, in some places, more than twenty feet thick; it is divided in two strata by an indurate seam of not more than a foot in thickness.

Exactly in the dividing line, at the same level, are found the most complete banks of exogyra costata I have ever seen. They are here in banks exactly as the oysters on the Atlantic coast, but not in so large banks; they are clustered together, and as completely preserved as if they had perished here a few years ago. Nearly on every one of them both valves are together, and most of them, which are taken from inside the bank, are very little water-worn; in fact, the completest and best preserved specimens that can be found. These banks of exogyrae, that must have lived and perished where they now are found, show, then, that there must have been once, at the time of the deposition of the glauconitic group, the bottom of a probably deep sea or ocean.

The seam of indurated green sand, cemented by carbonate of lime, must have been, for a long time, the very bottom of the sea; the exogyrae settled there, lived there for a long time, until they had formed large banks, and must then have been killed by an accident, which nevertheless left no traces, for the strata even lie conformably to each other (43). Had it not been so—had they been slowly buried in the sediment—they would have died by degrees, and perhaps been dispersed by the currents, as it is the case with others. Perhaps the banks of exogyrae were there, on a coast which, by a landslide, covered them at once, and preserved them. However it may be, these finely preserved banks of exogyrae costata give incontrovertible evidence that these molluscae, like the oysters, to the family of which they belong, lived in banks and clusters; and so many banks of them, on the same level, shows how slowly the deposition of a geological formation, by the water of the ocean, must have proceeded.

An interesting outcrop of the glauconitic group is on the road from Aberdeen to Columbus, about three and a half miles from the latter town. The road leads there over a hill, into which it cuts down to a considerable extent. The hill is of red sand, which, at first sight, every one would deem to belong to the orange sand group, which, as we shall see later, overlies the cretaceous formation nearly everywhere; but on a closer examination, impressions of inoceramus, and fragments of casts of baculites and hamites, were found, giving incontrovertible evidence of its cretaceous origin.

The sand here, which is an alternate of the green sand, or perhaps even green sand changed by the peroxidation of the protoxide of iron to hydrated peroxide, is nearly red, rather coarse-grained, and aluminous; no nodules of oxide or sulphate of iron, nor iron pyrites, are found in it. It is difficult to determine whether this hill originated from upheaving or denudation; it is the only instance in which I found the glauconitic group at so high an elevation above the general level of the country.

From this hill to Columbus there is no more outcrop of the glauconitic group; the alluvium of the Tombigbee river spreads over the country, and a part of the lower cretaceous formation has most probably been washed away by the river, whose bottom or alluvium is mainly on the E. side of it.

Near Columbus there is a very high bluff, immediately under the warehouse, near the river; on the top of it lies a stratum of red sand, about 30 feet thick, which, without doubt, is cretaceous, although no fossils give evidence of such origin; it is at most mixed with tertiary sands. A seam of indurated aluminous sand, of not more than one foot in thickness, separates it from the underlying stratum of green sand, of about 20 feet in thickness; this is of a reddish color, but characterized as cretaceous by innumerable casts of baculites, the species of which is perfectly irrecognizable, and by some exogyra costata.

This stratum of green sand is again separated from the one below it by an argillo-calcareous seam of not more than one foot in thickness. The stratum of glauconitic sand below this seam is 108 feet thick above low water of the river, but continues downwards, and forms the bed of the river; it is of a greyish green color, and contains also an immense number of fragments of casts of baculites.

A part of the western town of Columbus stands upon hills of red sand, which are all cretaceous, and characterized by a great quantity of fragments of casts of baculites, which at first sight would be mistaken for pieces of roots of trees, for those casts are not hard, and crumble to pieces if taken from the sand. A very interesting outcrop of the glauconitic group is 12 miles N. E. of Columbus, at Barton's Bluff, on the Tombigbee river. This bluff belongs entirely to the glauconitic group, or lower cretaceous formation; it consists of strata of bluish clay and gray sand, alternating with green sand. The bluff is in some places from 50 to 60 feet, in others, from 80 to 90 feet high.

The glauconitic group contains here the common cretaceous fossils, especially ammonites delawarensis, nucula, baculites, of several species, hamites, ostrea, etc., but especially such an immense number of shark's teeth, teeth of corax pristodontus, oxyrhina, otodus appendiculatus, odontaspis raphiodon, and others, as I have never before seen accumulated. Lumps of the indurated green sand, half a foot in diameter, consist fully half of fish teeth, which stick out like the teeth of a hackle (44). It is impossible to imagine from what cause these teeth have accumulated here in such quantity.

Other outcrops of the glauconitic group are farther S. W., along the left or E. side of the Ocktibbeha or Tibby creek, and S. below Columbus, on the Tombigbee river. Farther N., the lime group overlies it again, and continues to the northern part of Pontotoc and Itawamba counties.

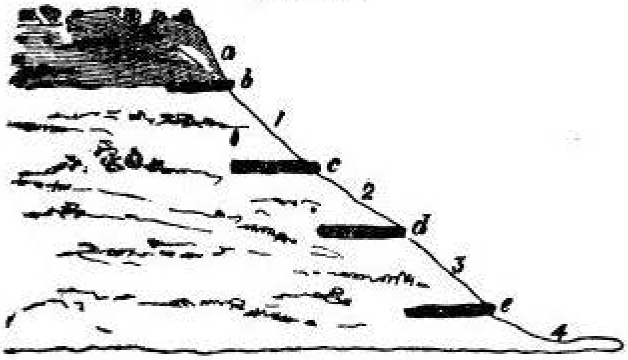
The lime group has, most probably, once covered the glauconitic group, but has been washed away, as this is indicated by dotted lines on Table II., longitudinal section I., from *a* to *b*. In Chickasaw and Monroe, and the southern parts of Pontotoc and Itawamba counties, no sign of the glauconitic group appears; the calcareous or lime group covers it there, and wherever the cretaceous rocks crop out, there is the white carbonate of lime, or the hard limestone of the lime group on the surface.

The first outcrop of the glauconitic group appears about six miles E. of the town of Pontotoc, on the road from there to Fulton, in R. 4, T.10, Sect. 3 or 4.

A range of considerable hills runs there from S. S. W. to N. N. E., which divides the water course. W. of the hills, the creeks run westward, and are tributaries to the Tallahatchie river; E. of the hills, the creeks run southeastward, and are tributaries to the Tombigbee river. These hills are thickly covered by the orange sand group, as will be shown later. Below that cover are the rocks belonging to the glauconitic group of the cretaceous formation.

An interesting outcrop appears on one of the hills not more than a few miles north of the town of Pontotoc. It is represented in the following diagram:

[No. 11.]



The stratum on the top of the hill, marked *a*, represents the orange sand cover, consisting here in a thin loamy soil, passing insensibly into red sand.

This loamy soil overlying the orange sand, and going gradually and insensibly into it, has been mentioned in several instances, and its origin will be discussed later.

The strata marked *b*, *c*, *d*, *e*, are indurated green sand of the glauconitic formation, rather softer than those green sandstones generally found along the banks of the Tombigbee river, and in other places. All of them are of the same nature and quality; they appear to have constituted once one and the same ledge or seam overlying the loose glauconitic sand, marked in the diagram with the numbers 1, 2, 3, 4, but to have been broken and elevated by an upheaval which seems very evidently to have here taken place.

The cretaceous nature of those rocks appears unquestionable; they contain a great many fragments of cretaceous fossils; for instance, exogyra costata, gryphea mutabiles, ostrea plumosa, &c., and others, which remove all doubt.

The Pontotoc ridge, of which the hill containing the above described outcrop is a part, constitutes the anticlinal line dividing the waters of the Tallahatchie and Yallabusha on one, and of the Tombigbee river on the other side.

On the west side it runs out into many large ridges or spurs, and terminates where the flat-woods, a level and sandy tract of land, commence, between ranges 2 and 3, in Pontotoc county. The western slope of these hills, towards the Tallahatchie river, is gradual, but the eastern descent, towards the Tombigbee river, is steep and abrupt.

The hills at the head of the Hatchie and Tallahatchie rivers, in

Tippah county, are originally nothing but a continuation of the Pontotoc ridge; but the soil along those hills is quite different, consisting either in a black heavy loam, mixed with a great deal of organic matter, and generally called prairies, although not properly belonging to the prairie soil; or in such places where the white carbonate of lime has not entirely been washed away, but constitutes the surface formation, which are called "bald prairies." They abound in all the cretaceous fossils.

Beyond the line of Pontotoc county, the soil becomes very heavy and fertile, which is indicated by an entire change in the forest growth, from oak and pine trees to the poplar (lyriodendron tulipifera), magnolia (magnolia macrophylla and umbrella), black walnut (juglans nigra), hickory (carya tumentosa, and others), locust (robinia), &c. Here appear, also, scattered fragments of limestone, indicating that the cretaceous rocks underlie, and soon appears the horse-bone limestone—a limestone having very much the appearance of big bones, hence its name.

On Sec. 25, T. 5, R. 2, E., there is a bluff of about 30 feet perpendicular elevation, falling off abruptly towards N. N. E., into a kind of a ravine, containing a cave, from which a powerful spring issues in the form of a small creek. Its water is clear and of the temperature of 17° Centigrade, or 62° 6′ Fahr. It is said to yield the same quantity of water during the whole year.

Along the whole bluff of that ravine, the cretaceous formation crops out. On the top of the bluff appears the orange sand; below this lie some ledges of a hard perforated or cavernous limestone. Below this stratum there is a loose sandy calcareous mass, containing, in many places, hard conglomerates. Into this stratum a cave has been excavated by the water.

The entrance of this cave is about 6 feet high by 9 feet wide, but, after having run for some 50 feet in an E. S. E. direction, it becomes narrower, and so low that it does not allow a passage in an erect position. A little farther on, the cave turns to the S. E., and at last to the south, and widens again.

The whole of the ceiling of that cave is covered with grayish white stalactites, but only a few stalagmites appear on the ground, which is mostly covered with mud; in some places only the carbonate of lime appears.

At the end of the hall the ceiling lowers again, and the cave turns there to the S. W. From a kind of a recess, coming from the S. E., a little creek flows in, which fills the whole cave with mud, rendering it inaccessible; and further on, it is nothing more than the small channel of that little creek.

A short distance from the entrance of the cave, there is a natural bridge across the little creek, also formed by the top ledge of the cave. It has only 18 feet span, and is not more than 14 feet wide at the south, and it is about 5 feet at the north end, and from 2 to 2½ feet in thickness. The inner surface is elevated about 5 feet above the creek.

On Sections 23 and 24, T. 7, R. 2, E., the orange sand caps the hills, and contains, in some places, large blocks of iron sandstone imbedded in it.

On Section 25, of the same T. and R., the horse-bone limestone crops out in a cut; on the road it is full of fossils, as, for instance, baculites, rostellaria, melania, turritella, spondylus, pectunculus cardium, crassatella, hamulus, and others.

On Sec. 18, T. 7, R. 4, E., there is also an outcrop of the cretaceous rocks on the bank of a creek, belonging to the head-waters of the Okomatyhatchee creek. The strata appear here exactly like tertiary marls on the banks of the Chickesawhay river, in Clarke and Wayne counties, but the fossils contained in them, consisting of trigonia, exogyra turritella, prove soon their cretaceous origin.

The marl is here of a bluish gray color, with white spots, the effect of innumerable disintegrated shells. It contains a large amount of mica.

The marl effervesces strongly with hydrochloric acid, and must be a fine manure, especially if mica scales should prove to be an indication of the presence of alkaline matter, as they frequently are.

The stratum of marl is exposed, to the thickness of about 2 feet above the level of the creek; but it constitutes also the bed of that creek, and may, therefore, be of much greater thickness.

The creek runs nearly S. S. W. through Sec. 18 into Sec. 19; and all along the east side, wherever the creek approaches the bluff, there the marl stratum appears all along on its east side; for instance, in Sec. 19, where it appears, in one place, to rise about 7 feet above the bluff of the creek, and contains casts of a large bivalve shell, probably tellina, and claws of a crab, probably pagurus (callianassa,) or astacus.

Near Ellistown, on Sec. 20, T. 7, R. 4, E., the conglomerate limestone of the glauconitic group appears near the surface, and crops out all along on the hills, exhibiting a great many fossils, as spatangus (a large specimen), ammonites placenta, spondylus, arca, cyprina, isocardia, exogyra costata, and trigonia.

The marl of the glauconitic group seems to underlie the country here generally, not only in Pontotoc county, but also in the N. W. part of Itawamba. It is generally found by digging wells, and lies under a ledge of hard rock.

It crops out in different places along Old Town creek; for instance, on Sec. 16, T. 8, R. 4, E., where it is about twenty feet thick, and contains many disintegrated shells—unfortunately, very few only in a good state of preservation; among them are, pectunculus, pecten, cytherea and others.

Along the Pontotoc ridge, in Townships 8 and 9, R. 4, the glauconitic group appears everywhere, on the hillsides, in the shape of marl, and may, therefore, be supposed to continue also below the bottoms, which are overlaid by tertiary sands. In many places the marl is much mixed with the overlying sand, and the mixture adopts then a greenish yellow color. The fossils are everywhere nearly the same: exogyra costata, gryphea convexa, spatangus, ammonites placenta, and other ammonites, hamulus, pyrula, baculites, and fragments of a crab, probably pagurus (or callianassa); in other places, turritella and trigonia are added.

In the northern part of Pontotoc county it is everywhere very perceptible that the lime group has once covered the glauconitic group, and been washed away by a violent current, the effect of which is there everywhere visible.

The marl of the glauconitic group appears again on Sec. 36, T. 6, R. 4, E.; it is here of fine quality, and contains a characteristic fossil of the green sand, of which it is an alternate—the ammonites placenta (45). Other fossils found here are, trigonia, spondylus, arca, several species; cyprina, turritella, rostellaria, exogyra costata, a large falcate ostrea, eight inches long, probably not yet described; pecten, spatangus, etc.

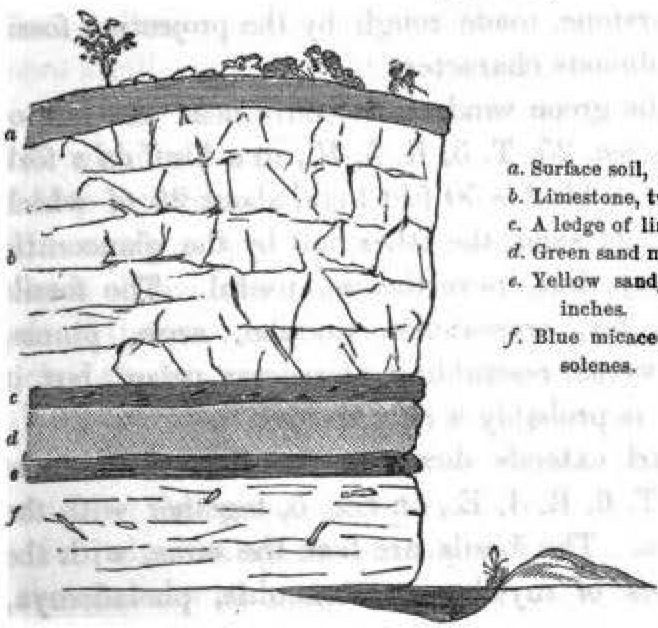
On Sec. 7, T. 4., R. 4, E., near Ripley, coral limestone crops out about twenty-five feet thick, which overlies here the blue marl, containing very fine cretaceous fossils, some of which—for instance, the ammonites, nuculae, and others—appear still with their enamel, and are of a brilliant irridescence. The prominent fossils are baculites, having also preserved their enamel, and giving evidence that the marl here is a member of the glauconitic group. In the baculites, sometimes, even the shape of the septa is preserved. Among the bivalves, crassatella and nucula are predominant.

The boring of an artesian well has here shown that the alternate strata of the blue marl and limestone have a thickness of about sixty feet.

On Sec. 20, T. 4, R. 3., E., about one mile and a half from Ripley, the black micaceous marl crops out, containing a great many baculites, which show its place in the glauconitic group, as an alternate of the green sand. The marl underlies here the coral limestone. It is found on all the creeks in that neighborhood.

On Town creek, near Ripley, there is a very interesting bluff, from thirty to forty feet high. The following diagram represents this bluff:

[No. 12.]



a. Surface soil, twelve inches.
b. Limestone, twenty-five feet.
c. A ledge of limestone, containing cerithia.
d. Green sand marl, a detritus of shells, one foot.
e. Yellow sandy material, void of fossils, eight inches.
f. Blue micaceous marl, containing baculites and solenes.

The baculites remove all doubt of its not being glauconitic. Near this outcrop, in a well in Ripley, the cretaceous rocks were also found, and contained rostellaria, turritella, and claws of a crab, as above stated, either pagurus or astacus.

The glauconitic marl again crops out on Sec. 21, T. 8, R. 4, E.; it is not covered here by the coral limestone (46). The upper strata of the marl are here more sandy. The same bed of marl was struck by digging a well on a hill, at the depth of 25 feet, and was found to be 18 feet thick. Below the marl, was met a yellow calcareous sand, without fossils. The same marl-bed continues to Sec. 9, of the same township and range.

On Sec. 27, T. 2, R. 4, E., a well was dug 75 feet deep. At the depth of 18 feet, the marl was struck, and three feet below the marl a kind of limestone, being nearly a conglomerate of shells, principally baculites. Very little doubt remains with respect to the character of the limestone, which is here generally called horse-bone limestone; it is a member of the glauconitic group, being here not only overlaid by the green sand marl, but containing also the characteristic baculites. The same stratum of green sand marl crops out at the foot of a neighboring hill, and contains here the same fossils already mentioned.

On Sec. 11, T. 2, R. 4, E., lies, among the glauconitic group, a stratum of hard limestone, characterized by a great many cerithia. The limestone appears to be originally a conglomerate of shells, among which an ostrea is recognizable. The stone is hard enough for millstone, and has been successfully used as such; it is evidently a kind of buhrstone, made rough by the projecting fossil shells, which are of a silicious character.

Another outcrop of the green sand marl occurs near the line of Tishamingo county, on Sec. 25, T. 3, R. 5, E., in a bluff on a fork of the Hatchie river. The bluff is 50 feet high, about 25 of which are occupied by the orange sand, the other half by the glauconitic marl, which is here sandy, but, nevertheless, useful. The fossils found in it are baculites, crassatellæ, nuculæ, arcæ, pinnæ, solenes, and a fine pterocera, resembling pterocera pelagi, but it has winged thorns, and is probably a new species.

In R. 4, E., the marl extends down to the line of Pontotoc county; it is found in T. 6, R. 4, E., on Sec. 5, together with the accompanying limestone. The fossils are here the same, with the exception of two species of mytilus, pectunculus, pholadomya, tritonium, and bulla.

On Sec. 24, the glauconitic group crops out on a hill covered with orange sand, as a soft argillaceous mass, with irregular streaks of lime, and black plastic clay of a schistose structure; below this follows the hard limestone, (horse-bone limestone), containing here, also, ammonites placenta, spatangus, arca, trigonia, etc.

Beneath the limestone stratum is a layer of green sand marl, not more than 10 inches thick, but composed almost entirely of disintegrated shells; under the marl, lies again a black plastic clay, interstratified by layers of sand and mica scales; below this follows a yellow ferruginous limestone.

The outcrops of the glauconitic group continue in Tishamingo county, and are found in T. 5, R. 6, Secs. 17 and 18. On Sec. 17, in a small creek, perhaps 100 feet below the level of the green sand marl, a whitish calcareous clay crops out, characterized as cretaceous by gryphea mutabilis, and exogyra costata. Bluffs of this rock, evidently of the glauconitic group, are found all about in that region, and in some of them were discovered several ostrae, among others O. falcata.

In the lower part of Tippah, in T. 6, R. 5, E., the glauconitic group is overlaid by rocks, differing somewhat from them. On a bluff in Sec. 14 those overlying rocks are composed of a blue marl, quite similar to the common glauconitic marl of that county, in its lithological character, but differing in fossils, which consist in gryphea mutabilis, exogyra costata, ammonites placenta, placuna scabra, pectens, inocerami, baculites, etc. This marl is capped by a more argillaceous material, of about eight feet in thickness, of a yellow color, similar, in lithological character, to the white carbonate of lime, of the calcareous group, which contains belemnites, probably americanus.

This marl, as well as the clay overlying it, must, evidently, be a remnant of the lime group which has, without doubt, covered the whole of the glauconitic group of N. Mississippi; the baculites of the clay are a sure sign of its character. It appears the more doubtful whether this clay and marl belong above or below the green sand marl, as the elevation of the latter above the former would favor the opinion that it belonged below the glauconitic group, but its palaeontological character is too clear, and an upheaval of the green sand marl formation, or a subsidence of the lime formation, must have taken place.

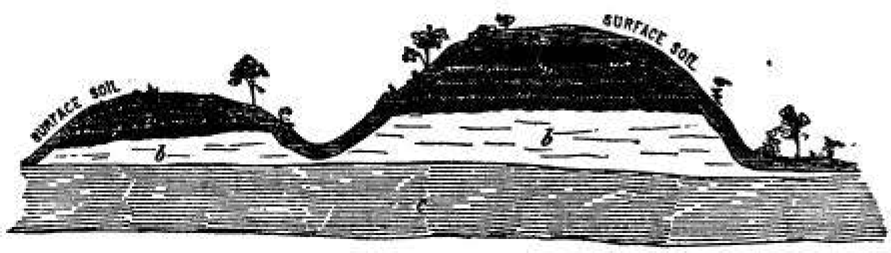
Another certain proof that the whitish marl belongs above the glauconitic group, is afforded by boring a well 330 feet deep. That whole depth was taken up by the white marl, only at intervals hard ledges of limestone had to be penetrated; when lastly such a ledge was bored through, the auger sank in real green sand, which proved to be water-bearing, but the water found its level below the mouth of the bore hole. The white marl corresponds, then, with the white argillaceous carbonate of lime of Chickasaw county, as its fossils clearly indicate.

Besides the already mentioned fossils, the white marl contains a species of ammonite, cardium, several pectens, spondylus, crassatella, and a placoid tooth of odontaspis raphiodon, many belemnites, and a tooth of mosasaurus, characteristic of the lime group.

The remnant of the lime group is also found overlying in T. 6, R. 6, E. of Tishamingo county, and causes the water of all the wells there to be very limy and scarcely drinkable (47).

The true position of the whitish marl appears on Sec. 23, T. 5, R. 7. E., in Tishamingo county. The deepest cut on the railroad there, is about 60 feet; it is represented in the following diagram:

[No. 13.]



a. Represents jointed or white calcareous clay, containing gryphea, exogyra costata, placuna scabra, janira quinque costata, &c.

b. Blue marl.

c. Blue micaceous sand without lime.

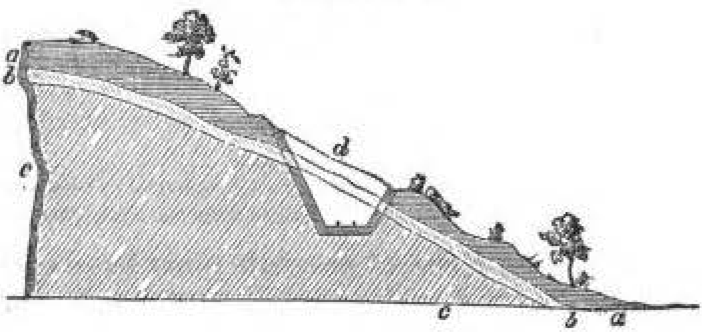
The surface soil is from 1 to 3 feet thick; below this there is a whitish, tenacious, very calcareous clay, with the fossils above mentioned. This calcareous clay corresponds evidently to the white carbonate of lime of the lime group. The clay goes insensibly over into the blue marl of *b*, and this not quite as insensibly into the blue micaceous sand. The teeth of mosasaurus were here also found, proving the presence of the lime-group. The blue sand corresponds with the green sand of the glauconitic group.

Higher up, in range 6, E., in Tishamingo county, the glauconitic marl appears again; for instance, in T. 4, Sections 27 and 7, T. 3, Sec. 38; T. 1, Sec. 34. At the last place, the marl is very fine; a well has there been bored, 300 feet deep, without penetrating the marl. Not far from the latter place, another well was bored, 200 feet deep, without penetrating the marl.

In Tennessee, very near the line of Mississippi, Sec. 7, T. 1, R. 7, E., not more than one mile from the Mississippi line, a well was bored, 356 feet deep, without penetrating the marl.

It is a remarkable circumstance that the glauconitic marl, wherever it is found, lies generally conformable to the surface strata of the tertiary sands, or even of the members of the lime group, and hence it happens that it is nearly everywhere struck at the same depth on the top of the hills, as well as in the bottom at the foot. A cut on the Memphis & Charleston railroad, on Sec. 32, T. 2, R. 9, E., contained in the following diagram, will illustrate this fact:

[No. 14.]

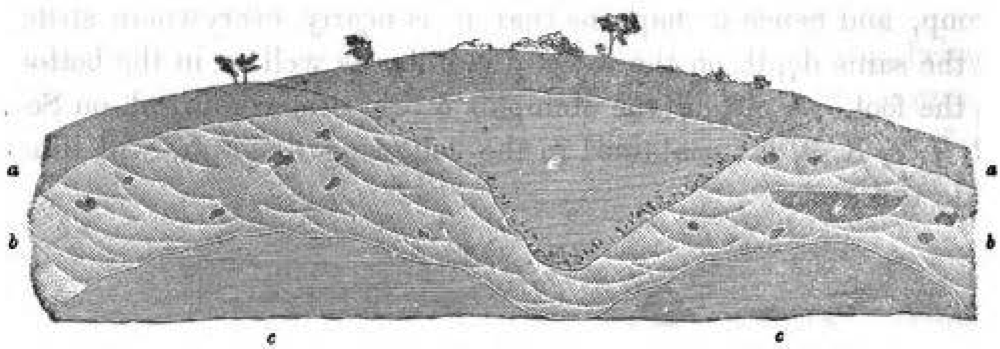


a. Is the surface soil, consisting of yellow clay.
b. Is a stratum of sand.
c. Is the glauconitic marl.
d. Is the railroad cut.

The strata cut through, at the dotted lines, continue in the same direction below, and the marl is as near to the surface at x as it is at y; this is a convincing proof that before the deposition of the surface strata a and b, a very powerful current must have swept over the country and washed a large portion of the cretaceous formation away; hence it is very easy to explain how it happens that here and there the glauconitic group is overlaid by the lime group. The cretaceous formation was certainly once complete here in N. Mississippi, but most of the lime group was washed by that current, and only a small part left, which now overlies the glauconitic group. The tertiary formation was later spread over both, and overlies them, therefore, conformably; which shows, then, that no long period elapsed between the action of the current and the deposition of the orange sand group.

The following diagram affords a still better illustration of those facts:

[No. 15.]

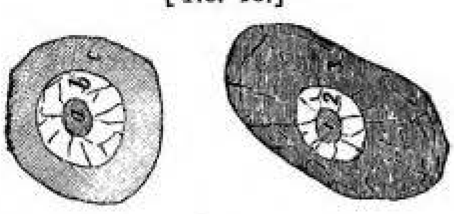


a a. Clay soil, from three to four feet thick.
b b. Variegated sand, with nodules.
c c. Black marl, or argillaceous sand, (glauconitic group).
d. A hollow, filled up with a postpliocene fine sandy clay, underlaid by loose and irregular fragments of iron conglomerate, forming a thin layer below the sandy clay.

It is very evident two different currents must have operated here, one after the deposition of the strata *c c*, the glauconitic black argillaceous sand. This may have been the case in the cretaceous sea itself, as it is now the case in our seas and oceans, the bottom of which consists of hills and valleys. The other current must have operated after the deposition of the cretaceous variegated sand; by it the hill was cut through in *d*, and two smaller hills formed of it. The valley or gully *d* was later filled up, most probably by atmospheric agency. The basin-shaped mass *e* is of a more indurated character, and of sand of a deeper hue.

The nodules in *b b* are somewhat singular; they are sometimes from two to three feet in diameter, round, or flattened; of different layers or coats of ferruginous sand, sometimes very hard. They are formed around a nucleus, which is of different size, sometimes very small, and consists of a bluish sandstone. The following diagrams represent forms of these nodules:

[No. 16.]



a. A nodule of loose sand.
b. Bluish sandstone.
Ferruginous sandstone concretion.

1. Loose sand.
2. Sandstone.
3. Ferruginous concretion.

These nodules, so similar in appearance and petrographic character to concretions in the orange sand group, would characterize the sand, in which they are found, as tertiary, were it not for the fossils, not only found in the sand containing the nodules, but also enclosed in the nodules themselves. These fossils are: lima, solen, mytilus, arca, spondylus, cyprina, cardium, isocardia, inoceramus, pecten, etc.

On Sec. 10, T. 5, R. 8, E., on Big Brown creek, there is a bluff about thirty feet high, which consists entirely of glauconitic green sand, which approaches, in its upper part, the variegated sand, with the nodules in diagram No. 16, and changes below, by slow transition, into a very calcareous sand with greenish spots. A great deal of fine green sand is found all along the creeks; sometimes it is indurated, and appears as a real green sandstone. This forms, frequently, the bottom of the creeks and branches. It is characterized by fragments of baculites and exogyra costata.

On Sec. 21, T. 6, R. 8, E., the glauconitic marl is again found from ten to fifteen feet under ground, by digging or boring wells; and this circumstance, together with the identity of the fossils, must discard every doubt with respect to the glauconitic marl, and the cretaceous formation in N. Mississippi itself. It consists, principally, of the lower glauconitic group; and the glauconitic marl is nothing but an alternate of the green sand, as it is found in Lowndes county, at Plymouth and Barton's bluffs, on Town and Ocktibbeha creeks.

2.—*The Calcareous or Lime Group of the Cretaceous Formation.*

The upper cretaceous formation, occupies a much larger area in Mississippi than the glauconitic group; with the exception of a portion of Lowndes county, it extends from the S. E. corner of Kemper county to the northern parts of Pontotoc and Itawamba counties; consequently, through the counties of Kemper, Noxubee, Ocktibbeha, Lowndes, Chickasaw, Monroe, and the largest part of Pontotoc and Itawamba; but its examination is unfinished, and my reports respecting this formation can only be considered preliminary and fragmentary.

In the eastern part of Kemper county, the white carbonate of lime crops out everywhere on the Sacamachee river, along the creeks, and on the brows of the hills.

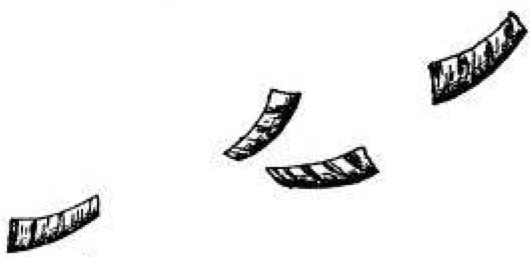
A very fine outcrop appears near Wahallack, Sec. 2, T. 12, R.

18, E.; the little town is situated on the top of a considerable hill, thickly overlaid by the orange sand, full of pebbles. On the slope of the hill the white carbonate of lime crops out, and contains deep gulleys, washed into it by the rain water running down the hill. It is very visible a powerful current passed here over the surface of the cretaceous formation after its deposition, and rendered it very hilly in some places, and in others, the valleys deep, but the lime group has nowhere been entirely washed away, and the glauconitic group denudated.

The fossils found near Wahallack indicate even that the uppermost stratum has not been washed away. The argillaceous carbonate of lime, here called *rotten limestone*, is very white on the surface, where it is dry; it has been washed by atmospheric precipitation, and is, to some extent, from six to twelve feet downwards, very hard. It assumes, by degrees, a more bluish color, and at the depth of from 12 to 20 feet it is perfectly bluish, but without having changed its lithological character.

The fossils found here are a great many vertebræ, teeth, and coprolites of the Mosasaurus. I found a whole skeleton, but its matrix, the upper portion of the white carbonate of lime, was so hard, that it was impossible to cut or hew it out entirely; I could only get very broken parts of it. The coprolites have generally the following appearance:

[No. 17.]

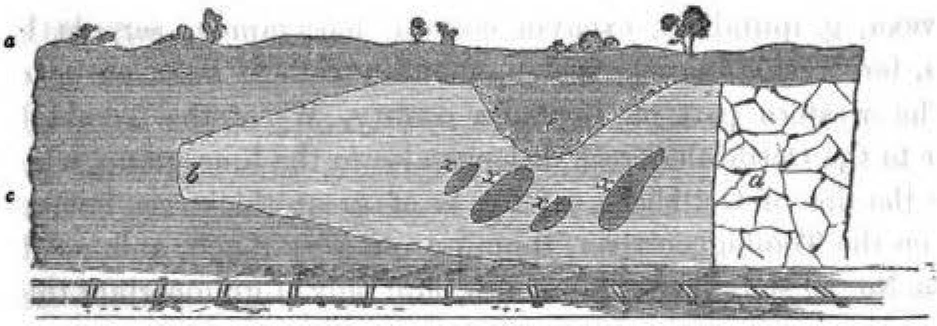


They have from two to three inches in diameter, and are sometimes found from four to six inches long (48).

Other important fossils are the bones and skeletons of chelonians, or turtles. Besides these, are found ostrea carinata, in great abundance, many of them with both valves; ostrea cretacea, O. plumosa, and several other species of ostrea; gryphea mutabilis, exogyra costata, belemnites americanus, etc., characterizing this stratum, which is here of immense thickness, not less than from 400 to 600 feet, as the upper member of the cretaceous formation.

Examining the cuts of the Mobile & Ohio railroad between Wahallack and Somerville, I found nearly all the deep cuts exposing the same lime group; in some of them, the argillaceous carbonate of lime was alternating with a yellow clay, or a mixture of lime and clay with some glauconitic sand. A most singular appearance afforded a cut, of which the following diagram gives an exact representation:

[No. 18.]



Railroad.

a. Surface soil.
e. A gully washed in the cretaceous formation, and filled up by sand and the surface soil.
c. Yellow calcareous clay, with glauconitic sand.
b. White argillaceous carbonate of lime.
xxxx. Spots of perfectly blue carbonate of lime.
d. Indurated blue carbonate of lime.

Among several fossils, as ostrea, the same as at Wahallack, pecten, and others, a large nautilus was found here, of more than six inches in diameter, and several smaller ones.

The bed of the Noxubee river, above the line of Kemper county, is altogether in the lime group; the white carbonate of lime alternates, in some places, with more argillaceous and harder strata.

The road from Wahallack to Dekalb leads first through the cretaceous formation, where the lime group crops out; this formation meets, near Dekalb, about five or six miles E. from there, the eocene, and disappears under it.

The eastern part of Noxubee county belongs entirely to the lime group of the cretaceous formation, and contains many prairies. Macon stands on a high hill, capped by the orange sand. South of the town runs the Noxubee river, and cuts deeply into the lime group; the bank consists entirely of the white argillaceous carbonate of lime, which is here of immense thickness. It has been attempted to bore an artesian well in Macon, but, at the depth of six hundred and thirty feet the white carbonate of lime was not penetrated.

The bluffs of the river are confined to its left or northern banks. There is a small cave near Macon, through which formerly a creek run into the Noxubee river; it is short and narrow, and entirely in the white carbonate of lime.

The principal fossils found here near Macon, especially in places where cisterns are dug into the white carbonate of lime, are many species of ostrea—for instance, o. plumosa, o. cretacea; gryphea convexa, g. mutabilis, exogyra costata, inoceramus, serpula barbata, terebratula, natica, pecten, anomia, teeth of mosasaurus, etc.

The western part of Lowndes county, W. of the Tombigbee river to the Octibbeha creek, belongs also to the lime group, which, near the line of Octibbeha county, is of great thickness, but runs out on the Tombigbee river, thinning out very much, and, as diagram No. 10 shows, is at Plymouth bluff only of unimportant thickness.

West of the Tombigbee river are important prairies, and nearly everywhere outcrops of the lime group. The Mahu prairie is comparatively a very large one, and from ten to twelve miles wide; beyond this prairie the country is overlaid, in a narrow strip, by the orange sand group. West of this strip of sand appear again, between hills covered entirely with the orange sand group, small prairies in the valleys.

On many places the lime group crops out, bearing everywhere the same lithological character, and exhibiting the same fossils—among which was found a piece of fossil rosin, frequently met with in the cretaceous formation; it is of a dark brown or black color. Its fracture is very conchoidal and glossy, and it resembles, somewhat, bituminous coal, for which it had been mistaken.

Remarkable and characteristic fossils, found in Octibbeha county, and shown to me by Dr. Spillman, of Columbus, who possesses very fine specimens of them in his collection, are some members of the family rudistae, the hippurites, and its modifications—sphaerulites and radiolites. I have been assured that the same fossil is also found in Kemper county; and having myself frequently found it in Alabama, in the very same lime group which crops out in Octibbeha and Kemper counties, and very nearly in the same latitude, I have every reason to admit the fact, although I have never been fortunate enough to find it myself in Mississippi.

A few miles S. and W. of Starkville, the cretaceous formation disappears under the orange sand group.

Chickasaw county belongs entirely to the cretaceous formation, and more especially to the lime group. The western part of the county contains a very level and flat country with a sterile soil, generally called the "flat-woods;" the cretaceous formation does not appear there, but wells dug or bored to some depth contain very limy water. The lime group begins to show itself very plainly a little W. of Houston; and in that town, which stands on the orange sand, the blue limestone, as it is called there, or the argillaceous carbonate of lime of a bluish color, is everywhere met with, at the depth of from ten to fifteen feet. The hills around Houston are all capped with the orange sand group, but on the brows of many the lime group crops out. This is especially the case about two miles and a half from Houston, on Sec. 2, T. 14, R. 3, E.

It would appear as if the cretaceous formation was here upheaved; but the hills are probably formed by denudation and erosion, after the deposition of the cretaceous formation. On the above-mentioned place an indurate and very hard yellowish white limestone crops out, containing many cretaceous fossils, as exogyra costata, gryphea convexa, G. mutabilis, ostrea, etc. Most singular, under this limestone lies a stratum of red ferruginous cretaceous sand, and then follows the white carbonate of lime. The oxide of iron contained in the red cretaceous sand comes, without doubt, from the overlying orange sand, and partly from peroxidation of glauconitic sand, so near to the surface; and the appearance of sand, alternating with the white carbonate of lime, is not extraordinary.

The hard cretaceous and compact limestone found in many places in Chickasaw county alternates, in some places, with the perforated or bored limestone, and both give an excellent material for burning quicklime. The bored limestone is found on Sec. 19, T. 12, R. 4.

On the plantation of Mr. McIntosh, a lump of galena was found among the cretaceous rocks, weighing from 25 to 30 pounds, and caused the belief that a lead mine might be found in the neighborhood. Small lumps of galena are frequently found in the cretaceous formation of Mississippi (and Alabama), but I never before heard of such a large quantity.

The lime group is everywhere here very thick, and hardly less so than near Macon, in Noxubee county. It is never dug or bored through by attempts to dig or bore wells (49). Higher up, in Chickasaw county, near Okolona, the Mobile & Ohio railroad cuts, in several places, deeply into the lime group, exposing everywhere the white carbonate of lime, which is there very indurate, and lower down of a bluish color. The principal fossil there prevalent is gryphea convexa, it is sometimes found very deep in the carbonate of lime, by digging cisterns.

The prairies are, in Chickasaw county, confined to the eastern part of it, which belongs to a large prairie basin, exhibited in the chart of that basin (Plate V). which is principally situated in Monroe, but partly, also, in Lowndes and Ocktibbeha counties. On the Succatunche creek, below Palo Alto, nearly on the line of Chickasaw and Ocktibbeha counties, there is, on the left side of the creek, a bluff about 30 feet high. From the top, 20 feet downwards, are occupied by the orange sand group, then follows the white carbonate of lime, extending downwards; it is, to the surface of the water, about 10 feet thick. Below this is a bluish calcareous clay, to which the white lime changes by a very slow transition; this clayey lime is full of sulphate of iron, or iron pyrites, and contains, besides, a great many fossils, as ostrea plumosa, O. cretacea, and others; gryphea convexa, exogyra costata, natica, nucula, tellina, fusus, and others.

About six miles below Pontotoc, on the Aberdeen road, in T. 10, R. 4, the lime group crops out on the S. side of a creek, and is very fossiliferous; it contains nautilus, of large size, gryphea convexa, G. mutabilis, exogyra costata, ostrea of several species, and a great many fragments of belemnites americanus, nearly every one of which is split in the middle.

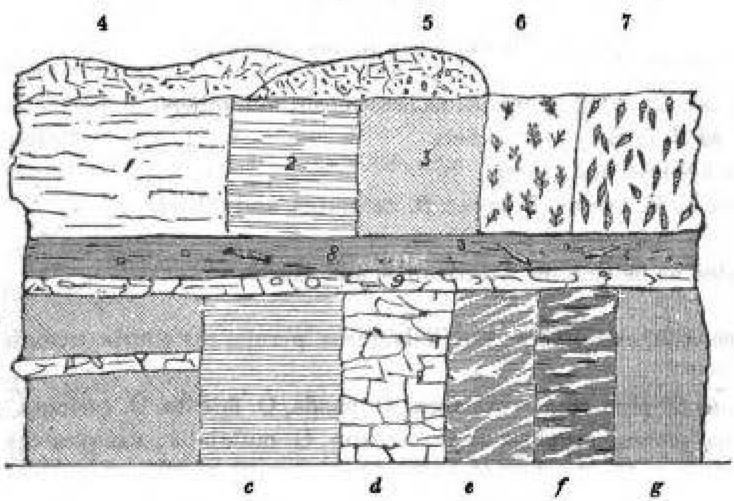
Near Aberdeen, in Monroe county, there is a bluff on the Tombigbee river, about 30 feet high, consisting mostly of a grey sand, appearing amorphous, or unstratified, with many pebbles, and is therefore probably a river deposit. Lower down, the sand assumes a yellow color, is exceedingly ferruginous, and contains many vestiges of cellular plants, resembling stems of fucoids, but which are not recognizable. This lower stratum of sand is destitute of pebbles, distinctly stratified, and contains, in some places, layers of clay; in it were found the impression of an inoceramus, and a piece of a baculite; it is, therefore, without any doubt, cretaceous; it must belong to the lime group which crops out in several places near Aberdeen, and contains fragments of an immense ammonite, which must have measured from six to eight feet in diameter.

The dip of the cretaceous formation W. of the Pontotoc ridge, and farther S. of the Tombigbee river, is from N. N. E. to S. S. W. The Pontotoc ridge and the Tombigbee river appear to be upon the anticlinal axis (50).

Having thus examined the different rocks of the cretaceous formation, I will endeavor to represent them in their position in the following diagram:

THE CRETACEOUS ROCKS IN MISSISSIPPI.

[No. 19.]



I.—Calcareous, or Lime Group.

1. White aluminous carbonate of lime.
2. White calcareous clay.
3. Yellow and greenish calcareous sand.
4. Hard compact white limestone.
5. Indurated perforated, or bored limestone.
6. Coralline limestone.
7. Cerithium limestone.
8. Blue calcareous clay, with pyrites and lignite.
9. A seam of indurate nodules of silicious limestone.

II.—Glauconitic Group.

a. Green sand, with pyrites and lignite.
b. A hard ferruginous seam.
c. Green sand marl.
d. Green sandstone.
e. Plastic clay, of various colors.
f. Schistose clay, generally dark, but varying in color.
g. Red sand.

FOSSILS OF THE CRETACEOUS FORMATION.

Phytogene Fossils:

Cellular fucoid plants.

Endogenous plants—calamites.

Coniferous plants.

Zoogene Fossils.

Bones of Chelonians.

Bones of Saurians:

Skeletons, vertebrae, teeth and coprolites of Mosasaurus.

Fishes:

Remains of ganoid and placoid fishes (51), vertebrae, teeth of such fishes, especially squalides, as of odontaspis raphiodon, *corax pristodontus, otodus appendiculatus, oxyrhina, ptychodus mortoni, picnodus, and others.

Articulate Animals:

Crustacea.

Claws of crabs, as pagurus or astacus.

Worms, as serpula barbata, and others.

MOLLUSCOUS ANIMALS.—(52)

Cephalopods:

Ammonites, as A. placenta, A. Delawarensis, and others.

Nautili, as N. deckayi, and others.

Hamites arculus, and others.

Baculites, as B. ovatus, B. asper, B. carinatus, and others.

Scaphites:

Belemnites, as belemnites Americanus, and others.

Gasteropods:

Natica petrosa, and others; turritella, fusus, pyrula, rostellaria, tritonium, bulla.

Acephals:

Ostreae, as O. plumosa, O. cretacea, O. panda, O. falcata, O. carinata, and others; placuna scabra, gryphea, as G. convexa, G. mutabilis; exogyra costata; janira quinque-costata; terebratulae, inocerami, nuculae, trigoniae, crassatellae, pectens, carditae, pholades, cardia, pinnae, spondyli or plagiostomae, lucinae, arcae, cyprinae, isocardiae, cythereae, pectunculi, pholadomyae, solenes, teredinae, limae, nuculae and rudistae, as hippurites, sphaerulites and radiolites; teredinae, etc.

Radiats:

Spatangus, cidaris, patellae.

Polypi:

Corals, and others.

The above enumerated characterize the whole cretaceous formation in the State of Mississippi; many of them are common to both of its constituent groups, the glauconitic and cretaceous groups; but some of them are either found exclusively or principally in one of those groups, and distinguish its palaeontological character from that of the other group.

To the *lime group* belong:

1, The fossil remains of mosasaurus; 2, the chelonian bones; 3, the rudistae; 4, gryphea convexa; 5, hamulus onyx; 6, natica petrosa; 7, gryphea mutabilis; 8, ostrea carinata; 9, the majority of the cerithia; 10, belemnites americanus.

To the *glauconitic group* belong:

1, Especially the baculites; 2, the scaphites; 3, ammonites placenta; 4, inoceramus alveatus and barabeni; 5, the teeth of the placoid fishes (squalides), as ptychodus mortoni, corax pristodontus, otodus appendiculatus, odontaspis raphiodon, oxyrhina, and pycnodus; 6, most of the terebratulae.

After having examined the lithological and palaeontological character of the cretaceous formation in the State of Mississippi, it appears not difficult to assign to it its place in the cretaceous formation of our globe.

This system is generally divided into four members or groups, under the following names:

In England.	*In France.*	*In Germany.*
1. Upper and lower chalk.	1. Sénonien.	1. Kreide Formation.
2. Upper green sand and chalk marl.	2. Turonien.	2. Pläner Formation.
3. Gault formation.	3. Albien.	3. Galt Formation.
4. Lower green sand.	4. Néocomien.	4. Hils Formation.

It is very evident, and a glance upon the diagram No. 19, containing the different rocks of the cretaceous formation in this State, will afford the conviction, that those rocks cannot, conveniently, be divided into four groups; there are indeed not superimposed strata enough. It is impossible to divide the lime group, which, even abstracted from the palaeontological identity of its members, bears in all of them such a marked and distinct character, that a horizontal division-line cannot be drawn, and a vertical one would give only a division in space, not in time, and only show alternation, not superposition or subterposition, which a difference in time only can produce, according to established principles of the science of Geology.

Besides, difference in the lithological character of the two strata, for itself alone, can decide nothing with respect to time; the corresponding difference of the palaeontological character is absolutely necessary, and so important that this, for itself, gives a sufficient reason for a separation of certain rocks in two members of a formation, even in two entirely different formations, nay, more than that, in two different geological ages.

The strata of our earth give us a striking illustration of that principle.

It appears as if after the deposition of the Permian formation, the fertility of the same animal creation was exhausted, or, as if circumstances, perhaps the will of the Almighty Lord of the Universe, had necessitated a change—it disappeared—*how*, short-sighted man cannot read upon the leaves of the chronicle of the creation of our globe.

With the beginning of the triassic or the new red sandstone formation, a new and entirely different animal creation appeared, less curious in its forms, less antique, and entirely modernized, much more approaching to our present forms.

The creative power of our earth for the same rocks appeared not exhausted; it continued during the larger part of the triassic period, and so we find the same red sandstone, the same variegated clays and sands, and even the same subordinate strata—immense deposits of rock-salt—in the trias, which characterize the permian period in a lithological point of view. Nevertheless, a big division line has been drawn, between the permian and triassic formations, by an unanimous consent of all geologists, beyond which not only commences a new geological formation, but a new age, a new reign, in which the saurians wrench the sceptre from the fishes.

A difference of the palaeontological character is all important with regard to time; a difference of petrographical or lithological character, by itself, is only important for division in space, unimportant for division in time or groups, formations and ages, the division of which is based solely upon difference in time.

So, for instance, as we shall see later, the chalk in England and France, wanting in continental Germany (53), as well as here, in America, in the cretaceous formation, belongs, nevertheless, to the same group here as it does in England and France, because it does not differ in its palaeontological character from our groups, although quite different in its lithological character. It is the same with our green sand, and the *quader* of Germany; our green sand is a loose sand, only indurated in some instances; the *quader* of Germany, a compact, solid, very hard silicious stone, and, nevertheless, on account of its palaeontological character, the representative of our green sand, and *vice versa* our green sand of the *quader*.

In classing our cretaceous formation, and assigning to it its place in the cretaceous formation of our globe, we must, therefore, nearly exclusively have regard to its palaeontological character, to the fossils which we find in it, and not be troubled with the difference of the lithological character.

If the lime group cannot be divided, much less can the glauconitic group be subject to division; all its members are only co-ordinate, not subordinate; deposited in different places only, not in different times, taking the time of the deposition of the green sand as unit.

Of the four cretaceous groups, adopted by general consent of the geologists, we have, then, here in Mississippi only two, and our task will, therefore, only be to find out which ones.

As characteristic fossils of the upper member of the cretaceous formation of the "upper and lower chalk" of England, the "terrain sénonien" of France, and the "Kreide-bildung" of Germany, are considered: cidaris and spatangus of the radiates, both of them are found in the white aluminous lime of Pontotoc county (54).

Among the acephalous mollusks, rudistae, and of this family especially, hippurites and radiolites, both of them, are found in Kemper and Ocktibbeha counties, in the white aluminous lime.

Among the gasteropodus mollusks: spondylus spinosus; a similar spondylus is found in Tippah and Tishamingo counties.

Exogyra columba, a similar exogyra, E. costata, is perhaps the most characteristic fossil of our whole cretaceous formation.

Pecten or janira quinque costata—the very same is found in our cretaceous formation in both groups, but especially in the glauconitic. Ostrea carinata—the same is found in many places in our lime group. Gryphea, or ostrea vesicularis—answering to our gryphea convexa, which is found in many places where our lime group crops out.

Very characteristic are the crabs, pagurus, as well as astacus—the claws of one of them are certainly found in Pontotoc and Tippah counties.

Most characteristic are the remains of the Mosasaurus, which are only found in the upper strata of the upper cretaceous formation in Holland, near Maestricht, and near Lewes in Sussex, in England, and which, with us, are found in many places of our lime group.

The last fossil, alone, is a sufficient characteristic to decide the position of our lime group in the cretaceous system of our globe

It takes, undoubtedly, the place of the "upper and lower chalk" in England; the "terrain sénonien," in France; and the "Kreide Bildung" in Germany. It is true, this group consists, in England, principally of chalk, which is unknown in our State, but such chalk is neither found in continental Germany nor in Holland, and, besides, chalk is nothing else than a modification of carbonate of lime, as is the principal member of our lime group, the white aluminous carbonate of lime, and it is evidently represented by the latter. The chalk of England is characterized by a great many flint nodules, of which, as before stated, I have at least found indications in our carbonate of lime. Besides, the upper and lower chalk stratum in England does not alone consist of chalk, but also of chalk-marl, an aluminous carbonate of lime, called in England, chalk-marl, but which corresponds exactly, even in its lithological character, with our white aluminous carbonate of lime, commonly called rotten limestone, which we could, with the same right as the English, call "chalk-marl."

The same stratum occurs in Germany, and is there called "Mergel," meaning marl. It occurs also in France, and is there called "craie-touffue." In Germany, as well as in France, that stratum bears the same lithological character as in our State. In both countries it is, perhaps, a little harder than here in most places, and I do not remember having seen it in both countries running into a bluish color, but those circumstances are of little importance.

Being then compelled to determine that our lime group corresponds with the upper stratum of the cretaceous formation in Germany, France and England, it is natural to suppose the underlying stratum—the glauconitic group—to correspond also with the next stratum of the cretaceous formations in England, Germany, and France—the "upper green sand and chalk-marl," the "Pläner-formation," the "terrain sénonien;" especially as our two strata appear to be deposited or formed by water in an uninterrupted succession, so many fossils being identical in both groups; as, for instance, exogyra costata, grypheae mutabilis and convexa, ostrea plumosa, janira quinque costata, hamulus onyx, a great many of the ammonites, the nautili, some of the baculites, and many others.

So, indeed, we find it; and it is even rendered probable by the common lithological character of the formations. It consists in England of green sand—sandstones and marl; in France, of "glauconie crayeuse, grès vert superieur, craie-chloritée, craie tufeau," which corresponds to, and indeed means, green sand, and green sand marl; in Germany, of Kreide-mergel, Grün sand-stein and "Quader," which means chalk-marl and green sandstone, alternating with "grün-sand" (green sand), and "farbigen Thonen" (colored clays), and "quader," a compact and hard sandstone, occurring only in Germany.

Not only the lithological character of our glauconitic group agrees with the second stratum in the general system of the cretaceous formation, but also its palaeontological character. The most characteristic fossil is the large quantity of cephalopods, especially baculites of different species, on account of which the upper green sand in England and Germany has received the name of "baculite stratum."

This is exactly the same with our glauconitic group; wherever it is found, it teems with cephalopods, especially baculites, and deserves the name of baculite stratum here as well as in other countries.

A common characteristic is also the occurrence of so many teeth of ganoid and placoid fishes, especially squalides, as ptychodus, corax pristodontus, otodus appendiculatus, odontaspis, oxyrhina, pycnodus, which occur either in genera or specie in the European upper green sand, as well as in our glauconitic group. Many of the ammonites and nautili are similar.

Of the acephals, especially janira quinque costata is characteristic. The same species occur in England, France, Germany and here, in our own State. Many of the oysters are similar; ostrea carinata, is common to all in specie. The grypheæ are similar—ostrea falcata is most probably identical; the inocerami and terebratulae are similar.

Among the gastropods, the rostellariae are very similar, so are the naticae and turritellae.

There remains, then, no doubt that our glauconitic group is identical with the upper green sand in England, the Pläner in Germany, and the terrain turonien in France; and this opinion will be confirmed if we cast a short glance upon the following underlying cretaceous formations as they are found in Germany, France, and England. The formation next to the glauconitic group, is on a descending line in England, called "gault;" in Germany, "galt;" in France, "terrain albien," but also frequently gault; being similar in all those countries, it has in all of them a similar name. It consists of a fat, light-gray clay, devoid of fossils, but full of glauconitic sand in the upper layers, teeming with pyrites, and especially concretions or nodules of phosphate of lime. It is not more than about 200 feet in thickness. Nothing is found in Mississippi, according to my present knowledge, which could be compared with the gault.

The last stratum or member of the cretaceous formation, the lower green sand in England, "terrain néocomien," in France, "Hils formation" in Germany, consists principally of a compact clay, fine-grained sand of different colors and silicious character, a ferruginous sandstone, and loose sand with pebbles, such as are nowhere found in our State. This member of the cretaceous formation is, besides, of great thickness, amounting to 1000 feet, which renders its existence here improbable. Near Columbus, where I have seen the lower of our groups, the glauconitic, bored through with an artesian auger, the auger penetrated a compact variegated plastic clay, which is entirely strange to the cretaceous formation, and does surely not belong to it; it has much more the appearance of the variegated clay "marnes irrisées," of the permian or triassic formations, to which I firmly believe it belongs.

The cretaceous formation in Mississippi, consists, therefore, according to the above exposition, most probably of only two groups, or divisions of the cretaceous formation, as it is found in Europe: of the lime and glauconitic group, corresponding with the two upper divisions, the terrain sénonien and turonien of D'Orbigny. The two lower groups, the albien or gault, and néocomien, are wanting.

This assertion is confirmed by another proof which, although negative, is of great importance. The néocomien of D'Orbigny, the lowest member of the cretaceous formation wherever it is found, is characterized by the cephalopodous mollusks, ancyloceras, and crioceras, which are no where found in the State of Mississippi, and I believe in none of the Southern States. The same is the case with the caprotinae which are of common occurrence in the néocomien, but found no where among our cretaceous rocks.

Dr. F. Roemer, in his work on the cretaceous formation of Texas

(Die Kreide-Bildungen von Texas, Bonn, 1852), comes, after a careful examination, also, to the conclusion that the cretaceous formation of Texas, a continuation of that in our Southern States, this side of the Mississippi, contains only the sénonien and turonien of Orbigny, the two upper members, but he finds them blended into each other, which is not the case in Mississippi; the lime group represents here the senonien, and the glauconitic group, the turonien or German Pläner (55).

ROCKS OVERLYING THE CRETACEOUS FORMATION.

1.—*The Orange Sand Group.*

The glauconitic and lime groups, which we have considered in the above, are all the rocks which belong to the cretaceous formation of this State. When they were deposited by the waters of deep sea, most probably many thousand feet in depth, as we have been obliged to estimate the sedimentary deposit of that sea at a thickness of from 1200 to 1500 feet, they must have been elevated above the level of the ocean before or at the commencement of the eocene period, the first of the tertiary age; for we do not find any of the deposits of that period overlying the cretaceous rocks, which would most certainly be the case, had they continued during that period below the level of the ocean.

The upheaval of the cretaceous rocks commenced soon after the deposition of the glauconitic or lower group along its eastern and northeastern line; it is there, where the lime group thins out and ends, as is seen in the Diagram No. 10, containing a section of Plymouth Bluff, near Columbus, in Lowndes county.

The whole of the lime group, in its western and southwestern portion more than 600 feet thick, measures there only a few feet in a vertical direction, downwards.

The cretaceous rocks did not remain in that elevated position for a long time, compared with the age of our globe; for there is a sedimentary formation overlying it, which belongs most probably to the period next to the eocene, to the miocene, or middle tertiary, that is to say, which has been deposited by the sea during that period, and gives evidence that the cretaceous rocks were then again depressed below the level of the ocean.

When first re-depressed, a most powerful marine current must have swept over the surface of the cretaceous rocks, which was then, according to all marks and indications, a uniform deposit of white carbonate of lime. The effects of this current are visible everywhere, N. and S., but especially N. in Pontotoc, Itawamba, Tippah, and Tishamingo counties; whole portions of the surface soil have been washed away, valleys and gulleys scooped out, and elevated hills left in the eddies of the current, on the top of which the soil is still visible, which has been swept away at their bases. So we find it even in Kemper, Noxubee, and Ocktibbeha counties. In a part of Lowndes county, where the lime group was not of great thickness, it has been swept away entirely, and not a trace is left of it. (The dotted line in Plate III., Sec. 1, indicates how the formation must have been before the upper strata were swept away by the current). In Chickasaw, Monroe, and the southern portions of Pontotoc and Itawamba counties, the lime group has not been entirely swept away, and overlies the glauconitic group still; in Tippah and Tishamingo, most of it has been entirely swept away, and only now and then remnants of it, with the characteristic fossils, have been left, and especially such parts have been left as consisted of hard limestone, as the coralline and cerithium limestone, which offered more resistance to water than the soft aluminous carbonate of lime. But, as it has already been remarked, the effects of a re-submersion of the cretaceous formation under the waters of the ocean do not only consist in the washing away of considerable portions of the surface of the cretaceous formation, they consist also in the accumulation of a considerable sedimentary deposit lying now over the cretaceous formation.

The orange sand group, which has been mentioned in the description of the carboniferous rocks, overlies also the cretaceous rocks, and the submersion has, therefore, most probably been a simultaneous one.

In Kemper and Noxubee counties, where the cretaceous formation in this State commences, it is bounded, along its west side, by high hills, but even E. of these hills, near Wahallack, Sec. 2, T. 12, R. 8, considerable strata of orange sand, with its characteristic pebbles, overlie it, and in many places conceal it entirely.

These sand hills continue all along through Noxubee, Ocktibbeha, Lowndes, Pontotoc, and Itawamba counties; on the western side of the prairies they form a more continuous range of hills; among the prairies they appear like isolated mounds. Where the glauconitic group, or the lower cretaceous formation, crops out, the tertiary deposit of the orange sand group is much more uniform and continuous, and outcrops of the cretaceous rocks are more scarce.

For a description of the orange sand group, I refer to that given in the foregoing chapter concerning the carboniferous formation, and to the diagram No. 8. The only secondary stratum contained in it is here, over the cretaceous rocks, the deposit of pebbles, which, in a few places, have been cemented into puddingstone. Neither kaolin, nor silica, nor red clay, nor terra sigillata, have been hitherto found in it, but of the first, at least, a vestige in nodules of a fine white plastic clay, nearly as pure as kaolin, near Summerville, in Kemper county, which is of no consequence, as the quantity is insufficient for any purpose, and large and inexhaustible layers of it have been found overlying the eocene rocks in Wayne county.

2.—*The Prairie Soil.*

The orange sand group of the miocene period is not the only formation overlying the cretaceous rocks; another one overlies them in many places, which has hitherto been mistaken for a disintegration of the cretaceous rock, but which is, without any doubt, a different and distinct formation.

The prairie soil, or prairie group, as we will call it, overlies the cretaceous formation only where the lime group has not been washed away, and stands, therefore, most probably, either chemically or mechanically, in some connection with the white carbonate of lime. This has been either necessary for the decomposition of the superimposed sedimentary matter, and for its transformation into the prairie group; or, after its deposition, it has been a porous and loose mass, which subsided, by exposure to the atmosphere, and formed large basins, in which the water collected, and caused the deposit which now appears as the prairie group.

The prairie soil or group consists of two distinct strata, the upper and lower; the lower stratum is a yellowish clay, mixed with a considerable quantity of lime, and containing, in many places, a large quantity of small concretions of carbonate of lime. In its lower parts this stratum appears somewhat stratified, and shows very frequently a great many small pebbles and fragments of cretaceous fossils, which are evidently washed out of the underlying cretaceous formation.

This lower part of the prairie group has very few characteristic fossils; it only commences to be fossiliferous in its upper parts, where it changes its yellow color, and adopts gradually that of the overlying black prairie soil (56).

The upper stratum of the prairie soil is of a dark brown, nearly black color; it is darkest near the surface, and changes gradually and insensibly to a yellowish gray or brown; it is very aluminous, and therefore extremely hard in dry, and sobby and sticky in wet weather; it is mixed with lime, a great deal of organic matter, and a good deal of oxide of iron. The silicious part of the soil consists of very fine sand.

The lithological character of the soil itself shows that it cannot have had its origin exclusively in the disintegration of the underlying cretaceous formation; and this becomes very evident, if we consider the fossils of this group.

These fossils are especially testaceous molluscs, partly aquatic, partly land shells. The aquatic shells are either univalves or bivalves; the univalves are paludina, the most numerous of all the fossils, and sometimes found in large layers; it extends deep down, nearly to the bottom of the deposit; they are farther, lymnea, physa, planorbis, auricula, etc. The land-shells are: helices of several species, bulimus, pupa, succinea, achatina, etc. The bivalves are: unio and cyclas, of several species.

A careful examination of those fossils of the prairie soil will convince us that all the aquatic shells above enumerated—paludina, lymnea, physa, planorbis, and auricula, as well as unio and cyclas—are shells which live in fresh water, and cannot exist in salt water; they afford, therefore, a certain proof that the prairie soil cannot be exclusively the detritus of a marine formation, as the cretaceous rocks are, but that fresh water must have been the medium of its production; and if we submit the prairie soil, with its characteristic fossils, which are found nearly everywhere in great abundance, to a careful examination, we cannot but come to the conclusion, not only from the fossils, but also from the admixture of a large quantity of vegetable substance, that it is a fresh water formation.

The interesting problems to be solved are then: How was it formed? and: In what period of our earth's history falls its origin?

We have already alluded to the fact that the prairie soil, or prairie group, is only found in this State, as well as in Alabama, overlying the lime group of the cretaceous and eocene formations; it is found nowhere superimposed upon any other formation, nor even upon the green sand group of the cretaceous rocks.

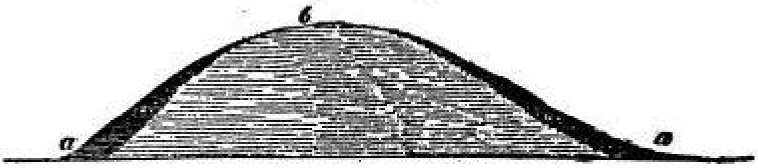
This circumstance leads, then, to the conclusion that there must be a certain connection, either chemically or mechanically, between the white carbonate of lime of the lime group, and the prairie soil. It is possible that the connection is a mechanical one, and that the white carbonate of lime, after its elevation above the surface of the ocean, was a very porous mass, which settled by degrees, and formed basins in which the fresh water collected, converting those basins into lakes and ponds, by which the prairie soil was deposited; but it appears to me more probable that the connection is rather a chemical one.

We have seen, after the cretaceous formation was deposited in a deep sea, it was upheaved and changed into dry land; but it did not remain so. Probably towards the middle or end of the miocene or middle tertiary period, it was re-depressed, formed again the bottom of the ocean, whose waves wrought a great change on its surface, sweeping away, on one hand, large portions of the original formation, and covering it, on the other, with a portion of its own formation, which we have called the orange sand group.

The re-upheaval of the then depressed formation has probably been very slow and gradual; and large portions of the surface of the cretaceous, and even tertiary rocks, in the middle of those formations, have been depressed, and formed, for a long time, basins filled with fresh water, constituting lakes and ponds, in which the prairie soil was deposited: and this deposit contained a great deal of vegetable matter, which, mixed with the carbonate of lime of the bottom of the lakes and ponds, formed the black soil which we now call "prairie soil."

Such a gradual elevation is rendered probable by the final elevation of the prairies to such an altitude that they are now no longer lakes or ponds, which they most certainly must once have been, but dry land. It appears still more probable if we consider the situation of the prairies. Most of them lie on a level, but not all; in some instances we find the prairie soil lying on the slope of hills. This, for instance, is the case in Lowndes county, about four miles W. of Columbus. The prairie group is here from four to six feet thick, and extends up a hill to very nearly its top, as the following diagram exhibits.

[No. 20.]



a a. Represents the prairie soil, extending very nearly to the top of a hill.

b. Is an outcrop of the white carbonate of lime, on the top of the hill, or a bald prairie, as it is called.

Examples of that kind occur very frequently; but sometimes small patches of prairie soil are found on the very top of hills; and their appearance on such places would be very difficult to explain, if we did not admit a continuation of the upheaving until the soil came to that situation.

Such a gradual upheaval is also rendered probable by the fossils of the prairie group. These fossils do not only consist of fresh water shells; they consist also of land shells, as we have seen above; but the fresh water shells, especially the paludinae, extend the deepest.

The lakes and ponds from which the prairie group was deposited can never have been very deep; but at one period they must have been so shallow that, perhaps, as it is the case with the everglades in Florida, the grass and herbs grew in them above the water-level, and harbored land shells, which fell into the water, and came in that way in the deposit of the water. Even a good many of the fresh water shells are such molluscs as live most frequently in swamps; as, for instance, planorbis, limnea, auricula, and even some of the helices, are most frequently found in wet swampy places.

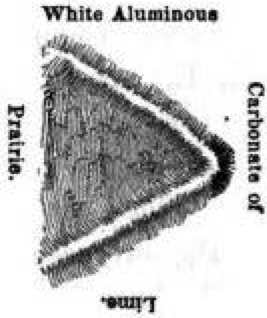
The prairie group is never very thick, generally from a few inches to about 10 or 12 feet. Of the depth of from 10 to 12 feet, it is only found in very few places; its average depth may be estimated at about 18 inches or two feet. It is generally not stratified, but the lower strata, the lowest part of the yellow limy soil, is frequently somewhat stratified, and contains very small pebbles, a great many fragments of cretaceous fossils, and pieces of nearly carbonized wood and sticks, from which it would appear as if the water had first rushed into those basins with great violence.

If it has not been difficult to determine that the prairie soil is a fresh-water formation, and not only a disintegration of the cretaceous rocks, it is, indeed, less difficult to ascertain during which period of our earth it has been deposited.

The prairie group is only found in those places in which the orange sand group has either not been deposited, or swept again away by marine currents. We shall see later similar fresh-water deposits are also found lying upon the orange sand group, but they are of quite a different nature, and by no means belonging to the prairie group. It can, therefore, not strictly be said that the prairie group overlies the orange sand group, but in some places it is, nevertheless, very evident that the prairie soil belongs above the orange sand group.

So, for instance, on the road from Macon, in Noxubee, to Louisville, in Winston county, the prairie soil overlaps the orange sand very distinctly; and wherever it appears is deposited in basins, surrounded by hills or elevated portions of the orange sand group overlying the cretaceous rocks. This is especially striking on the road from Macon to Louisville; the last small prairie, in a S. S. W. direction, terminates there in an angle, and is surrounded by elevated ridges, appearing like the embankments of a redoubt, as the following diagram exhibits:

[No. 21.]



The prairie is confined between the embankments; all around, the white carbonate of lime, with its characteristic fossils, crops out and is partly overlaid by the orange sand group. The prairie soil must, therefore, have been deposited at a period later than the deposition of the orange sand group. Accordingly it could be a pleiocene or pleistocene formation, dating from the end of the tertiary period, but this is not in conformity with the palaeontological character of that rock. All the fossil shells contained in the prairie group, are such as live now in the neighboring creeks, ponds, swamps and woods; the prairie group must, accordingly, be of very modern origin, and cannot belong to the tertiary formations, otherwise it would contain a few fossils of extinct shells, which is not the case. Besides the fossil mollusca, the remains of mammal quadrupeds are frequently found in the prairie group; as, for instance, the teeth of the mastodon giganteus, and bones of a species of sheep; the latter, especially, appeared first at the commencement of the present quaternary age; the prairie group is, therefore, a postpliocene deposit, originating from the commencement of our present age.

This is confirmed by comparing it with other rocks of that age; for instance, with the loess or lehm of the Rhine, which contains similar fossils, as helices, succinea, bulimus, pupa, limnea, and especially paludina and planorbis, and which is also doubtless of the same period.

The prairie group is, therefore, a postpliocene fresh-water formation, deposited, most probably, in shallow water, which, by a continued upheaval, perhaps still in continuation, became, by degrees, shallower, until it was overgrown by a vegetation; hence the large quantity of vegetable matter mixed with the soil, to which it owes its dark color, and the mollusca which live only on land or in swamps, and feed on vegetable matter.

These prairies are found everywhere in the State of Mississippi where the lime group of the cretaceous formation is met with; they commence in the N. E. corner of Kemper county, extend through the largest part of Noxubee into Ocktibbeha and Lowndes counties, and from there through Monroe, Chickasaw, into Pontotoc and Itawamba connties. They are the largest and most continuous in the middle of the cretaceous formation in Lowndes, Ocktibbeha, Monroe, and Chickasaw counties, and contain there considerable areas; towards the line of the cretaceous rocks they are only found in small patches, and the soil is not as thick as in the middle.

The largest of the prairies are found where the cretaceous formation is the widest and most considerable, just along the line of Monroe and Chickasaw counties; from there they extend downwards into Lowndes county, on the right or west side of the Tombigbee river. Plate V. exhibits those prairies, which extend from Ocktibbeha creek upwards to the line of Pontotoc and Itawamba counties. Plate VI. shows the prairies in Pontotoc county. The prairies in Itawamba county are very inconsiderable.

Very large prairies extend along the line of Lowndes and Ocktibbeha counties, of which the Mahu prairie is the largest; but the prairies below Ocktibbeha creek, downwards to the N. E. corner of Kemper county, have not yet been marked out on the chart, and are only indicated on the geological map of the State.

THE CRETACEOUS FORMATION IN A NATIONAL ECONOMICAL, AND AGRICULTURAL POINT OF VIEW.

However important the territory of the cretaceous formation may be, in an agricultural point of view, it is not so with respect to national economy. In this respect it offers, indeed, very few advantages.

The white aluminous carbonate of lime, commonly called "rotten limestone," is nowhere sufficiently hard to afford building stone; it does not resist the disintegrating influence of the atmosphere; the rain washes it too much, and it crumbles when exposed for a long time to the air. In some places, for instance in the southern part of the cretaceous formation, it is used for building chimneys, and where this carbonate of lime is very hard, it is useful for that purpose. The whole chimney may be built of it, provided it is covered with a thick coat of mortar, to protect the limestone from atmospheric precipitations; but it is better to build the chimneys from other materials, and line them, inside, with the white carbonate of lime, which contains clay enough to resist the influence of the fire much better than bricks.

For burning lime, this material is not sufficiently pure; it is even not pure enough, and contains too much aluminous matter, to use it for hydraulic mortar or cement. In some places the white carbonate of lime contains a large quantity of fossil shells, as, exogyra costata, gryphea mutabilis and convexa, and even rudistæ, which yield an excellent material for burning very fine quicklime, and which is also frequently used for that purpose. A superior material, as well for building purposes as for calcination or burning lime, is the hard indurate limestone, the bored limestone of the southern part of the cretaceous formation, and the cerithium and coralline limestone of the northern part.

These limestones are not only sufficiently hard to be used for building purposes, especially for chimneys and the foundations of houses, but they yield also a very good quicklime, and where they occur in large quantities, as in Chickasaw, Kemper, and the southern part of Noxubee counties, and again in Tippah, Tishamingo, Pontotoc, and Itawamba counties, these limestones could serve to burn quicklime for exportation, and especially for the use of manure for lands.

The cerithium limestone is in some places very hard; this is the case on Sec. 11, T. 2, R. 4, E., in Tippah county (see Plate VII); it is there so hard that it has been used for mill-stones, and answers that purpose remarkably well, the great many fossil shells (cerithia) rendering its surface very rough, as is the case with buhr stone.

The glauconitic group yields also a stone which could be used for building. The green sand of that group is in many places so hard that it resists the influence of the atmosphere a very long time, and can then especially be used for foundations of houses and chimneys. Such indurated green sand is found at Plymouth Bluff, large ledges and blocks are there broken down, and have been for a long time in the Tombigbee river; some of them have been immersed under water for a long time during high water, and dried again at low water, without disintegrating, and must, consequently, resist well the influence of the atmosphere.

In some places, especially where the glauconitic group lies on the surface of the country, the cretaceous formation gives origin to very fine mineral, especially chalybeate, springs, which result most probably from the disintegration of the sulphuret of iron, or iron pyrites, contained in many places in the green sand and clay of the glauconitic group.

Such mineral springs are found:—near Fulton, in Itawamba county, T. 10, R. 9, E., Sec. 7; there are two very valuable chalybeate springs; they not only yield a great abundance of very clear and palatable water, each about five gallons per minute, but the water is also cool (62° Fah., at the temperature of the air of 74°), strongly impregnated with sulphate of iron, and contains, besides, some lime, magnesia, alumina, soda, etc. These two springs are only 15 feet distant from each other, but nevertheless a considerable difference exists between them; the one, N. 30° W. from the other, is much the stronger. Both springs have caused a considerable deposit of hydrated peroxide of iron all around, and are now on the top of a small hill. There are more chalybeate springs in a range of hills extending in a southeasterly direction from Fulton, which have not yet been examined.

Near Houston, in Chickasaw county, T. 12, R. 4, E., Sec. 32; and another one, T. 12, R. 4, E., Sec. 19. These chalybeate springs are very good, but much inferior to those above mentioned, near Fulton. Both contain sulphate of iron.

In Tippah county, Sec. 11, T. 2, R. 4, E., near Jonesboro. This spring is very strong, and contains, most probably, no sulphate, but chloride of iron; it flows from underneath a ledge of hard cerithium limestone.

The elevation of the cretaceous formation is not considerable; its extent is from one hundred and fifty to three hundred and fifty feet. The water level of the Noxubee river is one hundred and fifty feet above the level of the ocean; the highest point, S. of Columbus, is a prairie N. of Macon, three hundred and sixteen feet high; the elevation of Columbus, Lowndes county, is two hundred and twenty-one feet. The highest point near Tallabonella creek, in Chickasaw county, is three hundred and twenty-seven feet; and the banks of the Tennessee river are three hundred and ninety-two feet above the ocean.

The country where the limestone group crops out is generally not well watered; and in summer there is a want of water, which is, in many places, supplied by artesian wells; but such artesian wells can only be bored, with perfect success, in Lowndes county and a part of Octibbeha county; only there the cretaceous rocks are not too thick, and the water has fall enough to rise above the surface. Lower down, in Noxubee county, the cretaceous rocks are extremely thick. At the depth of about six hundred and fifty feet, the white carbonate of lime has not been bored through by the artesian auger; and again in Pontotoc, Itawamba, Tippah, and Tishamingo counties, the water has not fall enough; it does not rise to the surface, and must be dipped or pumped out of the bored holes (57).

AGRICULTURE.

Of much more importance is the cretaceous formation in this State, with respect to agriculture, not only in offering a fertile soil, but also in furnishing the means of rendering the soil fertile.

The white aluminous carbonate of lime, being a mixture of carbonate of lime and clay, is a marl which can be used on sandy lands with the best effect. On heavy clay lands it conveys too much clay to the soil, rendering them too close and heavy; although the lime and the carbonic acid would benefit it, the benefit would be counterbalanced by the bad effect of the aluminous matter; but on light sandy lands, not only the lime and the carbonic acid have an improving influence, and serve as a solvent, and at the same time as nourishment, especially for such plants as require lime; but the clay, combined with the lime, renders the land closer, and increases its power for retaining moisture considerably.

The hard limestones, as the compact hard limestone, the bored or perforated limestone, and the cerithium and coralline limestones, when calcined, give a very fine lime for the improvement of lands.

Another good manure is afforded by the common green sand of the glauconitic group, which generally contains a large quantity of lime, some potash, and occasionally some phosphoric acid.

The analysis of a specimen of the green sand, from Lowndes county, gave the following result:

Carbonate of lime	22.381	per cent.
Oxide of iron and alumina	3.680	"
Carbonate of magnesia	1.368	"
Potash	0.311	"
Water and loss	3.740	"
Insoluble silicious sand	56.730	"
Insoluble aluminous matter	11.790	"
	100.000	

This glauconitic or green sand is, especially, a good manure for heavy clay lands, which are rendered loose by the large quantity of fine silicious sand contained in it. It would be a mostexcellent manure for exhausted prairie lands.

These substances are, indeed, most useful and valuable in agriculture, and will prove excellent fertilizers; but their importance disappears in comparison with another substance found among the glauconitic group in the northern parts of Pontotoc and Itawamba counties, in the eastern part of Tippah, and the western part of Tishamingo counties.

The place of the green sand of the glauconitic group is there occupied by the finest kind of shell marl, consisting almost entirely of the detritus of shells. The lithological character of this marl has been already described; it is a fine silicious sand mixed with grains of glauconite and the detritus of an innumerable quantity of marine shells; it has generally a greenish or bluish color from the silicate of iron, but is frequently nearly white from the great abundance of disintegrated shells.

A finer marl, indeed, cannot exist, and when in general use, it must prove to be a source of great wealth for this State, far more so than if the survey had disclosed mines of precious metals.

Such immense and inexhaustible beds of the finest marl, have now been found north and south in this State; in the south they lie between the eocene strata, commence near the line of Alabama, and extend entirely across the State; the last outcrop appears in the bluff of the Yazoo river, a mile below Satartia, underlying there several thousand square miles. In the northern part of Mississippi, they seem to extend all over the glauconitic group of the cretaceous formation, and the eocene marls again over the eocene of Tippah county. These marls must elevate the State of Mississippi to the highest rank among the agricultural States of the Union, and insure a continual wealth and prosperity; it can not, therefore, be enough recommended to the agricultural public to avail themselves of these rich marl beds and to keep their lands in fertility, and re-fertilize those which have become unfertile by an imprudent use.

It would be unnecessary to enumerate here the different outcrops of that fine marl; it underlies, most probably, the whole of the lower cretaceous formation in Pontotoc, Itawamba, Tippah, and Tishamingo counties. Such outcrops, as have hitherto been discovered, are marked with an M, on the special charts of those counties made for that purpose, and contained in Plates IV., VI., VII.

Only one specimen of the marl of the cretaceous formation, from Tippah county, has hitherto been analyzed. The analysis gives the following result:

Silicic acid	0.400	per cent.
Sulphuric acid	2.370	"
Carbonic acid	4.577	"
Phosphoric acid	0.652	"
Lime	9.474	"
Magnesia	1.677	"
Oxides of iron and manganese	3.707	"
Alumina	3.121	"
Potash	1.533	"
Organic matter and water	4.550	"
	32.061	"
Insoluble remnant of silica & alumina,	67.939	"
	100.000	

The specimen analyzed was not a very good one; the marl contains generally a larger quantity of lime, and the analysis of several other other specimens will be necessary.

Besides furnishing in the above manner the most excellent manure, the area of the cretaceous formation offers lands which are among the finest in this fertile State.

The arable lands lying on the surface of the lime group, or upper cretaceous formation of the State of Mississippi, are formed:

I. By a postpliocene fresh-water deposit, called the prairie soil; of its origin and lithological character we have spoken above. It is found only where the lime group has not been washed away from the surface of the cretaceous formation; we find it therefore only in the eastern, or rather northeastern parts of Kemper county; in Noxubee county, with the exception of its western range of townships; in Lowndes county, on the right or western side of the Tombigbee river; in the northeastern half of Ocktibbeha county; especially in Chickasaw and Monroe counties, on the line between the two counties, and in the eastern part of Pontotoc and the western part of Itawamba counties.

The prairies are the largest and most continuous, exactly in the middle of the cretaceous or lime group; along the line of Chickasaw and Monroe counties, and in the two northwestern townships of Lowndes county, they are about 32 miles long, and occupy an area of about 75 square miles, or 48,000 acres of land; and they occupy very nearly as much along the line of Lowndes and Ocktibbeha, and in Noxubee and Kemper counties.

Towards the end of the lime group, the prairies are only very small, and appear frequently in small plots of ground of not more than a few acres; this is the case in Kemper, and the upper parts of Pontotoc and Itawamba counties.

The geological group of strata forming the prairies, consists of two distinct layers; the lower stratum is a stiff yellow calcareous clay, not very fit for agriculture. On account of the large quantity of clay which it contains, it is very heavy, and difficult to work; in wet weather it does not allow the moisture a quick passage to the lower stratum, and is then too moist, forming pools of water, and in dry weather its surface becomes too hard. Where this soil crops out to a considerable extent, it is in some parts of the country called *post oak soil*, from the post oak (*quercus obtusiloba*), which it produces in great perfection, in preference to other forest trees.

Specimens of that post oak soil of Mississippi have not been analyzed, for want of a laboratory, but several years ago I made an analysis of that soil in Greene county, Alabama, which, being identical with the lower stratum of the prairie soil, will show its quality.

This analysis gave the following result:

Specific gravity of the soil=2.230, distilled water being unit.

Soluble in dilute acid.	Silica	1.38	per cent.
	Alumina	1.44	"
	Peroxide of iron and manganese	8.05	"
	Carbonate of lime	12.12	"
	Phosphate of lime	2.20	"
	Carbonate of magnesia	3.82	"
	Chloride of sodium	1.61	"
	Carbonate of potash	1.32	"
	Insoluble silicious sand	14.32	"
	Insoluble aluminous matter	46.11	"
		100.00	

The experienced agriculturist will easily perceive that even this lower stratum of the prairie soil contains all the necessary requisites of a great fertility, and that its deficiency consists only in such matter as renders it less impermeable and retentive of water, in moist weather, and less hard and close in summer.

According to the above analysis, the post-oak soil contains only 14.32 per cent. of fine silicious sand, and 46.11 per cent. of aluminous matter or pure clay, combined with 14.32 per cent. of carbonate and phosphate of lime; the soil must, therefore, necessarily be too argillaceous and close for agriculture, and, notwithstanding its great fertility, far too uncertain. In wet weather the vegetable growth must drown, and in warm and dry weather its growth is impeded by the hardness and closeness of the soil, which is then, in fact, very much like a slab of schistose slate. It is not difficult for a good agriculturist to remedy this defect, if not all at once, at least gradually.

The most fertile prairie soil which has ever come under my observation, is that of the Colorado valley, in Texas. It corresponds exactly with ours in lithological and palaeontological character; it has the same color, the same ingredients, only in different quantities, and the same fossils. It contains even less soluble and fertilizing matter than our lower stratum of the prairie group, or post-oak soil; but, instead of 14.32 per cent. of fine silicious sand, of the post-oak soil, it contains 46.50 per cent. of this material—31.18 per cent. more—and in proportion less aluminous matter or clay, which renders it a pulverulent loam, most excellent for agriculture, and fit to produce from sixty to seventy-five bushels of corn, and nearly two bales of cotton, per acre.

It is solely the admixture of so much silicious matter which renders the prairie soil of the Colorado valley so extremely fertile, and so easy to cultivate. Knowing this, how very easy is it for our agriculturists to improve that most excellent soil, which indeed contains all elements of fertility; nothing remains to be done, but to mix that stiff post-oak soil, every year, with a quantity of silicious sand, and to continue this until the soil has been changed to a pulverulent loam. This is generally very easy, because the manure is, in most places, very near, and requires no expense but the hauling.

The very best material for that purpose is the green sand of the cretaceous or glauconitic group, which has been mentioned above, and is found in great abundance in the eastern part of Lowndes county; but if this green sand should not be within reach, any silicious sand will answer the purpose. A very good material is found frequently among the orange sand group, which overlies the lime group nearly everywhere (58).

The upper stratum of the prairie group, the stiff black or dark brown clay soil, mixed with a great deal of vegetable matter, is called the prairie soil; it is also a very heavy soil, difficult to work, especially in some seasons; to a certain degree impermeable to water, and assuming in hot and dry weather, after a rain, a very hard crust. In fact, it participates of the faults of the post-oak soil, although in a less degree.

A specimen of the prairie soil, taken from a place in Noxubee county, which had not been in cultivation, gave the following result:—

I. Soluble Matter.		
A. Acids:	Per Cent.	
1. Sulphuric acid	0.324	
2. Phosphoric acid	0.192	
3. Chlorine	0.152	
4. Silicic acid	1.068	
5. Carbonic acid	0.100	
		1.834
B. Bases:		
1. Alumina	5.680	
2. Lime	1.247	
3. Magnesia	0.260	
4. Oxides of iron and manganese	6.784	
5. Potash	3.103	
6. Soda	4.496	
		21.573
II. Organic Matter.		
1. Humic acid	1.864	
2. Humine	0.252	
3. Undecomposed organic matter	8.094	
		10.210
III. Water in Combination		7.200
IV. Insoluble Matter.		
1. Silicious sand and gravel	17.920	
2. Aluminous matter	40.920	
		58.840
Loss in the analysis		0.343
		100.000

It is easily perceived that the prairie soil is originally of great fertility, but the proportion of silicious or loosening matter is too small; it is about 18 per cent. of silicious sand to 40 of aluminous matter. It is much better than the post-oak soil, which contains only 14 to 46 per cent.; but a comparison with the Colorado prairie soil, which may well be taken as a standard, and which contains 46½ per cent. of silicious matter, will at once show us the defect of the prairie soil—it contains too much clay. This must, however much fertilizing matter it may contain, render it a very uncertain soil. It must generally be too close and hard in dry weather, and too sobby and retentive of water in wet weather, and too inert in the spring, and unfit for an early cultivation. These faults are only remedied—

1. By a continual admixture of fine silicious sand, until it has

been changed into a fine pulverulent loam, as the prairie soil of the Colorado valley of Texas is. The best material for this purpose is the green sand of the glauconitic group; this answers two purposes; it not only conveys silicious sand into the clay, but it contains, besides, a great deal of fertilizing matter, as lime, potash, sulphuric and carbonic acids, and others, and operates at the same time as a manure.

2. By drainage. No arable soil requires more to be drained than the prairie soil; when wet it is very impermeable to water; the consequence is, the rain-water cannot percolate into the ground, but remains on the surface. As, now, the black prairie soil absorbs heat very eagerly, the water standing in pools on its surface must not only drown, but also scorch, the vegetables growing on the soil.

This fault of the prairie soil can only be remedied by a judicious and sufficient drainage. Ditches must be made wherever the rain-water can collect, and the superfluous water led off into a main ditch or canal.

The prairie soil, fertile as it is, can, in its natural state, only occupy an inferior place. When the season suits the soil, in dry summers, in which the soil is only moistened by moderate showers of rain, the prairie soil will produce immensely; but such summers are scarce, and, therefore, the prairie soil can only produce well occasionally, and in an average of ten years will scarcely yield as much as a common sandy soil.

But our prairie soil is no longer in its natural state; by an imprudent cultivation it has been exhausted without having been improved; the consequence is sterility, and diseases of its vegetation of every description (59).

The arable lands overlying the lime group are furthermore formed—

II. By a mixture of the material of the orange sand group with the white aluminous carbonate of lime. This forms also a very productive soil, which is generally found in the level country, near and around the prairies, where the cover of the orange sand is not too thick. All the counties in which prairies are found, contain a good deal of this soil, which is less productive, but much safer than the prairie soil in its natural state, and will give fully as good an average crop in the space of ten years as the most fertile prairies.

There is a great deal of this land in the middle part of Pontotoc county, in T. 9, R. 4 and 5; it produces there from 70 to 80 bushels of corn, and more than a bale of cotton per acre; it is there known by the name of mahogany soil, from its color, originating from a mixture of the orange sand with white aluminous carbonate of lime. Plots of real prairie soil are found now and then in the middle of this mahogany soil.

III. By the alluvium of rivers and creeks mixed with the cretaceous matter. This gives a very good soil, frequently called slough lands, which are equally as fertile as the prairie lands, but require also prudent management, especially ditching.

The best of these lands are probably found along the Tallabonella creek, in Chickasaw county, and along several other creeks.

IV. By the materials of the orange sand group alone; these are generally the most inferior lands, lying on and around hills. A great deal of these lands lies in the western part of Chickasaw and Ocktibbeha counties, and are there called flat-woods. They consist of tertiary clay overlying the cretaceous formation, and orange sand overlying the clay; a very thin stratum of the sand is mixed with vegetable mould, and forms a kind of soil, but it is only a few inches thick, and the soil, consequently, in its natural state, a very inferior one; but manured with the white carbonate of lime, and mixed with it to a certain degree, it can soon be changed into a productive soil, and this can be done with little expense, as the aluminous carbonate of lime is near at hand. The wells dug in the flat-woods having nearly everywhere calcareous water, the carbonate of lime can probably be had in most places on the land itself. Such flat-woods are found in other parts of the cretaceous formation, as, for instance, in Tippah and Tishamingo counties, probably also in Pontotoc and Itawamba.

Places where the white carbonate of lime occupies the surface are not scarce, but they are seldom very extensive, and do not exceed the area of a few acres; they are commonly called "bald prairies," and are entirely unproductive, the corrosive quality of the lime not allowing the growth of any vegetation, scarcely grass.

The arable soil lying on the surface of the glauconitic group, or lower cretaceous fotmation, is formed—

1. By a mixture of the orange sand with the clay and marl

of the glauconitic group. This affords a most excellent soil, which yields from 60 to 70 bushels of corn, and more than a bale of cotton, to the acre, and is fully equal, if not superior, to the prairie lands, being a less uncertain soil.

Such soil is found in the northern part of Pontotoc and Itawamba counties, and in some places in Tippah and Tishamingo; as, for instance, in T. 6. R. 5, E., in Tippah county.

2. By a mixture of a yellow loam, which overlies the orange sand in some places *with* the orange sand; this forms also a very good soil, generally at the foot of hills.

3. By the sand and clay of the orange sand group, mixed with vegetable mould. This soil is generally found lying on the hills, and affords arable land of a middling quality.

4. By the mixture of the alluvium of rivers and creeks with the orange sand and the detritus of the cretaceous marls and clays. This forms a most excellent soil. A great deal of it is found along the head waters of the Tallahatchie river. A specimen of this soil and subsoil, taken at some distance from the Tallahatchie river, and there called second-bottom land, (Sec. 4, T. 6, R. 4, E., in Tippah county,) was submitted to an analysis, and gave the following result:

I.—Surface Soil.	Per Cent.
Silicic acid	0.331
Sulphuric acid	0.086
Phosphoric acid	0.031
Carbonic acid	0.219
Chlorine	0.030
Lime	0.281
Magnesia	0.106
Oxide of Iron	4.590
Alumina	0.459
Potash	1.694
Soda	0.026
Organic matter	5.210
Hygroscopic water	1.200
Insoluble silicious and aluminous matter	85.735
	100.000

II.—Sub-soil.	
Silicic acid	0.100
Sulphuric acid	0.076
Phosporic acid	a trace only ....

SUB-SOIL—(continued).	Per Cent.
Carbonic acid	0.280
Lime	0.360
Magnesia	0.181
Oxide of iron and alumina	4.850
Alkalies	0.160
Organic matter	2.980
Hygroscopic water	1.220
Insoluble silicious and aluminous matter	89.753
	100.000

It appears, then, from the above analysis, that these alluvial lands are of an excellent quality, consisting of a fine yellow pulverulent loam. The country where the glauconitic group lies on the surface, being generally a hilly one, the creeks and rivers rise rapidly, overflow a large surface, and have unproportionately large bottoms.

The largest portion of the arable lands of Tishamingo county, overlies the cretaceous formation, and among them are the best lands of the county. They are much more level and fertile than those lying above the carboniferous rocks.

Especially the lands in the western part of the county are level and very fertile. In the south-western portions, there are considerable tracks of prairie and hummock lands, alternating with rich bottom lands, as on the Twenty Miles creek and its tributaries. All of them have wide bottoms, not subject to inundations.

The western and north-western districts of Tishamingo county abound, also, in very fertile bottom lands along the head waters of the Tuscumbia river.

About the twelth part of the county consists of fertile alluvial or bottom lands, along the rivers and creeks.

The average production of the county consists in from 10 to 12 bushels of wheat (this would be much increased by the introduction of a better preparation of the lands for this crop). On good lands, frequently, 20 bushels of wheat are harvested. The average corn crop amounts to 25 or 30 bushels, but the best lands produce, frequently, 60 bushels. The average cotton crop amounts to from 700 to 1000 lbs. per acre.

Nearly one-half of the area of Tippah county, the whole eastern part, is occupied by the cretaceous formation, but this is not the fertile part, it is too hilly, and the overlying orange sand group renders it generally too sandy. The south-eastern part of the county is the least fertile portion. The best lands are in the north-eastern corner, occupied by the miocene formation, they consist partly in extremely fertile postpliocene deposits, to be mentioned later.

This county possesses, also, large tracts of alluvial bottom lands along the Tippah, Hatchie, and Tallahatchie rivers, and Muddy creek. These bottoms are, within the county, from 15 to 25 miles long, from one-fourth to one-half mile wide, and very productive.

The average production of the county amounts to about 25 bushels of Indian corn, from 8 to 10 bushels of wheat, and from 700 to 1000 lbs. of cotton.

The other counties of the cretaceous formation have not yet been submitted to a particular examination, with respect to agriculture.

FOREST GROWTH OF THE CRETACEOUS FORMATION.

The growth of the forest trees on the cretaceous formation differs with the soil. On the upper cretaceous formation, or lime group, are found:

Post oak, *quercus obtusiloba.*
Red oak, *quercus rubra.*
Black oak, *quercus tinctoria.*
Spanish oak, *quercus falcata.*
Overcup oak, *quercus macrocarpa.*
White oak, *quercus alba.*
Chesnut oak, *quercus castanea.*
Sassafras, *laurus sassafras.*
Hickory, *carya tomentosa, amara*, and others.
Elm, *ulmus americana and fulva.*
Sweet gum, *liquidamber styriciflua.*
Black gum, *nyssa multiflora.*
Sumach, *rhus globosa.*
Short-leaf pine, *pinus rigida.*
Red maple, *acer rubrum.*
Persimmon, *diospicus virginiana* (in old fields).
Cedar, *juniperus virginiana.*

In moist places, in the bottoms of rivers and creeks grow especially:

Swamp oak, *quercus aquatica.*
Willow oak, *quercus salicifolia.*
Linn oak, *quercus palustris.*
Magnolia, *grandiflora.*
Buck-eye, *aesculus pavia.*
Cypress, *cupressus disticha.*
Poplar, *lyriodendron tulipifera.*
Hazel, *corylus americana.*
Linn, *tilia americana.*
Swamp snow-ball, *hydrangea quercifolia.*
Walnut, *juglans nigra.*
Willow, *salix nigra.*
Cucumber tree, *magnolia macrophylla.*
Beech tree, *fagus americana.*
Birch, *betula populifolia.*
Bay tree, *magnolia glauca.*
Umbrella tree, *magnolia umbrella* and *magnolia tripetala.*
Dogwood, *cornus florida.*
Holly, *ilex opaca.*
Pecan, *carya olivaeformis.*
Spanish mulberry, *calicaspa americana.*

Along the banks of the rivers are especially found: Sycamore (platanus occidentalis), and cotton-wood (populus deltoides). The long-leaf pine (pinus australis, or palustris,) is nowhere found on the cretaceous formation.

On the surface of the glauconitic group, or the lower cretaceous formation, the growth is very similar to that of the lime group; the Spanish oak is there more frequent, and the magnolia grandiflora and carya olivaeformis are entirely absent. Pine trees (pinus rigida), which are found nearly everywhere on the lime group, are here only in some places.

In some very fertile regions the poplar (lyriodendron tulipifera), and umbrella tree (magnolia macrophylla and magnolia umbrella), are found on the tops of hills; the cotton-wood (populus deltoides) is absent. Chestnut and hickory trees are perhaps more abundant than on the lime group, and always a sign of good land; whereas black jack and red oak are generally growing on indifferent land—for instance, in the flat-woods.

In the alluvial soil of the river and creek bottoms, immense sycamore and poplar trees are found; and in ponds and swamps, cypress trees (cupressus disticha). The magnolia macrophylla, and all the magnolias with deciduous leaves (that fall off in autumn), seem here to be much more frequent.

III.—LITHOLOGICAL AND PALAEONTOLOGICAL DESCRIPTION OF THE TERTIARY FORMATIONS.

The tertiary formations are, in extent, by far the most important in the State of Mississippi, occupying, of the 45,468 square miles of its area, 31,428 square miles, or a little more than two-thirds of the whole territory of the State. They occupy exactly the middle part of the State, and extend, in an uninterrupted continuation, from the line of Tennessee to the Gulf of Mexico, as the geological chart of the State exhibits. Nearly in the middle, the tertiary formation is divided into two parts, by a line running east and west, from the line of Alabama to the Yazoo river; N. of this line is the newer tertiary, or miocene; S. the older tertiary, or eocene. Having commenced with the older formations, we have to consider, first, the latter:

1.—THE EOCENE FORMATION.

It is the most extensive of the geological formations of the State, occupying an area of 20,637 square miles, nearly one-half of that of the whole State. Its surface is of quite a varied nature. Near the line of the newer tertiary formation it is hilly, and in parts very broken; from there the hills decrease; in its middle part it is only rolling, the hills are less high, and have very gradual and rounded slopes. Farther down, near the sea coast, it becomes gradually perfectly level, so much so that it is subject to great inundations after heavy rains.

The eocene formation has not yet been submitted to a particular examination; I have only crossed it in different directions, in order to get a general idea of the geological formations of the State, but enough of it has been seen to attribute to it the highest importance for the State. Fine deposits of marl have been found in the northern part of the State, on the glauconitic group of the cretaceous formation, but they dwindle into insignificance when compared with those immense and rich deposits of the finest kind of *shell marl* of the eocene formation, which are inexhaustible even for the supply of the whole Union. I have seen enough of the eocene formation in this State to know that these rocks are better developed here, in the State of Mississippi, than I have seen them anywhere else in Europe or America, and I cannot sufficiently recommend to the Legislature of Mississippi to authorize a very close and minute examination by their State Geologist, not only for the disclosure of the immense agricultural resources contained in the eocene rocks, resources which are of incalculable value for the State, insuring the permanency of its fertility and wealth, but also for the advancement of science; for a thorough search and examination of the eocene formation in Mississippi must throw more light upon the tertiary age of our globe than that of any State in the Union (60).

The deposits of the fine shell marl, which is entirely made up of disintegrated shells, underlie, as far as I am now able to judge, more than 2,000 square miles; they are from a few inches to more than 100 feet in thickness, and contain everywhere the finest tertiary fossils. Nearly every outcrop abounds with them, and in many places they are in a fine state of preservation; especially the bed and bluffs of the Chickasawhay river, from the formation of the river by two confluent creeks, near Enterprise, in Clark county, to the southern line of Wayne county, and probably much farther down, offer invaluable palaeontological treasures, phytogene as well as zoogene.

Not having subjected the eocene rocks to a particular and minute examination, a systematical report concerning this formation cannot be expected, and I have to confine myself to generalities. As far as those rocks are now examined, they consist of strata of sand, sandstone, chert or hornstone, clay, aluminous stone and ferruginous conglomerate, lime rocks, and especially marl.

In the lower part of Mississippi, from a line drawn from the boundary of Alabama, over Winchester in Wayne, Ellisville in Jones, Williamsburg in Covington, to Monticello on Pearl river, in Lawrence county, down to the coast of the Gulf of Mexico, the eocene, as far as it appears, consists especially of sand and clay; the latter is frequently of a dark brown color. The country is here first rolling, with some ranges of hills, of a gentle declivity and round form, but becomes gradually perfectly level, as the sand increases.

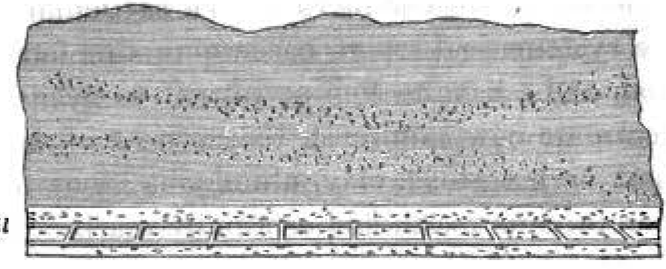
A stratum of quartzose pebbles commences on the right or W. banks of the Chickasawhay and Pascagoula rivers, and increases in thickness westwards. This stratum of pebbles, important and remarkable as it is, I will only mention here, and treat of it at large with the formation to which it belongs—the newer tertiary—and show there, also, that it is a great mistake to attribute it to the northern drift of the pleistocene period, to which it cannot possibly belong, and whose extension, as far down as the State of Mississippi, is indicated by no trace which can be *unhesitatingly* attributed to it.

On the west side of Pearl river there is, in the same latitude, less sand and more clay; the hills are more elevated, and the strata of pebbles increase here in frequency of occurrence and thickness.

A fine view of the formation of this part of the State is exhibited on the west side of the town of Holmesville, in Pike county, T. 3, R. 9, W., Sec. 28, in a gully washed by the rain, from twelve to fourteen feet deep; a fine red and brown-red clay extends there from near the surface entirely down to the bottom of the gully, and is in some places interstratified by the quartzose pebbles.

These strata of pebbles are finely exhibited in T. 3, R. 8, in a cut on the New-Orleans & Jackson Railroad, represented in the following diagram:

[No. 22.]



The cut is about fourteen feet through a red clay, which, all along for more than half a mile, contains a most remarkable stratum of pebbles. The pebbles begin to appear about four feet from the surface, and continue for about ten feet downwards, in different layers, as it appears in the diagram. They are so close and thickly crowded that it must have been impossible to dig the cut with a spade; strong pick-axes have been necessary. The railroad track is perfectly paved with the pebbles. They are all quartzose; agate and jasper are of most frequent occurrence; some of them are of the finest agate, and would make pretty ornaments if prepared by a lapidary. Many of the pebbles, especially the agate, consist of petrified corals, as: favosites, columnaria, and others. A great many of the agates have crinoidal impressions, and several petrified crinoidal stems were found agatized among them. These pebbles appear, therefore, to be of palaeozoic origin, most probably from the devonian and the mountain limestone of the carboniferous formation. The size of these pebbles is from coarse sand to that of a hen's egg; and the agates, which are in most instances cavernous and contorted, give evidence of a formation in water; they have, indeed, a stalactitic or stalagmitic appearance.

From Holmesville westwards, immense strata of pebbles are met with everywhere along the road.

North of the line before indicated, from the frontier of Alabama to Monticello, to the southern boundaries of Lauderdale, Newton, and Scott counties, the country is slightly hilly, but the hills are neither high nor steep.

It is in this belt, which goes through the whole State, and extends from Scott county a little northwards towards Vicksburg, in Warren county, where the eocene formation is best developed.

With respect to its lithological character, it appears here really to be a continuation of the cretaceous formation, and could be in many places mistaken for it, were its palaeontological character not so entirely different.

Like the cretaceous formation, the eocene could here indeed be divided into a glauconitic, and calcareous or lime group. It consists of marl, which takes the place of the cretaceous green sand, or the cretaceous marl of Tippah and Tishamingo, and contains, also, an admixture of glauconite, but only in smaller quantity; it consists, furthermore, of strata of clay of different colors, and ferruginous concretions; but the latter in smaller quantity, and occurring only in some places.

The lime group consists of a soft aluminous carbonate of lime, entirely analogous to the rotton limestone, of hard, compact limestone, and of clay, generally of light colors, as white pipe-clay. This eocene lime group appears to be frequently wanting farther west, and is replaced by a yellow calcareous loam, containing a great many concretions of pure white carbonate of lime.

It is indeed most singular, not only the intrinsic character of the eocene formation is here so very similar to that of the cretaceous formation, but also the external character; it is also overlaid by the orange sand; and over the white carbonate of lime lies the postpliocene prairie soil, appearing here less extensive, but in the same character as over the lime group of the cretaceous formation, with a stratum of yellow calcareous clay below, and a layer of dark brown or black very heavy clay soil above. The lower yellow stratum contains the same concretions of pure carbonate of lime; and where the white carbonate crops out, there are bald prairies, exactly like those above the lime group of the cretaceous formation.

Could the lithological character of both formations—the cretaceous and the eocene—be mistaken and confounded, the *palaeontological* could not for a single moment.

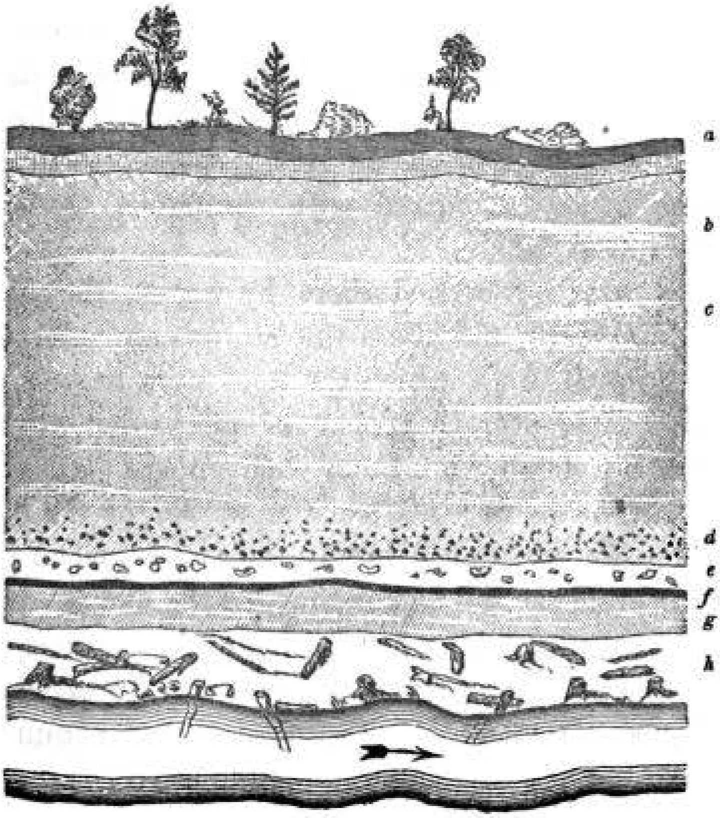
Here are no cephalopodous molluscs, no ammonites, hamites, scaphites, baculites and belemnites, to be found; scutellae, turritellae, cerithia and dentalia have taken their places; here is the so very characteristic exogyra costata entirely wanting, and replaced by cardita planicosta, which is nearly as characteristic of the eocene as the exogyra to the upper secondary formation. Here are no remnants of the last of the marine saurians, the mosasaurus hofmanni; a cretaceous mammal has taken its place—the monstrous zeuglodon cetoides, which characterizes the lime group of the eocene just as well as the mosasaurus the upper strata of the lime group, and extends from Alabama to the Mississippi river; its vertebrae are here frequently used to support the sills of negro cabins.

Here, then, is the example of the permian and triassic, or new red sandstone formations, repeated, where not only two formations but two ages run petrographically into each other. According to their petrographic character, the eocene could be mistaken for the cretaceous rocks, if it were not for the vast difference in the palaeontological character of both formations; if it were not that the same class of saurians, which characterizes the geological age, of which the triassic is the first formation, diappeared from the face of the globe, at the terminus of that age—never to return—and that a new kind of animal appeared, marvellous and immense as the fertility for such organisms of our maternal globe must then have been.

The eocene strata appear in a remarkable outcrop in Wayne county, Secs. 10 and 14, T. 7, R. 6, W.

The following diagram represents the outcrop:

[No. 23.]



The river bluff is there about 27 feet high. The stratum *a*, represents the surface soil; *b*, about two feet of brown, rather coarse sand; *c*, about 18 feet of yellow sand, the lower part of which, about three feet, *d*, contains a large quantity of pebbles, densely packed upon each other; they are all very round, water-worn, and of a quartzose character, consisting of cornelian, agate, jasper, &c.; *e*, represents a stratum of white sand, and not more than about 18 inches thick, containing nodules of the finest and purest white clay; this clay is pure enough to be called kaolin; it makes white porcelain before the blow-pipe. The quantity is, unfortunately, not sufficient for an extensive use; *f*, is a seam of clay of a darker color, mixed with a large quantity of very nearly entirely decomposed leaves, which appear in a layer. These leaves are so much decomposed that it cannot even be ascertained whether they are from endogenous or exogenous trees, or if the leaves of coniferous trees are mixed with them.

The stratum *g*, contains white sand, with marked stratification lines, and is about three feet thick; *h*, lastly, is a stratum of light blue clay, extending down below the water of the Chickasawhay river, of which it forms the bottom. It commences about four feet above low-water level. The clay is rather sandy, it contains a buried forest of tropical trees, which lie in wild confusion over each other, as they had been prostrated by some catastrophe. There appear the tall palm trees, the fern trees, with the scars and the fibres of the leaves still on the bark; there the caulinites, the nipodites, the cycadites, mixed with coniferous trees, probably beech trees, or even oaks.

These trees were not carried there by water; they appear not water-worn, and here and there the stumps are still seen rooted firmly in the ground from which the trees were broken, and—singular enough—those stumps appear as smooth and even as if the trees were not cut down from them with an axe, but sawed with a sharp saw; nevertheless, neither the stroke of the axe nor the rattling of the saw resounded then in the forests, when those trees extended their branches and foliage towards the clouds; the birds of the air could then more safely warble their merry tunes under the shelter of the leaves than now. Man—the terror of the sublunar world—had not yet made his appearance and commenced his ravages among the vegetable and animal creation (61).

Not far from that remarkable place, on Secs. 4 and 10, (same T. & R.), a large ledge of ferruginous sandstone, from 18 inches to 3 feet thick, crops out in the bed of the Chickasawhay river; above that ledge lies a stratum of yellow sand, of scarcely one foot thick, and above this another ledge of the same sandstone, which is very useful for building purposes, and hardens considerably if exposed to the air.

On the other side, S. of the bluff, where the buried tropical forest crops out, on Sec. 14, T. 7, R. 6, W., on a little creek, a stratum of fine white clay crops out, most excellent for the finest kind of pottery; it is perfectly infusible, and does not change after a long exposure to the flames of the blow-pipe. There is an abundance of clay for any purpose.

A most beautiful spring gushes out from under this white clay; it runs out of a hole of more than five inches in diameter, and yields, in a minute, much more than 50 gallons of water, of the temperature of 18.9° centigrades, or about 66° Reaumur, and of perfect purity and crystalline appearance.

A little higher up, on the Chickasawhay river, on Sec. 3, T. 8, R. 7, W., occurs the most southern outcrop of the large eocene marl stratum. It appears here about 30 feet below the surface, in a gully, (of which there are here a great many), from 25 to 30 feet deep, washed in the surface sands. Above the marl lies a stratum of hard limestone, which contains a great quantity of an ostrea, of large size.

The stratum of marl extends all along Yellow creek. It appears to run out here; it is divided in two strata by a ledge of hard and compact limestone; each stratum is not more than about 10 inches thick.

Here in this neighborhood, about a mile west of the Chickasawhay river, is one of the greatest natural curiosities of the State of Mississippi, a cave running eastward to the Chickasawhay river. The entrance of this cave is about 12 feet high, and fully 30 feet wide, excavated in the white carbonate of lime, which is here not very hard, and resembles very much the rotten limestone of the lime group of the cretaceous formation. The cave winds very soon to the left, and after forming a large hall from 20 to 30 feet high—the sporting place of numerous bats—it narrows considerably, and, within about 50 yards from the entrance, it is not more than three feet high; the visitor is obliged to advance creeping. I intended to explore the cave as far as possible, but having no other means of illuminating it than torches made of fat or resinous pine wood, it was soon filled with a dense smoke, which rendered it perfectly impossible to proceed, and I was obliged to give up the idea of examining it for fossil bones, and wait for another opportunity, which I have not yet found.

The whole cave is lined with stalactites and stalagmites; by the latter it is entirely floored, and it is very possible that interesting fossil bones are hidden under them.

The cave is said to be more than a mile long, and to lead to the Chickasawhay river; this is even more than probable, as it is very evident that it has once been the bed of one of the subterraneous creeks, which are here found in several other places.

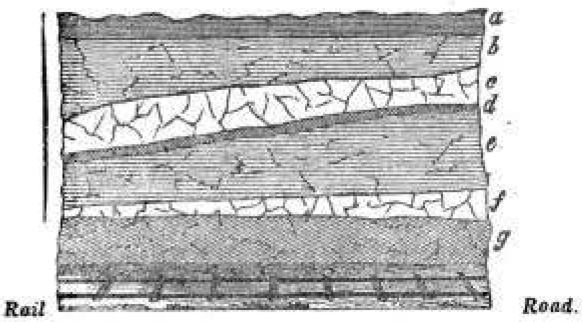
On the east side of Chickasawhay river, in T. 9, R. 6, W., there is a very deep and large gully washed in the orange sand by the rain water; the bluffs of this gully are more than 20 feet high, and nearly perpendicular. The orange sand extends entirely down to the bottom, and is in some places interstratified with considerable nodules of a pure and fine kaolin, called white chalk, and used for marking.

The deposit would be an important one, as the kaolin is exactly of the same quality as that of Tishamingo county, if the quantity were not insufficient.

This kaolin here, so far from any feldspathic rocks, is indeed a singular phenomenon. It is nearly in the same longitude in which the kaolin in Tishamingo county is found, and must have been carried by water from that direction.

Near Red Hill, in Wayne county, on Limestone creek, the Mobile & Ohio railroad is cut through a considerable hill, where the limestone group of the eocene formation is well exhibited. The following diagram represents a section of this cut:

[No. 24.]



a. Represents a stratum of yellow sandy loam, the surface soil, about two feet thick.
b. A stratum of loose and brittle limestone, from two to six feet.
c. Hard carbonate of lime, three feet thick.
d. A seam of loose calcareous clay, three inches thick.
e. Soft and brittle limestone, from six to eight feet thick.
f. A seam of hard and compact limestone, from six inches to two feet thick.
g. Loose calcareous and aluminous material.

Towards the S., this group runs under a stratum of indurate fine white sand, not well cemented, and easily crumbled.

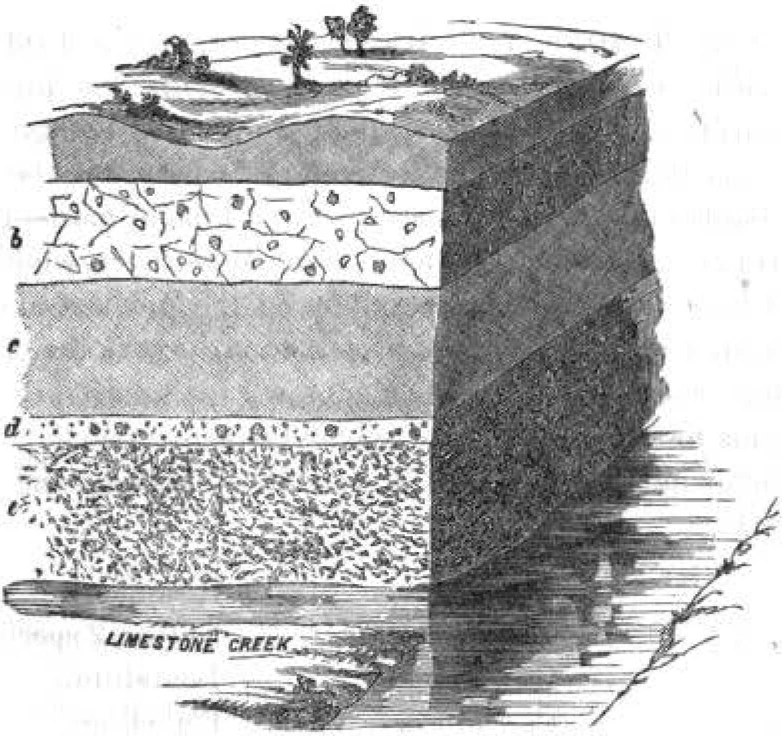
The limestone found in the cut, especially that of the hard seam, *f*, is a good material for calcination into quick lime; it is also hard enough for building stone.

The only fossil found here in the limestone is a cast of a trigonia, difficult to cut out of its matrix.

Limestone creek, which runs S. of this cut in the railroad, and empties about 400 yards from it into the Chickasawhay river, contains large ledges of hard and compact limestone; and south-east of the cut, about a mile and a half from it, the sandstone which appears S. of the cut so very loose, and not well cemented, crops out as a hard compact limestone, an excellent material for building purposes.

Where Limestone creek empties into the Chickasawhay river there is a high bluff exposed, which exhibits also a fine view of the eocene limestone group. The following diagram represents the bluff:

[No. 25.]



The stratum *a* contains the surface soil, consisting of sand.

b Is a stratum of yellowish limestone, containing pecten, of several species, gallerites, and several ostreae.

c Is a stratum of calcareous sand, containing pecten and gallerites, the same as above.

d A stratum of calcareous marl, filled with orbitoides, ostrea, pecten, of several species, arca, flabellum, cardita, gallerites, &c.

e Is the shell marl, consisting of the detritus of innumerable shells, of a greenish blue color.

The above is the only place, of the eastern part of the State, where the orbitoides are found; they are here conglomerated in the limestone in immense quantities. It is very difficult to recognize them; they are from $\frac{3}{10}$ to $\frac{6}{10}$ of an inch in diameter, perfectly discoid, not more than from $\frac{1}{100}$ to $\frac{2}{100}$ of an inch in thickness, and so much water-worn that all marks on their surfaces have disappeared, and neither radii nor pores are visible with naked eyes; they can, therefore, easily be mistaken for nummulites. The orbitoides resemble very much the orbitulites complanata of Lamarck.

The stratum of marl along the Chickasawhay river is very frequently forty feet thick, but contains, in some places, ledges of indurate sandstone, cemented by carbonate of lime; it continues under the water, forming the bottom of the river, and its exact thickness cannot be ascertained. The upper stratum of the marl contains generally a large quantity of lime; it changes lower down in the bed, often, into sandy and aluminous marl, with very little sand.

On Sec. 27, T. 10, R. 7, in Wayne county, on the bank of the Chickasawhay river, there is a bluff about forty feet high. The lower stratum of this bluff consists of a pure and fine green clay, perfectly plastic, and very fine for pottery. Above this clay, which is not fossiliferous, there lies a stratum of a kind of marl—probably the equivalent of the marl which is here found everywhere, interstratified with dark gray clay—containing the greatest abundance of fossils, in a very fine state of preservation. Above the clay there is a seam, consisting of nodules of a brown red sandstone, also full of the same fossils, especially of spondylus and turritella.

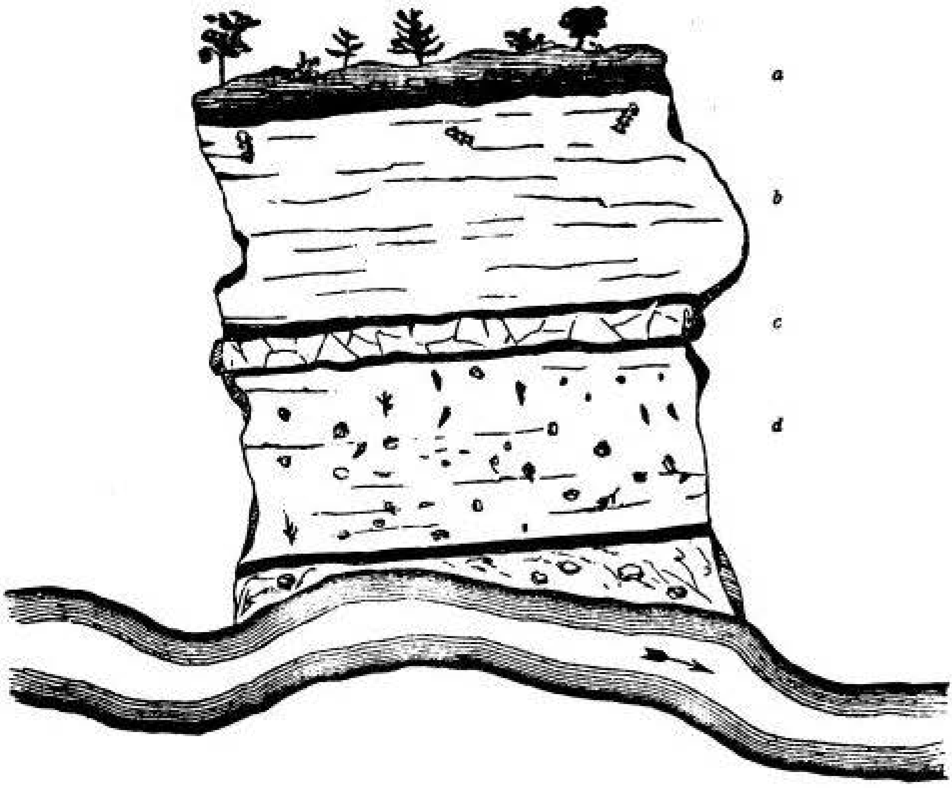
The following is a list of the genera of fossils found here in abundance:

Cytherea,	Cassis,	Rostellaria,
Spondylus,	Murex, 3 species,	Natica, 2 species,
Nucula,	Cassidaria,	Dentalium,
Cardium,	Cerithium,	Flabellum,
Cardita, 2 species,	Tritonium,	Turbinolia,
Pectunculus,	Pleurotoma, 3 species,	Ancillaria,
Ostrea, 2 species,	Mitra, 5 species,	Teeth of carcharodon,
Turritella, 3 species,	Pyrula, 2 species,	Corals (madrepora),
Bulla,	Actaeon,	An entirely unknown
Eburna,	Capulus,	fossil, probably phy-
Cyprea,	Conus,	togene.

This deposit of fossil tertiary shells is decidedly one of the finest in the United States, and fully equal, if not superior, to that of Clayborne, in Alabama; it has, besides, the advantage that many of the above species are new and undescribed.

Another remarkable bluff is about four miles farther up, on the Chickasawhay river, on Sec. 3, T. 10, R. 7, W. A section of it is represented in the following diagram.

[No. 26.]



The marl commences here immediately below the surface soil *a*; it is not as good as farther below, but nevertheless a fine manure.

The whole bluff consists here of marl; the stratum goes down into the water of the river and forms its bottom; it must be estimated at least at 100 feet in thickness, and is, in its lower parts, a most excellent marl, consisting altogether of detritus of fossil shells, mixed with aluminous matter; it is, nevertheless, not the same in all its parts; in some places it is more aluminous, in others more sandy.

Through the middle of the stratum extends a ledge of indurate limestone, *c*. The whole of the bluff is fossiliferous, the upper stratum, consisting of black prairie soil, not excluded.

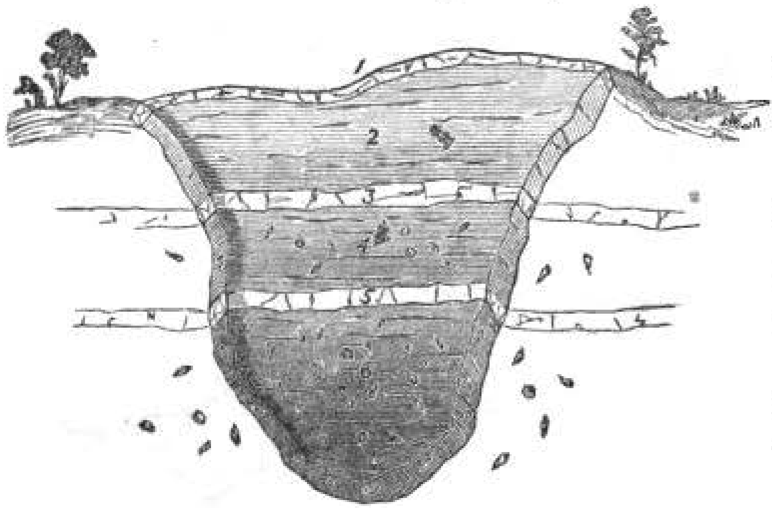
In the latter are found helices, achatinae, auriculae, helicinae and others. In the upper stratum of the marl, *b*, was found nearly a whole skeleton of zeuglodon cetoides; in the lower, *d*, a great many corals, two species of clypeaster, cardita, pinna, pecten, several species of ostrea, and others.

The marl deposit continues here along the river for several miles; it changes, nearly in the middle, from the left to the right or western bank of the river.

This immense deposit of marl was first discovered by the author, in the fall of the year 1855, in a gully on the plantation of Gen. W. Trotter, on Sec. 3, T. 10, R. 7, W.

The following diagram exhibits this gully:

[No. 27.]



No. 1. A seam of hard limestone.
No. 2. Marl containing fossil bones of the zeuglodon.
No. 3. A seam of indurate limestone.
No. 4. Marl with many fossils.
No. 5. A seam of hard limestone.
No. 6. The finest marl with innumerable fossils.

Analogous to the outcrop on the Chickasawhay river, near this place, in the same Section, T. and R., the marl commences immediately under the surface stratum No. 1, which is here a seam of hard limestone. The upper strata are not as good as the lower stratum, but very fine; the lower stratum appears greenish-blue when wet, but nearly white when dry and pulverized. It is, indeed, here the finest marl ever found by the author, consisting entirely of the detritus of innumerable shells, which are so much disintegrated that very few of them—some carditae, turritellae, pectens, and others—can be identified. The analysis of this marl will be given later.

In a field above this gully, the white carbonate of lime crops out in several places; in one of them nearly the whole of the vertebral column of a zeuglodon cetoides was found, a few years ago, and appears to be of immense length; it had been, unfortunately, removed at the time of the first geological examination of the neighboring gully and bluff of the Chickasawhay river, and many of the vertebræ were lost.

Not far from the latter place, on a hill, the formation of the surface is very plainly exhibited; the upper part consists of a greenish gray clay with red veins, which, evidently, does not belong to the eocene formation, having the appearance of an amorphous drifted material; below it lies a white ledge of limestone, containing pecten, ostrea, scutella, and others, and is, therefore, decidedly eocene. On the side of the limestone, southwards, the orange sand is overlying it, containing, here, innumerable small and rounded pebbles. Not far from this hill, some gullies are washed out, from 16 to 35 feet deep, which show everywhere that the orange sand group overlies here the eocene very thickly, and the above mentioned clay must belong to that group.

Northwards from Gen. W. Trotter's plantation, the road is intersected by Garland's creek. Under the bridge, over this creek, is a fine outcrop of the green sand marl, which is here very near the surface. The stratum of marl appears from 12 to 15 feet above the water, but extends downwards below the water; its thickness can, therefore, not be ascertained. The marl, although very valuable, is more sandy, and the fossil shells are in a fine state of preservation.

The following fossils were found here:

Astarte.
Cytherea, several species.
Psammobia.
Nucula.
Pinna.
Crassatella.
Cardita, several species (C. planicosta among them).
Cardium.
Corbula.
Pecten, two species.
Rostellaria (velata).
Fusus.
Solarium.
Actaeon.
Pectunculus.
Voluta (dumosa).
Morio (petersoni).
Mitra.
Cardium.
Ostrea, several species (gigantea).
Corals (ceriopora).

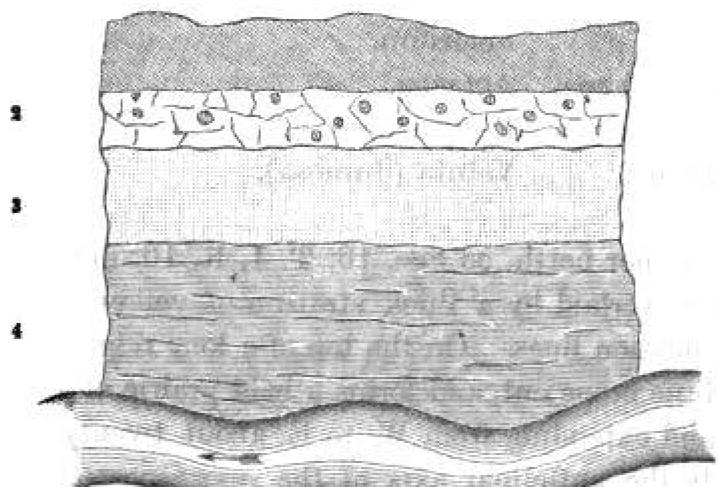
A little farther north, on Sec. 16, T. 1, R. 16, in Clarke county, the hills are overlaid by a thick stratum of yellow sand, with distinct stratification lines. On the top of a long ridge the white carbonate of lime crops out, and forms a bald prairie of about one mile in width, and extending from W. to E. about twenty miles, which is decidedly the anticlinal axis of the upper eocene rocks; from here the strata dip evidently south, and probably also north. The white limestone—" rotten limestone "—is of a soft nature, and contains a great many finely preserved fossils; among which are: turritella, murex, actaeon, cardita, rostellaria, scutella, etc.

About four miles from Quitman, R. 2, T. 16, a stratum of marl, containing some indurated nodules of limestone, crops out on a small creek; it extends here to about four or five feet above the water, but its thickness cannot be ascertained; it goes down lower than the creek of which it forms the bottom. Prominent among the fossils here found is a large ostrea of a rather globular form, more than six inches in diameter; it is not ostrea gigantea, and appears to me to be a new and undescribed species.

Here in this region the marl crops out on every river and creek, and nearly in every gully; it underlies the whole country. Near Quitman it appears not only on the banks of the Chickasawhay river, where it is nearly nineteen feet thick, and contains, in some places, valuable deposits of sulphate of alumina (T. 2, R. 15, Sec. —), but also on a small creek (Anchusa creek), south-east of the village, near a very valuable red sulphur spring, which will be described later. It appears here about three feet above the water, and is full of the fragments and detritus of fossil shells (Sec. 11, T. 3, R. 16).

A different aspect of the eocene strata gives the right bank of the Chickasawhay river, in Enterprise, which divides the town in two parts, the eastern and western parts. The following diagram represents this bluff:

[No. 28.]



The upper stratum No. 1 is red sand, of the orange sand group, covering the eocene about ten feet thick.

No. 2 is a stratum of aluminous rock, six feet thick, consisting nearly entirely of a conglomerate of shells, as scutella, clypeaster, pecten, several species; ostrea, several species; cardita, several species, and others.

No. 3 is, again, a stratum of ferruginous sand, probably an alternate of the marl; it is about ten feet thick, and full of grains of glauconite; in some parts it assumes a greenish color. It is not fossiliferous; its fossils are most probably all decayed, so as to leave no trace, as it is frequently the case in ferruginous sand.

No. 4 is a stratum of greenish yellow clay, non-fossiliferous, as the sand above it; it forms the bottom of the river, and its thickness cannot be ascertained.

The innumerable fossils which are lying everywhere in the river, and on its banks, came all from the hard stratum of aluminous stone, which is full of them, and large blocks of which are broken off and have fallen down into the river, and upon the bank, near the water's edge, where they disintegrate.

The most northern outcrop of the marl, hitherto found in the eastern part of the State, occurs on Hassanlowey creek, (Sec. —, T. 3, R. 14). There the marl crops out for more than two hundred yards, not more than eight feet below the surface; it is generally of a bluish color, but appears white where it is dried and oxidized, and contains, frequently, indurated nodules. The whole is filled with innumerable fossil shells, nearly all in fragments; among them were recognized: ostrea, cerithium, dentalium, pecten, fusus, crassatella, etc.

The eocene extends much higher up, to the northern part of Lauderdale county; and, most probably, other outcrops of the marl will be found in this county.

Above Marion, about a mile N. W. of the town, on a hill, eocene sand crops out, full of fossils, especially cerithium, turritella, cardita, of several species; fusus, and others. This sandstone is in some places as hard as flint; and as the fossils in it cause its surface to be very rough, it is an excellent *buhrstone* for millstones. A great quantity of it appears to be in the neighborhood.

By digging a well, in the town of Marion, a stratum of fine lignite was found, from sixteen to twenty feet below the surface, consisting of three different layers, each more than one foot thick. This lignite crops out in different places of the county; it is of very good quality, dark brown, glossy upon its fracture, hard, and nearly free from sulphuret of iron.

About two miles W. of Marion a very fine spring comes out under a hill, from above a large stratum of white clay, known under the name of fuller's earth; it is here of white or rather grayish color, has a soapy feeling, and consists of alumina, silica, lime, magnesia, and some oxide of iron.

The spring yields a large quantity of water—so much so as to turn a mill, not more than two hundred yards farther down. In the neighborhood, W. of this spring, a large quantity of shells are found all over the top of a round hill, but most of them injured by the fire, when the grass and the dry leaves of the hill were burnt; among them were, nevertheless, recognized, cardita planicosta, conus, fusus, natica (helicoides), voluta, and others, which leave no doubt of their being eocene shells, and are probably from the marl which may underlie there.

The eocene formation seems to contain, near its northern boundaries, a yellowish white aluminous rock, which is, near that boundary line, without fossils, but becomes fossiliferous farther south. This rock is found in the northern part of Lauderdale county, in the southern parts of Neshoba and Kemper counties, in Newton and Scott counties. It is generally not hard enough for any use, but in some parts it becomes sufficiently hard, especially where it appears fossiliferous. About three miles from Chunkey creek, in Newton county, this rock underlies the orange sand; it is here, in some places, very hard, and runs into real sand or buhrstone, very valuable for millstones.

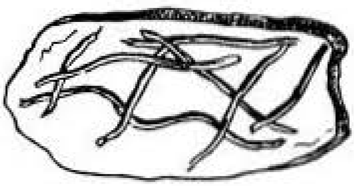
The same rock is also found in Clarke county, on Sec. 33, T. 5, R. 15, in a railroad cut. The upper stratum is here the white aluminous rock—a ledge about four feet thick; then follows a stratum of a soft crumbling rock, which changes gradually into sandstone, in which eocene fossils were found. Farther south a stratum of very hard chert, or hornstone, lies on the top of the rock, running in connected nodules through the yellow sandstone, which fills up the spaces among the nodules. This chert, lying among the eocene rocks, must, consequently, be eocene. Prominent fossils in the sandstone are fucoids; a slab with very fine specimens was found; and also among other fossils the ovary of a large pyrula, exactly such as are now frequently seen on the beaches of the Gulf of Mexico and the Atlantic. It is represented in the wood engraving:

[No. 29.]

The dip of the different strata in this embankment on the Mobile & Ohio railroad appeared to be from two to four degrees towards S. W.

The same aluminous sandstone was found in the southern part of Neshoba county, T. 9, R. 18; it contains here not only some eocene shells—as, for instance, a small cardium and an astarte—but also some fossils, which appear at first sight like corals; they are lying upon the slabs of the aluminous stone, as the following diagram exhibits:

[No. 30.]



But as none of them were found standing in an erect position, and as their ramification does not appear like that of corals, they must be fossil fucoids.

An outcrop of the eocene marl occurs in Scott county, on Coffeebogue creek, T. 7, R. 6, E. It is here about 16 feet under the surface, of greenish blue color, rather more indurate than on the banks of the Chickasawhay river, in Wayne and Clarke counties, but by no means inferior; it consists almost entirely of the detritus of shells, cemented by aluminous matter, and mixed with some fine sand. It can be found everywhere here, at a depth of not more than from 12 to 16 feet below the surface.

The same marl crops furthermore out on the bluff of the Yazoo river, a mile S. of Satartia, in Yazoo county, on Sec. 12, T. 9, R. 4, W. The hills are here from 80 to 90 feet high, apparently consisting entirely of the postpliocene deposit of the loess, or bluff formation, as we may call it. West of one of the hills a deep gully, of about 20 feet in depth, is washed in the soil by the rain water running off from the hill; here it appears that under the loess lies first a stratum of a greenish aluminous marl, effervescing strongly with acids; this is from three to four feet thick; then follows a seam of a perfectly white aluminous earth, of the appearance of lime, but showing no sign of effervescence with acids, and containing, therefore, very little or no carbonate of lime.

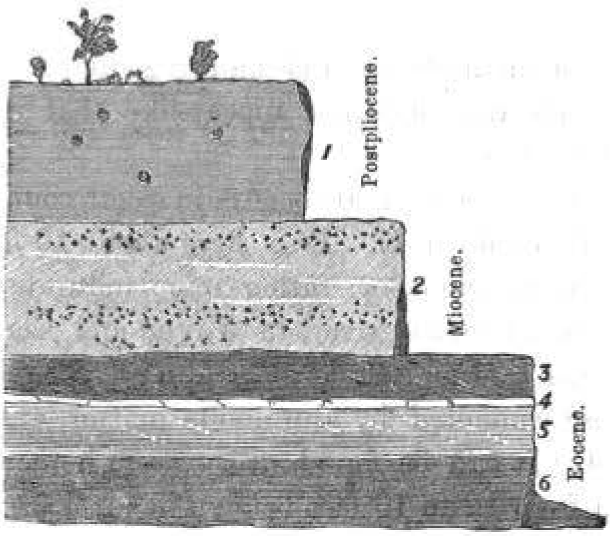
Below this seam, of not more than nine inches thickness, is again a stratum of light green aluminous marl, about three feet thick; then follows a stratum of dark green very aluminous marl, full of eocene shells, and effervescing strongly with acids; the thickness of this stratum could not be ascertained, as it goes down into the bottom of the gully. The fossils found in the marl are cardium, cardita planicosta, panopea, dentalium alternatum, fusus, voluta, flabellum, pecten, etc.

The dip of those strata is apparently from N. N. W. to S. S. E.

One of the hills projecting a little into the Yazoo bottom, and denudated on its N. W. side, is very remarkable, showing the rock of three different periods and two different ages.

The following diagram represents a section of it:

[No. 31.]



No. 1 represents the loess with its characteristic fossils of helices, auriculae, helicinae, uniones, and others.

No. 2, a stratum of orange sand, with the characteristic pebbles, which are here in two strata, one in the upper part of the orange sand stratum and one in the lower; the pebbles of the two strata are different.

The pebbles of the lower bed consist almost entirely of jasper and agate, mixed with silicified pieces of endogenous plants, mostly calamites; some of these pieces are nearly two feet long and one foot wide. Some of the pebbles are also very large, weighing several pounds. This stratum contains no other than those phytogene fossils. In some places ferruginous sandstone, so characteristic of the newer tertiary, is found in the stratum No. 2.

Nos. 3, 4, 5, and 6, represent the eocene rocks.

No. 3 is a stratum of greenish clay, mixed with carbonate of lime.

No. 4, a seam of white aluminous matter, without lime.

No. 5, again, a stratum of lighter clay, mixed with carbonate of lime.

No. 6, a dark green stratum of very aluminous marl.

The strata Nos. 3, 5, and 6, are fossiliferous, and contain all the fossil shells above mentioned, with the addition of eburna.

Farther south, along the bluff, near Warren county, the eocene compact limestone crops out in large ledges, containing eocene fossils, as cardita planicosta, crassatella, pecten, and others. This limestone affords a very good material, not only for burning quick-lime, but also for building.

The eocene shell marl bed was furthermore found to crop out on Sec. 1, T. 18, R. 5, E., in Warren county. The marl is here not of so excellent quality as in Clarke, Wayne, and Scott counties, but it is nevertheless a fine manure.

The appearance of the eocene marl stratum near Hillsboro', in Scott county, and on the Yazoo bluff, in Yazoo and Warren counties, seems to be a sure indication that this marl bed extends all across the State, and will, therefore, most probably be found in all other counties, from the northern boundary line of the eocene formation down to Jones, Covington, Lawrence, Copiah, and Jefferson counties. As it is of the highest interest for these counties, most of which have only a light and sandy soil, and would be immensely benefited by the application of that rich manure, a close examination of all the counties enclosed in that belt will be very necessary.

In the lower part of Yazoo, and in the upper part of Warren counties, the eocene formation is very thickly overlaid by a very fertile soil, consisting partly in the loess, partly in a yellow loam mixed with it to a great extent; only now and then a perfectly black plot of a very dark clay appears, giving evidence of its underlying everywhere.

About eight miles E. of Canton, in Madison county, T. 9, R. 19, the eocene formation appears in a gully, in an old field washed from four to five feet deep by the rain water. The rocks consist here of a clay of yellowish gray color, which is very calcareous, and contains a great many concretions of pure carbonate of lime (generally called agaric mineral), such as are found in the loess and the lower stratum of the prairie soil. This clay effervesces strongly with acid, and is a very fine marl for light and sandy soil; deeper down, this marl changes to a stiff, limy clay.

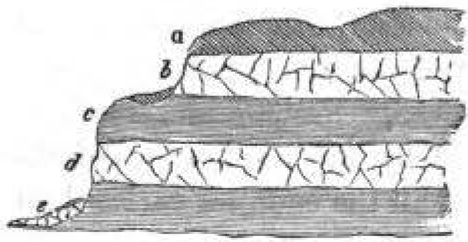
The only fossils found in this soil, are fragments of a large shell, most probably an ostrea; its upper valve is very much like that of gryphea mutabilis.

The same kind of marl crops out all along the railroad from Canton to Jackson, and by grading the railroad, nearly the whole of a skeleton of the zeuglodon cetoides was found in it; the eocene origin of the stratum is, therefore, beyond question, and this fossil renders it most probable, or rather certain, that it takes the place of the white carbonate of lime of the eastern part of the State, in which the fossil remains of the zeuglodon are found.

A very fine outcrop of the eocene rocks is near Vicksburg, on the Mississippi river; the hills which form the bluff on the left side of the Yazoo river, come here round, forming a semi-circle, and meet the Mississippi river, where they terminate abruptly, and where the strata constituting them have been denudated.

The following diagram represents the last of the hills:

[No. 32.]



Letter *a* represents a stratum of the loess, which is found everywhere near Vicksburg, overlying the eocene, and which contains here all the characteristic fossils, consisting of land-shells only.

b is a stratum of hard and compact limestone, sufficiently hard for building purposes; it is fossiliferous and contains a great many pectens.

c is a stratum of loose and crumbling argillo-calcareous rocks, containing some fossils.

d is, again, a stratum of hard fossiliferous limestone, analogous to *b*, but contains more and a greater variety of fossils, which will be hereafter specified.

e is, again, a stratum of loose rocks like *c*.

The whole hill is about 50 feet high. The last stratum goes down to the bottom of the creek, which winds around the hill, and empties into the Mississippi river.

Below this limestone, lies a stratum of dark-brown clay, which is covered by the talus of the bluff; and under this clay, lies a large deposit of lignite, which is situated lower than the water-level of the Mississippi river, and can only be seen when the water is very low. I have been assured that it is very nearly half a mile long, but its thickness has not been ascertained. Other eocene deposits of lignite are found in Hinds and Rankin counties. Perhaps the lignite stratum cropping out in the bed of the Mississippi river, near Vicksburg, may be a part of this deposit.

The lignite, or brown-coal, of the Vicksburg deposit, is very good, and it is astonishing that the proprietor has not tried to quarry it there and sell it to the steamboats, for which it would prove to be a valuable fuel, as it contains very little sulphuret of iron.

The fossil shells collected along the Mississippi river, from the above described rocks, are of the following genera:

Arca.	Ancillaria.	Natica.
Cytherea, 2 species.	Pleurotoma.	Mitra, 2 species.
Crassatella, 2 do.	Cerithium, 2 species.	Ostrea (gigantea).
Corbula.	Turritella.	Lunulites.
Cardium.	Conus.	Orbitoidès.
Pecten.	Solarium.	

Not only from the occurrence of the same species of orbitoides here in the eocene deposits, near Vicksburg, which are also found in so large quantities near Red Hill, on the Chickasawhay river, and on Limestone creek, in Wayne county—consequently in the extreme western and eastern parts of the State of Mississippi—but especially from the occurrence of the fossil bones of the zeuglodon cetoides, not far from Vicksburg as well as in Wayne county, near the boundary-line of Alabama, and even in Alabama, near St. Stephen's, on the Tombigbee and at Clayborne, on the Alabama river, from the identity of so many other genera and species of fossils (radiata as well as mollusca), and from the similarity of the lithological character of the different deposits themselves, in the various parts of the eocene formation, in the eastern and western portions of the State of Mississippi, from the Mississippi river to the boundary line of the State of Alabama, *the conclusion must be drawn that the whole upper part of that formation, within the boundaries, in which those fossils occur, belong to the same geological period.*

It is evidently a mistake to admit, within those boundaries, the existence of different geological stages, originating from different times, because certain fossils occur in one of the deposits which are not found in the other. Such an admission, would pre-suppose a variety of movements, of upheavals and depressions, in the crust of our terrestrial globe, which are unatural and no more found on it.

It is true, upheavals and depressions are continually going on, as we have stated in another place of this report; but they are gradual, and, as it were, regular; they extend over large areas, last for an immense space of time, and are so insensible that they nearly disappear before the observation of, comparatively, ephemeral beings as we are. Never, since the beginning of the zoic period, of our globe, have they been confined to small portions of this terrestrial globe, in such a manner that small portions of its crust have been upheaved here and other small portions subsided there, as it seems to have been the case during the azoic period, where the solid crust of this globe appears to have been still very thin, and where the internal heat was certainly much more active than it was during the zoic period, and especially during the last geological ages.

It is decidedly too often the case that, if different fossils are found in different deposits, they are unhesitatingly ascribed to different geological periods, instead of attributing them simply to different localities. The anomaly resulting from a disregard of local difference, and attribution of all difference to time, is strikingly exemplified in the present case.

The orbitoides (orbitulite mantelli of Conrad), a very characteristic fossil, as it cannot be denied, is found near Vicksburg, in Warren county, immediately on the banks of the Mississippi river. It is not found in the deposits of Jackson, nor anywhere else from Vicksburg to the Chickasawhay river, but appears again in large quantities at Red Hill, on the Chickasawhay river, and along Limestone creek, in Wayne county. It disappears again further east, and reappears only at Clayborne, on the Alabama river, nearly in the middle of the State of Alabama. If now, according to Dr. H. G. Bronn, of Germany, and Alcide D'Orbigny, of France, certainly two of the highest authorities in modern geology, the orbitoides (or orbitulites mantelli) belong only to the lower parts of the eocene formation, by an imputation of all difference to time only, we would conclude that those regions where the orbitoides are found belong to an older, and where they are not found, to a newer deposit; the consequence would be, that there must have been, within a longitudinal distance of about 300 statute miles, two upheavals and three depressions. The orbitoides are found at Vicksburg. This territory (which has most certainly been erroneously ascribed by modern geologists to the newer eocene) must then have been depressed. The orbitoides are not found in the Jackson deposits; this must then have been upheaved during the time of the existence of the orbitoides. They are again found on the Chickasawhay river; there must have again been a depression. They are not found from there to St. Stephen and Clayborne; there is again an upheaval. They are lastly found on those two places, and would indicate again a depression. The absurdity of such an acceptation is obvious; but certainly not less incorrect would it appear, if we should conclude *against the character which the orbitoides impart to the deposits in which they are found*, that the deposits of Vicksburg, where these fossils are found, were newer than those of Jackson, where they are not found, and still newer than those on the Chickasawhay and Alabama river, where they are again found.

As we have aready stated, according to Dr. H. G. Bronn, and Alcide D'Orbigny, the orbitulites and orbitoides belong to the lowest part of the eocene formation, and the Vicksburg and Red Hill deposits, where the orbitoides are found, and which surround the

Jackson deposit on the east and west sides, ought, therefore, rather to be taken for underlying the latter, and not for overlying it. If there is any difference in the age of those rocks, this must certainly be so, not only according to the stratigraphical position of the rocks, but to the circumstance that the fossil bones of the zeuglodon cetoides are found overlying the orbitoides-limestone.

But is very certain that different localities have always, during the same period, harbored different animals, and that different fossils, differing in *genera and species* of the same period, belong to different localities only. It was during the time of their animal existence exactly as it is now. Within even a few hundred miles of our sea-coasts, we find mollusks differing in *genera and species*, according to the difference of the bottom found on those coasts, and the food for those mollusks, which varies according to the bottom: the different fossils which we are now most prone to attribute to different times or ages, must therefore frequently only be ascribed to different localities.

All the eocene deposits from Vicksburg, on the Mississippi river, to Clayborne, on the Alabama river, and even further east, belong most probably to the same formation, and are identical in time. The zeuglodon cetoides, found everywhere from Jackson to the Alabama river, seems to be here the most conclusive fossil; for it is well known that such gigantic organism existed generally, comparatively, only for a short time on the surface of our globe. So we find it be the case with those gigantic saurians, the megalosaurus, the ichthyosaurus, plesiosaurus, and many others; and so with the enormous quadrupeds, the missourium, the mastodon, the mylodon, the dinotherium, the elephas primigenious or mammoth, and many others.

Even the appearance of the fossil orbitoides, in the eastern as well as in the western part of the eocene formation of Mississippi, on the banks of the Chickasawhay and the Mississippi rivers, seems to afford a very reliable proof, that the whole of that formation belongs to the same part of the eocene rocks.

Such genera of bryozoa have ever been creatures of comparatively a short period only, as the nummulites show, which are only found in a formation rather unimportant with respect to time, whereas the molluscs, especially the gasteropods and acephals, belong, even specifically, to much longer periods.

The opinion that those eocene rocks belong all to the same formation, is also asserted by Dr. Alcide D'Orbigby (62), who deems them contemporaneous to the eocene of the Paris basin, and belonging immediately above the nummulitic rocks.

That the eocene formation of Alabama and Mississippi belongs to the lower part of the eocene rocks, is also confirmed by C. G. Ehrenberg. After an examination of the zeuglodon limestone, the green sand below it, and the polythalamia, he appears to be doubtful whether it is parallel with the nummulitic rocks or belonging above it.

I am, indeed, sorry not to be able to extend this preliminary report to the Legislature of our State, over other parts of the so interesting eocene formation; besides the counties named in the report, it extends over many others, as Rankin, Smith, Jasper, Simpson, Copiah, Claiborn, Jefferson, Franklin, Lawrence, Covington, Jones, Perry, Greene, Jackson, Harrison, Hancock, Marion, Pike, Amite, Wilkinson, and Adams—the geological examination of which promises interesting and important results.

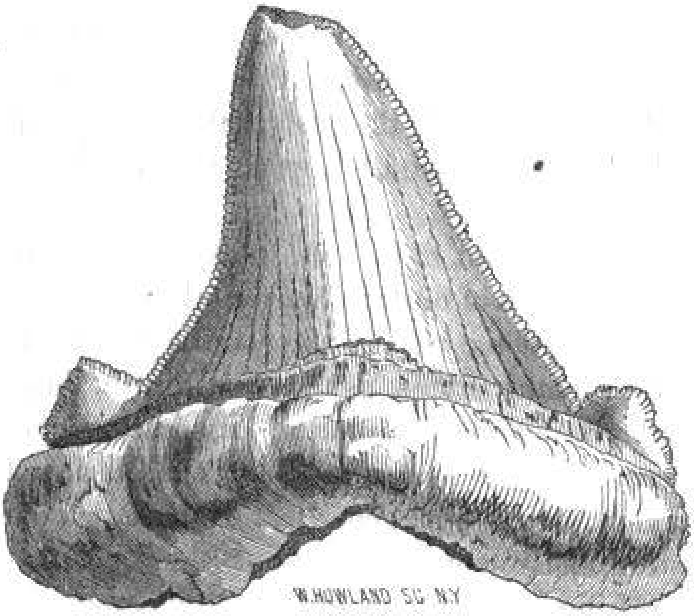
Very interesting is an outcrop of the eocene strata, near Jackson, in Hinds county, the rocks of which have not yet been examined; the generic names of the fossils taken from it are the following:

Arca,
Pectunculus,
Pecten,
Corbula,
Cardium,
Teredina,
Voluta,
Fusus, 2 different species;
Pyrula, 2 different species;
Natica, 2 different species;
Morio (petersoni),
Capulus,
Cardita,

Eburna,
Crassatella, 2 different species;
Cassidaria, 2 different species;
Cytherea 2 different species, (immutabilis);
Solarium, 2 different species;
Mitra, 5 different species, (dumosa);
Turritella, 4 different species;
Physa, 2 different species, (columnaria);
Flabellum,
Cerithium,
Rostellaria,
Pleurotoma, 5 different species;
Conus,
Murex,
Ancillaria.

To which may be added a tooth of carcharodon angustidens, a magnificent fossil, found in the town of Jackson. The following diagram represents it in its natural size (63).

[No. 33.]



Carcharodon Angustidens.

The eocene rocks occupy another small area of the State of Mississippi, quite remote from the above mentioned large territory occupied by them in the southern part of the State, in Tippah, and small parts of Marshall, Lafayette, and Pontotoc counties. The geological chart of the State, and the particular charts of the counties of Tippah and Pontotoc, show this territory. It has only been partly examined, and even its boundaries are not yet finally determined, and may vary a little from those marked out in the before mentioned charts.

The eocene of the northern part of the State seems to consist of aluminous sandstone, a thick stratum of white clay, a stratum of very dark, nearly black clay, and the shell marl.

In T. 1, R. 4, E., about a mile W. of Muddy creek, where I examined it, I found it cropping out in a stratum of hard aluminous sandstone, in lithological character very nearly the same as that in Neshoba, Newton, and the northern part of Clarke county. It contains cardita planicosta, and an astarte among its fossils, generally in a bad state of preservation, and scarcely recognizable.

Farther downwards the eocene strata consist in a stratum of white clay, overlying the marl; and below the marl lies a layer of black clay, which appears to be very thick; wells have been dug into it two hundred feet deep, without coming to the end.

In other places it consists of a mottled clay, and of a very hard sandstone, too hard to be cut for building purposes. Such a sandstone occurs in Tippah county, Sec. 35 and 36, T. 4, R. 1.

On Sec. 17, T. 2, R. 3, the eocene strata contain a white plastic clay, a good material for pottery.

The marl of the northern eocene stands near the surface in Ripley, and is penetrated by every well dug in a part of that town. It is also a shell marl of an excellent quality, not much inferior to that in Clarke and Wayne counties.

The fossils found in this marl are: rostellaria, perhaps velata, and similar to that found in some places in the southern eocene (in Choctaw county, Alabama,) pectunculus, cardita—several species, turritella, and others.

This marl resembles much the cretaceous marl found very near it, and it is very difficult to distinguish it.

The eocene formation here, in the northern part of the State, is, in every respect, different from that in the south; it is evidently of a different period, and probably newer than that in the latter. No vestiges of the zeuglodon and orbitoides have been found in it.

The hard eocene sandstone crops, likewise, out on Sec. 35, T. 4, R. 1, and on Sec. 19, T. 5, R. 2; in this last place the rock is so hard and silicious that it can be used for mill-stones.

The eocene in the northern part of the State is, like that in South Mississippi, also overlaid by the orange sand group.

Having reviewed the rocks of the eocene formation in this State, as they are seen in the different outcrops of that portion of the formation which has been examined, I shall try to give a general view of the different rocks, as they appear in their natural position; but it must be remarked that, after the completion of the survey, rocks may be added, or it may be necessary to change the position; the following sketch can, therefore, only be considered as a very preliminary one, and requires an indulgent allowance:

[No. 34.]

<table>
<tr><td>White carbonate of lime.</td><td>Compact limestone.</td><td>Yellow calcareous clay, mixed with carbon. of lime.</td><td>Yellowish aluminous sandstone.</td></tr>
<tr><td>Hard sandstone, buhr stone.</td><td>Clay of different colors. Mottled clay.</td><td>Black micaceous clay.</td><td>White plastic clay.</td></tr>
<tr><td>Hard limestone.</td><td>Ferruginous conglomerate.</td><td>Loose limestone.</td><td>Yellowish sand.</td></tr>
<tr><td>Shell Marl.</td><td>Glauconitic and ferruginous sand.</td><td>Calcareous clay.</td><td>Indurate sandstone.</td></tr>
<tr><td rowspan="3">Fine green plastic clay.</td><td rowspan="3">Black clay.</td><td colspan="2">Laminated clay.</td></tr>
<tr><td colspan="2">Lignite, or brown coal.</td></tr>
<tr><td colspan="2">Laminated clay, resembling shale.</td></tr>
</table>

The lime group is decidedly the upper stratum of the eocene, and alternates with compact limestone, and yellow calcareous clay mixed with concretions of carbonate of lime (in Madison and Hinds counties); all three of these strata contain the petrified remains of the zeuglodon. I take the yellowish aluminous sandstone of Neshoba, Newton, and Clarke counties, also, for an alternate of the limestone, because I never found it underlying. The second range, the buhr stone, mottled clay, black micaceous, and white plastic clay, are only very local, and I am still uncertain whether to consider them also as alternating with the lime group, or as underlying, the seam which separates the strata is therefore put below. It seems certain that the next members of the eocene rocks are in their right places, and the different strata could conveniently be divided in the cretaceous and aluminous group; but such a division may more appropriately be delayed until after the completion of the survey.

The fossils found in the eocene strata of Mississippi are, according to their generic names, the following :

PHYTOGENE FOSSILS.

Cellular plants : Fucoids.
Endogenous plants : Palms, ferns, caulinites, cycadites, etc.
Exogenous plants : Fagus, quercus.
Coniferous plants : Cupressinea, pinites etc.

ZOOGENE FOSSILS.

A Cetacean : Zeuglodon cetoides.
Fishes : Teeth of carcharodon angustidens, a placoid fish.
Mollusks.

GASTEROPODS.

Fusus.	Murex.	Turritella.	Rostellaria.
Pyrula.	Ancillaria.	Phorus.	Bulla.
Natica.	Solarium.	Cerithium.	Cyprea.
Cassadaria.	Voluta.	Eburna.	Cassis.
Pleurotoma.	Mitra.	Conus.	Tritonium.
Capulus.	Dentalium.	Actaeon.	Patella.

ACEPHALS.

Arca.	Pecten.	Nucula.	Cardium.
Cardita.	Ostrea.	Corbula.	Plagiostoma.
Cytherea.	Astarte.	Pinna.	Teredina.
Crassatella.	Venus.	Pectunculus.	Psammobia.
Umbrella.			

RADIATES.

Clypeaster. Gallerites.

POLYPS.

Orbitoides, lunulites, flabellum, turbinolia, ceriopara, tubulipora, and other corals.

ROCKS OVERLYING THE EOCENE.

THE eocene formation is only in very few places found to constitute the surface soil of its territory; like the carboniferous and cretaceous formations, it is overlaid, and, in some places, very heavily overlaid, by the orange sand group of the newer tertiary or miocene formation. This cover is thickest where the eocene meets the miocene, it decreases southwards towards the sea-coast and the State of Louisiana; but nevertheless, hills of the orange sand, with the characteristic pebble stratum, are found here and there, even very near the sea-coast.

The diagram No. 22, page 134, represents such a deposit of orange sand, with the pebble stratum, in T. 3, R. 8, W., of Pike county.

Diagram No. 23, page 137, represents, likewise, a thick stratum of the orange sand, with the pebbles, under the letters *b*, *c*, and *d*, in T. 7, R. 6, W., in Wayne county.

Diagram No. 28, page 146, exhibits, in the stratum No. 1, the orange sand group on the banks of the Chickasawhay river, in Enterprise, in Clarke county.

Diagram No. 31, page 150, represents, in the stratum No. 2, the orange sand, with its secondary pebble stratum, in Sec. 9, R. 4, W., near Satartia, in Yazoo county, which is there overlaid by the post-pliocene stratum of the loess.

Similar strata have been found over the eocene, in Lauderdale, Newton, Scott, Madison, Greene, Perry, Marion, Amite, and other counties. The rocks, or materials which they contain, are the same as have been described overlying the carboniferous and cretaceous formations, and will be treated more at large in the next chapter, concerning the newer tertiary or miocene formation of the State.

It appears, then, that even the eocene formation, after having been deposited only immediately before the newer tertiary, or miocene, and elevated above the level of the sea, was, nevertheless, re-submerged during the latter time of the deposition of the miocene, and covered by a part of the deposits of that period.

It could be objected here that the eocene formation was, perhaps, not elevated before the deposition of the miocene rocks over it; but this cannot be so, otherwise the lower strata of the miocene would overlie it also, which is not the case, as will appear from the description of the miocene rocks (64).

The Prairie Soil Overlying the Eocene Rocks.

The eocene formation is not only overlaid by the orange sand group of the miocene rocks, but, as has already been mentioned, its similarity to the lime group of the cretaceous formation is completed by another formation overlying it—the postpliocene fresh-water formation of the prairie soil.

Exactly as is the case with the cretaceous formation, this prairie soil is only found where the white carbonate of lime constitutes the upper stratum; it is more extensive in the middle of it, and exists only in small plots towards the border of the white carbonate of lime.

This prairie soil must, therefore, here be in the same connection with the eocene cretaceous group, as it is with the lime group of the cretaceous formation. To ascertain this connection, requires a closer examination than has hitherto been bestowed upon it.

In several places the white carbonate of lime, of the eocene formation, appears of a tufaceous structure, the rocks of which can be reduced, by pressure, to about one-third of their usual bulk. Such a stratum was found in Wayne county, T. 10, R. 11, W.; but especially in Warren county, on Sec. 1, T. 18, R. 5, E. Not far behind the hills constituting the bluff of the Yazoo bottom, a hill was discovered of a most extraordinary construction, consisting entirely of a tufaceous limestone, having the appearance of a loose sponge with large holes. So porous is this limestone that the roots of trees penetrate it easily, and grow in it to a very large size. Any heavy pressure upon this hill would reduce it, unquestionably, to one-third its present size.

If the eocene carbonate of lime should have consisted, to a large extent, of such tufaceous rocks, it is very possible that they sank down under the pressure of the overlying strata, and formed basins, in which, later, the fresh water collected, forming lakes and ponds, in which the prairie soil was deposited; for the prairie soil overlying the eocene rocks is exactly such a postpliocene fresh-water formation as that overlying the upper cretaceous rocks.

According to its lithological character, this soil consists, also, of two different strata—the lower and the upper stratum; the lower stratum is a yellowish calcareous clay, containing a great many small concretions of pure carbonate of lime; it effervesces with strong acids.

The upper stratum is a stiff black clay, greasy to the touch, containing a large quantity of organic matter, and, comparatively, still more clay, and especially more lime and magnesia, than the prairie soil overlying the cretaceous formation; it is, indeed, a heavier soil, as the analysis contained in the following chapter will show.

There can be no doubt that this prairie soil is of the same origin as that overlying the cretaceous formation; it bears not only the same lithological character, but it contains, also, similar fossils, consisting especially in such land shells (helices, achatinae, helicinae, etc.,) as are still found alive.

The largest of these prairies are on the line of Wayne and Clarke counties, near Miltonville, in Wayne county, in T. 10, R. 6, W., containing here from five thousand to six thousand acres of fine land.

The prairies overlie here the white carbonate of lime, and this the marl of the lower group. All around the prairies the white carbonate of lime crops out, and contains everywhere the remains of the zeuglodon; and not far from there, on Sec. 8, T. 10, R. 5, W., along the Buckatunna creek, the eocene marl crops out, and continues for several miles along the creek, containing many of the fossils named above, but especially a large number of cerithia.

These prairies extend from Miltonville, in Wayne county, or from the N. E. corner of Wayne county, in a N. N. W. direction, through Jasper county, where they appear, below and above Paulding, and especially near Montrose, in T. 3, R. 10. From there they continue, but only in small plots, through Smith and Scott, to Rankin county; they have not yet been examined in those counties.

THE EOCENE FORMATION, IN A NATIONAL ECONOMICAL, AND AGRICULTURAL POINT OF VIEW.

NATIONAL ECONOMY.

With respect to national economy, the eocene, large as is its area, cannot be compared with that of the carboniferous formation, if we do not consider those extensive and excellent strata of marl, which must contribute much to the wealth and prosperity of the State, as belonging under this head. Those strata, having immediate influence upon the agriculture of the State, demand rather a consideration as such.

Valuable, with respect to national economy, are:

1. Stones useful for building purposes.

Such stones are contained in abundance among the eocene rocks. A fine sandstone for building purposes crops out near Red Hill, in Wayne county, on the bank of Limestone creek, not far from the Chickasawhay river.

An aluminous stone, in many places hard enough for building purposes, crops out in T. 5, R. 16, in Lauderdale county. Other outcrops are not far from this place.

Another outcrop of the same kind of stones is on a range of hills extending from N. W. to S. E., called Burton hills.

Another outcrop of a hard compact limestone, solid enough for building purposes, is immediately under Red Hill, in Wayne county, and is represented in diagram No. 24, in the strata *c* and *f*, (page 140).

A very good building stone is found about three miles from Chunkey creek, in Newton county. It appears, first, as an aluminous stone, and changes into a sandstone hard enough for millstones. The same material is found in Clarke county, Sec. 33, T. 5, R. 15, and appears there in a railroad cut.

Very nearly the same kind of aluminous sandstone is found in Neshoba county, T. 9, R. 13, and offers, in many places, a good material for building.

A very good limestone for building purposes crops out in Yazoo county, T. 9, R. 4., W.; it is a white carbonate of lime, but perfectly compact, and hard enough to resist the influence of the atmosphere.

A similar kind of building material is found near Vicksburg, and represented in diagram No. 32, page 152, in the strata represented by *b* and *d*. The limestone, here, is also hard and compact.

A similar limestone appears in Hinds county, W. of Clinton, on the Vicksburg & Jackson railroad, on Sec. 28, T. 6, R. 2, W.

2. Limestone for calcination, or burning lime.

Such limestone crops out near Red Hill, in Wayne county. There are three different kinds of limestone—the hard limestone (good for a building material, and mentioned above as such); the soft limestone, which crumbles and disintegrates very easily; and the shell limestone, consisting, to a large extent, of fossil shells, principally pectens and ostreae.

As some inhabitants of that part of the country appeared very anxious to calcine this material, and send the quicklime, by the railroad, which passes there, to Mobile, they desired to know the quality of the material, and which of the three different carbonates is the best for that purpose; all three of them were, therefore, subjected to a quantitative analysis, which gave the following results:

I. The hard limestone contains:

1. Insoluble silica and alumina...........	6.300	per cent.
2. Oxide of iron and soluble alumina......	7.200	"
3. Carbonate of lime....................	86.500	"
	100	

II. The soft limestone:

1. Insoluble silica and alumina...........	15.050	"
2. Iron and soluble alumina..............	5.350	"
3. Carbonate of lime....................	79.600	"
	100	

III. The shell limestone:

1. Insoluble silica and alumina...........	9.200	"
2. Oxide of iron and soluble alumina......	6.650	"
3. Carbonate of lime....................	84.150	"
	100	

As carbonate of lime is now composed of 56.116 per cent. of lime, and 43.884 per cent. of carbonic acid, the 86.500 of carbonate of lime of No. 1 contain 48.540 per cent. of lime, and 37.960 of carbonic acid; consequently, after the expulsion of the carbonic acid by heat, it will yield 48.540 per cent. of pure lime; but as this limestone contains, besides 86.5 per cent. of carbonate of lime, also—

1. Insoluble silica and alumina..........	6.300	per cent.
2. Oxide of iron and soluble alumina......	7.200	"
Consequently impurities..........	13.500	"

which cannot be removed by heat, there will remain, after calcination of 100 pounds of the limestone No. 1, in all, 61.840; and these contain 13.500 pounds of impurities—not more than common quicklime generally contains.

The 79.600 per cent. of carbonate of lime contained in the soft limestone, No. II., would be composed of 44.668 per cent. of lime, and 34.668 per cent. of carbonic acid; after calcination, there would therefore remain, lime, 44.668 per cent., and impurities—

1. Insoluble silica and alumina..................	15.050
2. Oxide of iron and alumina....................	3.350
	20.400

consequently impure quicklime, 65.068 pounds.

The 84.150 per cent. of carbonate of lime contained in 100 pounds of the shell limestone, No. III., would be composed of 47.222 per cent. of lime, and 36.928 per cent. of carbonic acid, and, after calcination and expulsion of the carbonic acid by heat, there will remain of pure lime 47.222 per cent., and impurities—

1. Insoluble silica and alumina	9.200
2. Oxide of iron and soluble alumina...............	6.650
	15.850

The total amount of impure lime found by addition of the impurities to be pure lime, is, consequently, 63.072 per cent.

The hard lime, No. I., is therefore the best; the shell limestone, No. III., the second, and the soft limestone, No. II., the third in order, and rather inferior.

A very fine limestone for burning quicklime is found in Yazoo county, in T. 9, R. 4, W., which is fully as good as the hard limestone No. 1. of Red Hill, in Clarke county, and perhaps purer.

The eocene formation yields, furthermore—

3. Lignite, or brown coal.

Such deposits are found in Marion, in Lauderdale county. The lignite is here of a very good quality.

Near Vicksburg, on the banks of the Mississippi river; this lignite seems to be of a superior quality, and the stratum inexhaustible.

On Big Black river, in Claiborne county, T. 13, R. 3, E.

In Franklin county, on Sec. 29, T. 6, R. 4, E.

In Hinds county, on Sec. 11, T. 4, R. 3, W. The stratum of lignite is here about 20 feet thick, and perhaps connected with the Vicksburg deposit.

In Rankin county, where it crops out in a cut on the railroad.

Another remarkable stratum of very fine lignite is found on Sec. 27, T. 9, R. 4, W., in Yazoo county. It is about 14 in thickness, lies between two strata of green clay, both of about the same thickness, and extends all under the hill, cropping out again on the opposite side of it; it covers about one-fourth of the area of a square mile.

The most remarkable circumstance is the following: on the S. side of the hill a small creek winds around it. The surface of the water is about ten feet below the stratum of the lignite; the bottom of this creek is entirely paved with pebbles, characteristic of the orange sand group, and the pebbles are found on the banks of the creek, underlying the lignite.

The lignite stratum overlies, therefore, here most decidedly the pebbles: it proves that the pebble stratum must be older than the lignite, and the lignite newer than the pebbles; this is by itself a sufficient proof that those pebbles cannot originate from the very last part of the tertiary age,—cannot be pleistocene, or a portion of a northern drift, for which they have so generally been mistaken. It proves, at the same time, that the lignite must here be newer than eocene, or even the lower part of the miocene; it must, at least, belong to the upper miocene, or perhaps to the pliocene, or third period of the tertiary age.

Other valuable materials furnished by the eocene formation of this State, are:

4. Clays of different quality.

A very fine green clay is found near Red Hill, in T. 9, R. 7, in T. 10, R. 7, on the Chickasawhay river, and in T. 8, R. 7, also on the Chickasawhay river, both in Wayne county.

In all three places the clay is exactly the same—it is of a green color, and perfectly plastic; it dries without much cracking, becomes very hard, and takes a fine polish; it is very nearly pure; its green color is most probably due to an admixture of some silicate of iron. It is infusible before the blowpipe, and not only a good material for fine pottery, but also for fire-proof bricks (65).

A much finer clay, of white color, generally called pipe clay, fine enough even for inferior kinds of porcelain, and perfectly infusible, is found on Sec. 14, T. 7, R. 6, W., in Wayne county, which is really of great value.

A very fine clay for pottery, and perfectly plastic, is found near Woodville, on Sec. 28, T. 2, R. 2, W.; it is of superior quality, and will make fine fire-proof bricks.

A fine clay is found among the eocene rocks in Tippah county, on Sec. 17, T. 2, R. 3; it is very good for pottery, and has been used for it already.

All the different clays above indicated are nearly pure, and perfectly plastic; most of them are useful for modeling of statuary by sculptors.

5. Sulphate of alumina.

This salt is found near Quitman, in Clarke county, on the bank of the Chickasawhay river, in T. 2, R. 15. It is an excellent material for reduction to the recently discovered metal, aluminium.

6. Mill stones.

A very fine sandstone, a real buhr stone, as good as it is found anywhere in the United States, is to be found near Marion, in Lauderdale county. It is a very hard silicious stone, containing a great many silicified shells, which give the stone a rough surface, and render it very fine for mill stones.

A similar kind of stone, perhaps not quite as hard, is found near Chunkey creek, in Newton county, and in Clarke county, on Sec. 33, T. 5, R. 15.

A tolerably good stone for mill stones is found in Tippah county, in the northern eocene, on Sec. 9, T. 5, R. 2.

7. Mineral springs.

The eocene formation of this State contains a great many valuable mineral springs, and, in this respect, exceeds all the other formations.

The most important sulphur and chalybeate springs are the *Lauderdale Springs*, situated very nearly in the line of separation of the eocene and miocene formations. These springs are valuable, not only on account of the superior quality of the water, but also on account of the quantity. There are five or six sulphur springs, which create, morning and evening, a sulphuric atmosphere; the water which runs off forms a considerable creek.

Not much less copious is the chalybeate water coming forth from two different springs.

A complete analysis of these springs is found in note (66).

Other mineral springs are near Enterprise; one of them is a good chalybeate spring, and another one, on Sec. T. 4, R. 15, contains some sulphuretted hydrogen.

A very valuable red sulphur spring is near Quitman, on Sec. 11, T. 2, R. 15, E. The principal ingredients are sulphuretted hydrogen, lime, magnesia, chlorine, alkaline matter in the state of a carbonate, and apocrenic acid, which imparts to the water a fine red color. The spring deserves notice. A qualitative analysis of it is found in note (67).

A strong chalybeate spring is in Clarke county, T. 1, R. 16, not far from the Chickasawhay river; it contains, besides sulphate of iron, some sulphuretted hydrogen, and appears to be valuable.

Watering-places, known as such, are, besides the Lauderdale Springs, Cooper's Well, in Hinds county; a very reliable analysis of which, by Professor Lawrence Smith, of Louisville, has been published, and the artesian springs in Madison county.

A good chalybeate spring is on Sec. 31, T. 9, R. 4, in Yazoo county; it is chalybeate, and contains, besides, sulphate of iron, carbonic acid, chlorine, alumina, lime, magnesia, and soda.

AGRICULTURE.

In an agricultural point of view, that part of the State of Mississippi which is occupied by the eocene formation is of the greatest importance, on account of the material it yields for the fertilization of the cultivated lands of the State.

We have seen that the cretaceous formation yields in that part of its area, where the glauconitic group occupies the surface, in Pontotoc, Itawamba, and especially in Tippah and Tishamingo counties, fine marls in large quantity, but neither the quantity nor the quality is equal to that furnished by the eocene formation.

The eocene rocks can be divided into a cretaceous and an aluminous group; the aluminous group consists mostly of most excellent marl beds, which cannot fail to have the most salutary influence upon the agriculture of the state.

This agriculture has hitherto been a very exhausting one. Mississippi is a new State; it dates its existence only from the year 1818; and notwithstanding all its fertility, a large part of the land is already exhausted; the State is full of old deserted fields. It is, then, a most fortunate circumstance, that nature has so kindly provided for the re-fertilization of those exhausted fields, and that the highest authorities of the State made such careful and prudent arrangements to open those resources at once.

The first trace of those marl beds which now appear so immense, I found when conducted by Gen. W. Trotter to a gully in his plantation, represented in the diagram No. 27, page 144. The marl was found there of a most excellent quality, and in a very thick stratum, of the existence of which nobody had an idea. I discovered soon that the marl was not confined to that place, but cropped out also on the Chickasawhay river, in a stratum perhaps much more than 100 feet in thickness, a section of which is represented in the diagram No. 26, page 143.

A specimen of the marl from the place where it was first discovered, on Sec. 3, T. 10, R. 7, W., was analyzed, and gave the following result:

Specific gravity=2.300.

Oxide of iron and alumina	8.000	per cent.
Carbonate of lime	32.954	"
Phosphate of lime	3.352	"
Sulphate of lime	3.684	"
Chloride of magnesium	0.900	"
Alkalies, mostly potash	7.840	"
Insoluble silica and alumina	41.530	"
Hygroscopic water and loss	1.740	"
	100	

The superior quality of the marl appears here; much more than one-half of it, 68.470 per cent., is soluble in dilute hydrochloric acid, and 39.99 per cent. of this soluble part consists of carbonate, phosphate, and sulphate of lime, and very nearly 8 per cent. of alkaline matter.

A better manure can hardly be found; it is far superior to all manure which the agriculturist himself can produce, and *indeed better than guano itself.* It is true, guano has the first year a better effect upon the crops than the marl can produce, but its effect is confined to one year, while the effect of the marl lasts for 10 years. In the first year, the effect of the marl is only slight; it is much better the second, third, and fourth years, and decreases then again. Whilst the guano supplies only the food for the vegetation for one year, and acts, as it were, only as a stimulant, the marl improves and enriches the soil.

This marl is not of the same quality everywhere; it varies much; in some places it is aluminous, or clay marl; in others, it is sand marl, or real eocene green sand; and in some places it ranges between the two, but this constitutes one of its excellencies. Clay marl is not suitable for all kinds of land, it is best for sand land; sand marl is also not suitable for sand lands, but best for clay lands; and it is therefore a most fortunate circumstance that the marl is not confined to clay or sand marl, bnt that all kinds are found for the selection of the agriculturist.

The best marl which I have found is on the place where it was first discovered, on the banks of the Chickasawhay river, Sec. 3, T. 10, R. 7, in Wayne county, and again in Scott county; and more of it of this fine quality will certainly be discovered in many other places.

The marl is here so fine that, without doubt, when its qualities are fully known, it will make an object of commerce, be packed in tuns or boxes, and sent to other counties and states, exactly as is the case with the guano; and the means of transportation are at hand: the Chickasawhay river is navigable in the winter, and the marls can be transported on it in flatboats, and on rafts; moreover the Mobile & Ohio railroad crosses the marl beds.

The marl was soon after discovered under the bridge on Garland's creek, where it appears in the shape of green sand, but full of the detritus of shells. It is here not as good as in the former places, but nevertheless a most excellent manure, as the following analysis of it shows:

Carbonate of lime	21.090	per cent.
Oxide of iron	3.415	"
Alumina (soluble)	3.412	"
Sulphate of lime	0.962	"
Carbonate of magnesia	1.152	"
Potash	1.048	"
Hygroscopic water and loss	2.000	"
Insoluble silica, or sand	41.650	"
Insoluble alumina	25.721	"
	100	

The marl was then discovered near Quitman; it is here still more silicious, and deserves still more the name of eocene green or glauconitic sand, but it is also a fine manure, especially for clay soil, as the following analysis of it will show:

Alumina (soluble)	1.0922	per cent.
Carbonate of lime	19.3636	"
Oxide of iron and manganese	5.4640	"
Carbonate of magnesia	0.1652	"
Potash	0.9784	"
Insoluble silicious sand	53.0940	"
Insoluble aluminous matter	19.8462	"
	100	

The same marl was afterwards found on the Buckatunna creek, near Col. Horne's mill, Sec. 8, T. 10, R. 5, W., in Wayne county, near Red Hill, on the Chicksawhay river, and on Sec. 34, T. 8, R. 7, W., in Wayne county. On Hassanlowey creek, T. 3, R. 14, in Clarke county.

According to these different outcrops the marl underlies an area of 40 miles in length, and 24 miles in width, and occupies, therefore, an area of 960 or very nearly 1000 square miles; but since that time the very same marl has been found, of a very superior quality in Scott county, on Coffeebogue creek, T. 7, R. 6, E., and of a very good quality, in the bluff of the Yazoo river, one mile below Satartia, in Yazoo county, on Sec. 12, T. 9, R. 4, W., and on Sec. 1, T. 18, R. 5, E., in Warren county; it is, therefore, more than probable that that stratum of excellent shell-marl extends all across the State from Clarke and Wayne counties, through Jasper, Newton, Smith, Scott, Rankin, Madison, and Hinds, to Yazoo and

Warren counties, which would be, indeed, of immense value for the State, and render that excellent manure accessible for the larger part of its inhabitants, especially in those counties of the interior where it is most needed on account of the infertility of the soil.

It has already been mentioned that the eocene formation of the State is not limited to the Southern part. It is, also, found near the line of Tennessee, in Tippah, and a small part of Marshall, Lafayette and Pontotoc counties.

It has there only been examined in a few places, in which the rocks have been found similar to those of South Mississippi, but not entirely identical; they are probably not contemporaneous; nevertheless, it is there also characterized by excellent deposits of marl. Several of the outcrops of this marl are marked upon the special map of the county of Tippah.

A stratum of this marl underlies a part of the town of Ripley, and is there always reached at a depth of about 16 feet by digging wells. A specimen of this marl was analyzed; the analysis gives the following results:

Specific gravity=2.416

	Per Cent.
Carbonic acid	6.712
Chlorine	0.040
Sulphuric acid	0.176
Phosphoric acid	0.060
Silica (soluble)	0.060
Oxide of iron and alumina	17.550
Lime	4.733
Magnesia	1.250
Potash	3.960
Organic matter	2.027
Hygroscopic water	0.830
Loss in the analysis	0.072
Insoluble silicious and aluminous matter	62.530
	100

It appears, from this analysis, that the eocene marl of North Mississippi, although not quite as good as the marl of the eocene of South Mississippi, is, nevertheless, a very fine manure, and of great value for the northern counties of the State.

It is probable that this marl stratum extends farther down into Pontotoc and Lafayettè counties; it would especially be beneficial for the latter county, whose soil is, comparatively, a sandy and inferior one, and can be very much improved by the use of such manures.

There is in South Mississippi another deposit which yields a very valuable marl, and may serve as a substitute for the shell marl.

It was first found in an outcrop about six miles from Sharon, and eight miles from Canton, in T. 9, R. 19, W., in Madison county. It consists, as has already been stated in the proper place, of a yellowish gray clay, mixed with a great deal of lime and effervescing with strong acids. It contains a great many small concretions of pure and white carbonate of lime, called agaric mineral, exactly such as are found in the loess along the Mississippi river from Vicksburg to the line of Louisiana.

Below this stratum lies a stratum of a very stiff limy clay, of a yellow color, resembling the soil of the bald prairies.

Both of these materials can be used as marl, and will have an excellent effect upon the light lands of Madison county, a part of which are now much exhausted.

This marl is not confined to the immediate locality where it was first found; it crops out in many places along the railroad from Canton to Jackson, and may be easily recognized by its characteristic concretions of white carbonate of lime, which may probably also contain a phosphate of lime, and render the marl so much more valuable.

I cannot but strongly recommend to the agriculturists of Madison, Rankin, and Hinds counties, to make use of this manure, which must be analyzed for their benefit, in the progress of the geological survey.

If we cast a glance upon the territory of the eocene formation, in the State of Mississippi, and examine the soil with respect to agriculture, we must confess that the soil is less adapted to that purpose than that of any other formation.

We do not intend to say that there is no good land in the territory of this formation; that would imply an ignorance of the country. There are, indeed, very fine lands within this territory, really as good as any in the State; but the average quality is inferior. The best lands, with the exception of the prairie soil, are in the northern part of the territory, where the eocene meets the miocene;

in Lauderdale, Newton, Scott, Rankin, Hinds, but especially in Madison, Warren, and Yazoo counties. The lands are here heavier, and not only formed from the sand strata of the miocene, but intermixed, also, with a part of the lower aluminous strata of that formation.

Madison county has certainly been one of the best counties for agriculture in the State; the land lies here perfectly level; the soil is a light yellow loam, formed from the calcareous clay of the eocene, mixed with sands of the orange sand group, and also, to some extent, with the loess of Yazoo and Warren counties. It has, indeed, been of great fertility; it is still so in some parts of the county, but a good deal of it is exhausted, and requires a restoration of the ingredients lost by an improvident agriculture, which is easily done, by application of the marl which has already been found on both sides of the county, and will probably yet be found much nearer, perhaps in the county itself.

Yazoo and Warren counties (abstracted from the Yazoo bottom) have also, naturally, a most excellent soil, mostly formed from the loess and the orange sand; but these counties are too hilly for agriculture. The soil is so very mellow and loose, that deep ravines have been cut in it everywhere. This is especially the case with Yazoo county. At a superficial glance it would scarcely be believed that such ravines—sometimes more than one hundred feet deep—could be cut, simply by erosion by the rain-water; and, nevertheless, this is the case; the shape of the ravines shows it very clearly.

The fertility of those hills and ravines, in Yazoo county, is evinced by the enormous growth of the forest trees; the white oaks, the poplars, the sweet-gum trees, attain a diameter of from four to five feet; even sassafras trees are found from three to four feet in diameter. The very tops of the hills, in Yazoo county, are of an astonishing fertility; and the county would rank among the first in the state, in this respect, had it a level surface.

Next in fertility to these counties are probably those counties along the loess formation of the Mississippi river, where the soil is partly formed of the loess, the second range of counties from the Mississippi river. (The first range belongs to the loess formation, and will be considered under that head.)

Next in fertility to those counties, is the prairie soil in Wayne, Jasper, and other counties.

This prairie soil, formed, as has already been stated, by deposition from fresh water, and mixed with the lime and clay of the eocene calcareous group, and a large quantity of vegetable matter, is, indeed, of immense fertility, as the following analysis of a portion of prairie soil, taken from Sec. 8, T. 10, R. 5, W., in Wayne county, shows:

	Per Cent.
Sulphuric acid	0.25568
Carbonic acid	0.64885
Phosphoric acid	0.47360
Silica	0.12112
Lime	0.35529
Magnesia	0.33860
Alumina	3.29568
Oxide of iron	9.18080
Oxide of manganese	1.59920
Potash	0.60816
Soda	0.32368
Organic matter	14.46000
Insoluble aluminous matter	54.93128
Insoluble silicious matter	13.40806
	100

Notwithstanding the large quantity of fertilizing matter, this soil must be a very uncertain one; it is much too heavy and aluminous, more so than the prairie soil overlying the cretaceous formation, and it requires a very careful and prudent agriculture; if properly ditched and drained, and continually mixed with a large quantity of fine silicious matter, it must, after the lapse of years, become a soil of great fertility. It may, indeed, now produce fine crops, if the season suits—if the summer be a dry one, with light showers of rain; but in wet summers the soil is too close, too retentive of moisture, and absorbs, on account of its dark color, too much heat.

The lands farther down towards the line of Louisiana, are very sandy, and formed by a mixture of the orange sand of the miocene, and the sand strata of the eocene group, and some of the clay of the latter formation; they can only yield very light crops, and remunerate the labor of the agriculturist with little liberality. Only the bottom lands are worth cultivating, and even they are light in the lower counties. The land of these counties can be very much improved by an application of the clay marl, and even rendered grateful for the labor bestowed upon them, which they are not in their natural condition.

For those citizens of the State who live near the Chickasawhay or Pascagoula river, it is very easy to provide themselves with the marl. It can be had of the finest quality and in the greatest abundance, along the banks of the Chickasawhay river, and carried down in flats, or on rafts, when the river is high enough, during fall, winter, and spring, and requires no other expense than the labor.

The forest growth of the country is entirely different from that of the other formations. On all the other formations the great majority of the forest trees, with the exception of the pines, have deciduous leaves, which fall in the autumn, and are renewed in the spring. On the eocene formation it is different altogether; the majority of the trees have here succulent leaves, which remain during the winter, and hence the winter produces very little difference in the woods, and less the nearer we approach the sea-coast.

It is only on this formation where the beautiful long-leaf pine (pinus palustris or australis) appears, a tree which is so very useful, not only on account of its timber, but also because of the large quantity of turpentine it exudes. It really indemnifies the inhabitants of the lower part of the eocene formation for the inferior quality and the ingratitude of their lands.

Why the long-leaf pine grows only here on the eocene formation, I have not yet been able to ascertain. There can only be two reasons for it: either the *soil* is here alone suitable for the tree, or the *atmosphere* of the vicinity of the sea necessary.

It seems indeed most probable that the latter is the reason, for there are other counties where the eocene crops out, even in this State, in Tippah county, but the long-leaf pine does not appear there. The situation of that country, too far northwards for the growth of the tree, cannot be the reason; for the long-leaf pine grows in South Carolina and North Carolina, farther north than

Tippah county, but also there only at a certain distance from the sea-coast.

The long-leaf pine is, then, decidedly the principal forest tree of the eocene formation, but besides, there are all the different kinds of oak trees, the red, black, and white oak, the overcup oak, the post oak, the black jack, and others. Nearly all the different kinds of oak trees which characterize the other formations of the State appear where the eocene meets the newer tertiary or miocene formation, in the middle of the State.

The country is here still hilly, and very heavily covered by the orange sand, which has a great influence upon the soil, more so even than the eocene rocks themselves. It is on that account that the short-leaf pine (pinus rigida) is there first met with, but it disappears gradually; as the miocene strata become thinner, and the distance to the seacoast less, the long-leaf pine takes gradually its place.

Also the different species of the oak trees, which lose their foliage, diminish, and some of them disappear entirely, as, for instance, the chestnut oak (quercus castanea), and others, and the evergreen oak, the swamp oak, willow oak, pin oak (quercus aquatica, quercus salicifolia, quercus palustris), and at last, near the seacoast, the beautiful and useful live oak (quercus virens), take their place.

Besides those trees, the eocene soils produce, on the hills and elevated lands, different kinds of hickory (carya tomentosa, carya amara, and carya alba). Carya olivaeformis (the pecan tree), has not yet been found on the eocene, but it may exist in some of the river bottoms, as it requires a very heavy and fertile soil, and is more a sign of fertility than any other tree.

On the rolling and high lands of the eocene grow, furthermore: sweet gum (liquidamber styriciflua), poplar, (lyriodendron tulipifera), persimmon (diospycus virginiana), sumac (rhus globosa), sassafras (laurus sassafras), walnut (juglans nigra), etc.

In the swamps, in low moist places, and the bottoms of the rivers and creeks, grow: the magnolia (m. grandiflora), the bay tree (magnolia glauca), the tupelo (nyssa villosa and tomentosa), swamp spice (ilex prinoides), sycamore (platanus occidentalis), cotton wood (populus deltoides), paupau (uvaria triloba), prickly ash (zanthoxylum tricarpum), red maple (acer rubrum), linn tree (tilia americana), the beech (fagus americana), Hercules' club (aralia spinosa), the holly (ilex opaca), the elm (ulmus americana and fulva), dogwood (cornus florida), the cypress (cupressus disticha), chinquepin (castanea pumula), birch (betula populifolia), the ash (fraxinus quadrangulata and acuminata), and others.

The undergrowth is: buckeye (aesculus pavia and picta), candleberry (myrica conifera), especially near the sea coast; the hazel (corylus americana), honeysuckle (azalea rubra and viscosa), huckleberry (vaccinium corymbosum and vascillans), hydrangea (hydrangea arborescens), dwarf sumac (rhus), poisonous oak (rhus toxicodendron), Spanish mulberry (calicarpa americana).

The principal climbers are: trumpet-vine (bignonia radicans and capreolata), yellow jessamine (jelsaminum sempervirens), supple jack (ziziphus volubilis), sarsaparilla (schisandra coccinea), woodbine (lonicera sempervirens and flava), etc.

The appearance of the gray moss (tillandsea usneoides), which hangs down from the trees in festoons, imparts to the forests a singular aspect, especially where it hangs down from the old live-oaks. This and the palmetto leaf (sabal palmetto and serrata)—a forerunner of the tropics—are always an indication of the vicinity of the sea coast. They require the humid atmosphere of the sea, and are seldom, if ever, found more than about one hundred and fifty miles (in a straight line) from the sea coast. The sabal I have never found farther than that from the sea, and it may be taken for an indication of that distance to the sea. The tillandsea may ascend a little higher up on large rivers, and in dense swamps; but I have never found it, either on the Atlantic sea coast nor on that of the Gulf of Mexico, more than two hundred miles, and scarcely that, from the salt water. It is found in greatest perfection very near the sea coast, as far as the live oak grows, and even between the estuaries of the sea. The range of the live oak is immediately on the sea coast, from which it retires very seldom, if ever, to a distance of from thirty to fifty miles. In greatest perfection it is found on the islands in the Atlantic Ocean and the Gulf of Mexico.

Some other plants, of a tropical character, deserve to be mentioned, which decorate either especially or entirely the territory of the eocene formation: the yucca gloriosa and filamentosa—the first is generally called Spanish bayonet (perhaps because these are not more fearful to the valiant sons of Uncle Sam than the sharp thorns on the end of the succulent and lanceolate perrennial leaves of the yucca gloriosa); and bear-grass, the floral diadems of which are of unrivalled beauty, and requiting, as it were, the kindness of their former fosterers, they continue to adorn their wonted home when its former inmates have long forsaken it.

The prickly-pear (opuntia vulgaris) occurs more and more frequently towards the sea shore, and is there found associated with several other species of cactus.

It deserves to be noticed here, that it is especially the area of the eocene formation of the State which furnishes the best timber, and the greatest quantity of it. The whole country is overgrown by the long-leaf pine (pinus palustris), which grows here to a very large size, and yields most excellent lumber.

Indeed this tree seems to indemnify the inhabitants of the lower part of the eocene—generally called the "Piny Woods," or also "Pine Barrens"—for the deficiency of their soil, yielding not only excellent timber, but also turpentine in abundance, and, when dry, for chimneys, the very best of fire-wood.

Besides the pines, this country furnishes most excellent cypress trees; all the low places, where the water does not dry away entirely, are full of them. They also yield excellent timber, which resists the water for a long time without decaying, and is, therefore, especially useful for boats, canoes, and for shingles.

2.—THE MIDDLE TERTIARY, OR MIOCENE FORMATION.

This formation, in its proper limits, has not yet been subjected to anything more than a general examination; the report concerning it must, therefore, be considered as entirely preliminary; it has even not been possible to ascertain satisfactorily to what part of the tertiary system it belongs. It is very singular none but phytogene fossils, consisting in lignite, pieces of silicified wood, impressions of leaves, etc., have hitherto been found in it. The absence of all zoogene fossils render the determination of this formation extremely difficult, and time and circumstances have not permitted me to bestow on it the necessary care.

The lithological character, the extensive beds of lignite in it, characterize this formation strongly as middle tertiary, or miocene; but it is very possible, and even probable, that the whole of it may not exclusively belong to the miocene group, and contain formations more recent than that; in fact, in its northern and western parts, basins of fresh-water formations have already been discovered, which belong most certainly to a more recent, either the pliocene or pleistocene, period.

This middle tertiary formation *proper*, or, more correctly, that portion of the State of Mississippi characterized by a geological formation newer than the eocene, extends from the boundary line of Tennessee (which cuts it off from its continuation in that State), or from the 35th degree of N. latitude, to the line of the eocene formation, running through the counties of Yazoo, Madison, Scott, Newton, Neshoba, and Lauderdale, very nearly along a line determined by the 32° 30′ of N. latitude, and extends, westwards, to the alluvium of the Yazoo and Mississippi rivers, where it has been washed away to a great extent, and the remaining portion overlaid by the sediment of the rivers.

Eastwards it extends to the cretaceous formation, as the annexed geological chart exhibits. Within those boundaries it is, in extent, the second of the geological formations of the State of Mississippi, comprising about 10,692 square miles—very little more than half as many as the eocene formation.

Its influence is not confined to this territory; its upper members, in some instances, also its lower strata, overlie, to a certain extent, all the geological formations of this State older than it. This is exhibited—

With respect to the carboniferous formation:

In diagrams No. 2, page 44, and No. 6, page 50, where the red sand of the newer tertiary formation overlies the carboniferous sandstone.

In diagram No. 3, page 45, where not only the orange sand and pebbles, but also a black schistose clay (a kind of "Tegel" of the German geologists), overlie the carboniferous sandstone.

In diagrams No. 7, page 53, and No. 8, page 54, where even lower strata of this formation lie over the carboniferous rocks.

All the newer tertiary rocks, found overlying the carboniferous formation, are represented in diagram No. 9, page 61. For their description see also page 61.

With respect to the cretaceous formation:

In diagram No. 10, page 78, where the superficial stratum of disintegrated lime is mixed with tertiary ferruginous sand.

In diagram No. 11, page 83, where the top of the hill consists in orange sand, mixed with its characteristic pebbles. For the description of these rocks, see pages 107, 108, and 109.

With respect to the eocene formation:

In diagram No. 22, page 134, where the pebble stratum of the newer tertiary is so remarkably developed.

In diagram No. 23, page 137, where the eocene is thickly overlaid by the newer tertiary, containing the stratum of pebbles in its lower part.

In diagrams Nos. 24, 25, and 28, pages 140, 141, and 146, where the yellow sand of the newer tertiary overlies the eocene.

In diagram No. 31, page 150, where the miocene overlies the eocene, and is again covered by the postpliocene.

For a description of the miocene rock overlying the eocene, see page 162. The newer tertiary rocks are, accordingly, with respect to the surface soil, and consequently for agriculture, the most important in the State of Mississippi, and enter nearly everywhere, with the exception of those portions of the State where they are either washed away or overlaid by more recent formations, into the composition of the arable soil.

The surface of the newer tertiary formation is generally very hilly. Its upper members consist most generally of different kinds of sand or clay, which are very easily washed and swept away by the water of the atmospherical precipitations, and high hills and deep valleys, or gullies of erosion and denudation characterize it everywhere, and render it, in some parts, unfit, in others difficult for cultivation. The surface of this formation is, with very few exceptions, nearly equally hilly from the line of Tennessee to within a short distance from its southern boundary. Near this boundary it appears generally a little more level.

Towards the west, along the line of the alluvium of the Yazoo and Mississippi rivers, it is bordered by an uninterrupted chain of considerable hills, which have prevented those rivers from encroaching farther eastward, and which cannot be considered as originally formed by the rivers.

Towards the line of the cretaceous formation, eastward, it is in some places bordered by very high hills; in others it is more level than in the middle. In Kemper county, for instance, near Summerville, and between there and the little towns of Wahallack and Scober, the ridge is from 550 to 570 feet elevated above tide water, and forms one of the highest parts in the State of Mississippi.

The upper strata of the newer tertiary formation consist mostly of sand of great variety. Its principal color is orange; the group of which it is the principal member has, therefore, been called, by Prof. Jas. M. Safford, of Lebanon, the State Geologist of Tennessee, the Orange Sand Group. This name, which is a very adequate one, I willingly adopt. The orange color is prevalent in this group; but, besides, the sand appears brick-red, rose-red, purple, violet, white, yellow, blue, brown, &c. It is often interstratified with clay of different color, especially white, blue, reddish, greenish, &c., and with conglomerated stone, consisting of oxide of iron and silicious and aluminous matter, with an aluminous stone of different hardness, generally of a yellow color, and with very hard hornstone or chert.

In this sand group lies a remarkable deposit of pebbles which will later be discussed.

The front view of a deep cut into a hill, in Lafayette county,

[No. 35.]

Front view of a cut through a hill on the Mississippi Central Rail Road, in Lafayette County, on S. W. quarter of Sec. 16, T. 8, R. 3, W.

IN NATURAL COLORS.

not far from the University of Mississippi, on S. W. quarter of Sec. 16, T. 8, R. 3., W., represented in the annexed wood engraving. No. 35. Page 185, gives a fine representation of the sands and clays of the Orange Sand Group, especially of the upper strata, in their original colors.

The upper stratum represents a thin soil, mixed with vegetable mould; the red stratum is sand containing two diverging seams of ferruginous conglomerate; the yellow stratum is clay interstratified with white sand, and overlaid by sand on the south side; the strata below the clay are sands of beautiful colors, alternating with each other.

From the University of Mississippi, near Oxford, towards the line of Pontotoc county, about nine miles from Oxford, there are occasionally outcrops of the loose schistose or slaty iron sandstone, or conglomerate, interstratified with the yellow sand. The orange sand assumes here a more clayey character.

In R. 1, T. 7, Sec. 20, in Pontotoc county, the orange sand disappears. Sharp ridges, bearing from S. E. to N. W., appear there, which are overlaid with blocks of a white silicious sandstone of different hardness, in some places crumbling easily, in others as hard as flint, and assuming the character of chert or hornstone. These rocks are decidedly no more in their original place; they appear to have belonged to strata dipping from 18 to 20° S. S. W., or S. W., and broken down, the sub-stratum having been washed away.

Most of these rocks are distinctly stratified, but not all in the same direction. In some instances the stratification lines appear almost at right angles; in this case the ledges are frequently perforated by holes in the same inconformable direction. These holes seem to have been caused by blades of grass, or perhaps small stems of herbs agglomerated in the originally soft mass which forms the stone, and fallen or washed out, later, in a decayed state. At the orifices exposed to the influence of the atmosphere, these holes are generally washed out by rain, and of a round shape; whereas they are angular in the interior of the rocks.

The same rock continues on the Rockyford ferry, over the Tallahatchie river, in the corner of T. 8, R. 1, in Pontotoc county, where it lies in the bed of the river. The bluff at the W. S. W. side of the river is about 25 feet high; it is covered with river alluvium.

Below this is a deposit of a schistose, micaceous clay, of a bluish gray or black color, containing frequently nodules of schistose, micaceous, mostly soft, ferruginous, or aluminous sandstone, and sometimes, also, in its upper strata especially, a brown, aluminous, rather inferior iron ore disposed in concentric layers round a nucleus of pure iron ore. Some of the nuclei of this ore are 18 inches in diameter.

Those sandstone blocks continue also on the right side of the river for a mile and more, but disappear farther east. Farther northwards, in T. 7, R. 1, of the same county, the orange sand appears in some parts covered by the iron conglomerate.

The sandstone above mentioned is entirely without fossils, either zoogene or phytogene, which could betray its age; it remains, therefore, doubtful, whether it belongs to the eocene or miocene formation; the more so, as also the black schistose clay, upon which those rocks now lie, is characteristic of both of these formations.

The iron sandstone on the hills alternates frequently with considerable quantities of nodules of a brown aluminous iron ore, commonly of a flat shape, and from two to twelve inches in diameter. These nodules of inferior iron ore towards the surface, contain very pure ore in the interior, but are of no practical use, the quantity being too inconsiderable. The formation of these ferruginous nodules in water is indicated by their frequent stalagmitic appearance.

The newer tertiary rocks extend probably over a small part of Pontotoc county only; most of its territory belongs to the cretaceous formation. There is still less of those rocks in Tippah county. They extend only over a few townships in the N. W. corner, and exhibit there the orange sand, especially in Townships 2 and 3, Range 1; and in Township 2, Range 2. This sand is here again interstratified with iron conglomerate, and underlaid, in some places, by a plastic clay; for instance, in T. 2, R. 3, E., Sec. 17; a pottery is here established which furnishes very good earthenware of a light gray color.

The counties of Lafayette and Marshall, and also the western portions of De Soto and Panola, are very similar in their formations. The orange sand group, represented in the front view, No. 35, is most generally the uppermost group, covering the lignite group, which only crops out in comparatively a few places, where powerful denudations and erosions have taken place. The real orange sand is frequently exhibited in high bluffs and hills, increasing in thickness towards the line of Tennessee. In many places an amorphous yellow loam overlies the orange sand group ; but as it goes imperceptibly in it—as a line of separation is not perceptible—it must be taken for its upper member, perhaps, or most probably formed or altered by atmospheric influence and admixture of vegetable matter.

With the exception of the northern part of Marshall county, and of some of the bottoms of the rivers and creeks, this portion of the miocene territory is of inferior fertility. The table lands of Marshall county, in the range of Townships 1, 2, and a part of 3, consequently of about two full townships, extending twelve miles from the line of Tennessee, are of exceeding fertility, and belong to the first class of lands in Mississippi.

The western part of Lafayette county is very hilly, and thickly overlaid by orange, red, and yellow sands. In some places the brown iron sandstone, the slaty as well as the compact, is found on the surface—for instance, on the road from Oxford to College Hill, in Township 7, Range 3, where a part of the sandstone is really pudding-stone, the pebbles in it having been cemented by oxide of iron.

Near Chulahoma, in Township 5, Range 4, there is a large fertile plain, thickly overlaid by the reddish loam. Near Byhalia, in Township 3, Range 5 (both in Marshall county), the stratum of pebbles is finely developed, more so than it is found anywhere farther eastwards. It consists here mostly of smooth and water-worn fragments of jasper, agate, chalcedony, chert, and other quartzose and some aluminous pebbles, exactly like those found in the S. W. part of Mississippi. They are here, also, characterized by fossil stems of crinoidea, impressions of bivalvous shells (orthis, leptaena, etc.), fragments of agatized corals (columnaria, favosites, etc.), and evince thus clearly their palaeozoic origin (probably of the devonian or carboniferous periods).

These pebbles belong here to the surface formation, to the red sand of the orange sand group, with which they are interstratified. They overlie, in this place, the iron sandstone of the slaty kind. Below the red sand follows here a stratum of white sand.

Near Salem, in T. 8, R. 1, of Tippah county, and near the plantation of ex-Governor Jos. Matthews, not far W. from there, is a range of hills, of which it is uncertain whether they originate from erosion or upheaval (more probably from the latter cause). They extend north-eastwards, are thickly overlaid by the orange sand group, and covered, in many places, by the slaty conglomerate of iron, or iron sandstone.

In some places this conglomerate has a stalagmitic appearance, as if it had been in a state of fusion. This has most certainly not been an igneous fusion, for intense heat would have produced an entire change in the state of the contents of this sandstone; it originates, decidedly, from the formation of this sandstone in water.

In several places this conglomerate contains, on its plains of cleavage, a great many impressions of leaves, among which were identified impressions of hickory leaves (carya), leaves of sweet gum (liquidamber styriciflua), several species of the oak (quercus obtusiloba, q. salicifolia), the willow (salix, two species), the mulberry (morus nigra), the chestnut (castanea vesca), and the elm tree (ulmus); also, an impression of an equisetum (mare's tail), (68).

All the leaves, with the exception of the equiretum, are from dicotyledonous, exogenous trees—none endogenous, none even coniferous. This fact leaves no doubt but that they are all of a very late origin, most probably postpliocene (69).

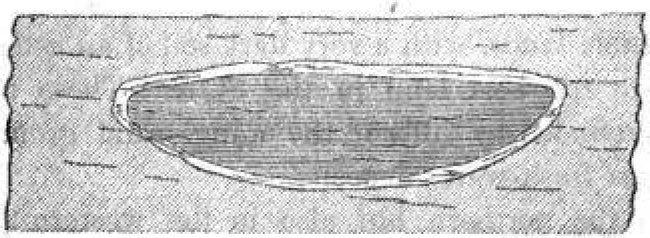
Such impressions of exogenous leaves were also found in the southern part of Lafayette county, but no trace of an endogenous or tropical vegetation among them; most of them are impressions of oak leaves, and many of them of the post-oak (quercus obtusiloba).

In some places the orange sand is overlaid by a red loam, which appears here and there very much like an overlying stratum of a different formation. It is always amorphous, and has frequently been mistaken for a diluvial deposit—for drift or altered drift—which it certainly is not, and cannot be. Its origin will be discussed later, in a chapter devoted to the strata overlying the miocene rocks, to which discussion I refer here.

A most remarkable deposit is found in the orange sand in Sec. 36, T. 1, R. 3. E., on Big Hill, on the Charleston & Memphis railroad, about five miles from the little town of Pocahontas, in Tennessee. A basin-shaped mass of black and exceedingly tenacious clay, with very little sand and mica, about 75 yards long, and not more than 25 feet high, of which only about 15 feet are visible above the level of the track, lies here, like a vein of segregation, in the orange sand, entirely surrounded by it.

The following diagram represents this remarkable deposit:

[No. 36.]



The whole deposit of black clay is surrounded by a thin layer of white clay, differing entirely from the black clay of the deposit, which is full of fine grains of sulphuret of iron, not much larger than grains of powder, and has a fetid smell like the muck of a swamp or marsh. It contains no zoogene fossils, but now and then a few small fragments of gramineae and salices.

The clay proved to be so hard that it was exceedingly difficult to remove it with spades and grub-hoes or pick-axes; blasting was, therefore, resorted to, but with no better effect.

The basin-shaped mass is, without any doubt, a fresh-water formation. After the elevation of the miocene formation a depression remained here, which became a fresh-water pond, and filled gradually up by a mixture of clay and vegetable mould, and was then covered by atmospherical influence with the surrounding sand. The fragments of grass and willow leaves, the inhabitants of the vicinity of ponds, seem to confirm that supposition.

It is more difficult to explain the origin of the thin layer of white clay all around, and even *above* the black clay. Were it only below, it might be deemed the first deposit from the water before it was impregnated with vegetable mould and acids; but this layer of white clay is also found upon the black clay, and is, therefore, most probably produced by an extraction and washing away of the vegetable substance from the clay by the waters of the atmospheric precipitations, which could penetrate the surrounding orange sand very easily, but for which the clay was impenetrable.

Such fresh-water deposits occur frequently in the northern part of the miocene formation in Mississippi, especially in Marshall county. A well was dug near Mount Pleasant (in T. 1, R. 3, W.), and, 70 feet under ground, a large quantity of finely preserved oak leaves were found in a similar black clay, which had the same fetid odor as the mud of an old pond.

The northern part of Marshall county contains a great many plateaux, or table lands, with a very dark soil of an astonishing fertility, equal to the best land in the State. These table lands, which are surrounded by hills of the orange sand group, are most probably similar fresh-water deposits.

Not only in the northern but also in the western part of the newer tertiary formation of Mississippi, such fresh-water deposits are found. About six or seven miles W. of Benton, (in T. 13, R. 8, of Yazoo county), a well was dug, and in a bed of blue clay, about 40 feet deep, a great many oak leaves were found in a good state of preservation; about two miles from that place, another well was dug, and at the same depth a great many finely preserved acorns were found in the same kind of clay.

The clay which contains such leaves and acorns is doubtless a fresh-water deposit, and perhaps, also, the overlying strata; they originate probably from a late period—from the pliocene to the postpliocene ages. It has hitherto been impossible to bestow the necessary attention on this remarkable deposit (70).

The orange sand group is best developed and much more extensive in vertical as well as horizontal extent in the northern part of the State, especially near the line of Tennessee; bluffs of the really orange-colored sand, of from 10 to 25 feet in thickness, are very frequent; the group appears most conspicuously along the Memphis and Charleston railroad, just a mile or two beyond the line of Tennessee, and all along on that railroad, to within a short distance of the city of Memphis, where it is overlaid by more recent, probably fluviatile, formations.

The line of Tennessee strikes Horn Lake, as the geological chart exhibits, exactly in the middle, where a small creek empties into it, a range of hills coming from S. E., and terminating here at the lake from the point of separation of the States of Mississippi and Tennessee at the lake. These hills belong evidently to the newer tertiary formation, and exhibit, a little above the water line of the lake, from 20 to 60 feet below their tops, the characteristic stratum of pebbles.

Here, on the N. W. side of the hills, is also the beginning of the loess or bluff formation in Mississippi. It appears first, especially in the bend of the lake, on a shallow place, S. of the mouth of the above mentioned little creek, on a mud flat of the lake, and is there from 60 to 80 feet high. It contains there only a few of its characteristic fossils, consisting entirely of helices (pulmonates), aquatic shells (branchifers as well as lamellibranchiates), are entirely absent. It contains a singular kind of nodules, consisting mostly of a hard carbonate of lime, which are represented in the following diagram:

[No. 37.]

All of them are of a rounded form; some perfectly round, some oval, some even more oblong; generally several of them are firmly cemented together, or hung together, and those hanging together have generally all the same shape. They are most frequently full of small protuberances, and seldom only found without them. In their interior they are perfectly solid and homogeneal. They differ in size from half an inch to an inch; are of greyish color, and very different from the calcareous concretions of the loess found immediately on the Mississippi river, which are loose and frothy, and much softer and whiter, and most probably of purer carbonate of lime, nearly free from an admixture of alumina, of which the above nodules, only found along the bluffs distant from the Mississippi river, where the Coldwater and Yazoo rivers intervene, seem to have a considerable quantity. It will be necessary to ascertain by a careful chemical analysis, what is the material difference of those concretions of the loess so different in external form and color.

The land around Horn lake, and to a considerable distance backwards, is of great fertility. Near the lake the soil is thickly covered with a black vegetable mould of inexhaustible fertility; but this black mould does not extend beyond a few miles from the lake. Farther east, towards the Tennessee and Mississippi railroad, a singular formation commences, and extends far into the southern part of De Soto and the northern part of Panola counties, covering the orange sand group entirely, to which it does most evidently not belong immediately.

The color of this formation differs very little from that of the loess or bluff formation; it will be more fully discussed under the head of formations overlying the newer tertiary.

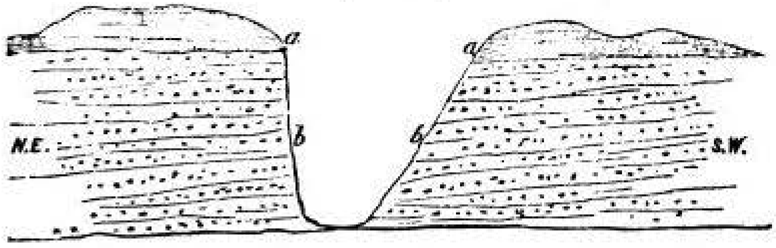
South of Hernando (R. 3, T. 3, De Soto county), the orange sand contains a large deposit of pebbles cropping out in ditches and ravines from six to eight feet below the surface. Among these pebbles were found fragments and impressions of petrified stems of encrinites and other corals.

The town of Hernando stands on the above-mentioned formation of the yellow loam which caps there a hill, and is of a great thickness—of 20 feet and more; on the base of the hill the stratum of pebbles crops out.

Near Taitsville (T. 5, R. 8, De Soto county), a well was dug recently in which, at the depth of from 80 to 100 feet, the stratum of pebbles was met with and penetrated. At the little village of Sledgeville (R. 7, T. 7, Panola county,) another well was dug to the depth of 130 feet, at which depth the pebble-bed was likewise met with, lying in a coarse, yellow sand, containing a large quantity of scales of mica.

The same stratum of pebbles appears finally developed near the little village of Belmont (R. 7, T. 8, Panola county,) in a deep gully washed in the orange sand, and fronting the Tallahatchie river. The following diagram represents the gully:

[No. 38.]



a a Represent the yellow loam.
b b The orange sand containing the pebble deposits.

The stratum containing the pebbles in a stratified position dipping several degrees from S. W. to N. E., appears here fully 40 feet above the bottom of the gully, and exhibits the pebbles from the top to the bottom; they extend probably much deeper, corresponding with their lowest level at Sledgeville, not more than about seven or eight miles distant from here.

The pebbles are here nearly entirely quartzose, without any pure quartz; they consist of chert or hornstone, jasper, chalcedony, agate, &c., and some aluminous stones, the latter have nearly all the color of the sand in which they are deposited. Most of them are small, water-worn, and rounded, resembling very much the shingle of the sea-shores and beaches, but some of them of considerable size, weighing about a pound. Neither fossils nor impressions were found among or in them; which must be merely accidental, the deposit of pebbles being exactly the same met with before.

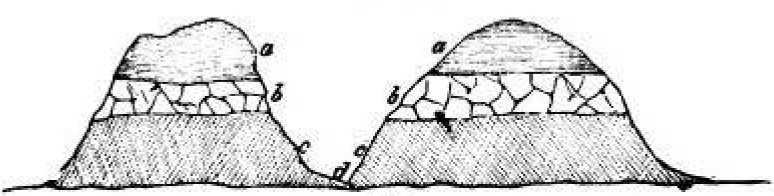
The orange sand containing the pebbles continues on the south side of the Tallahatchie river; the latter are there mixed with slaty iron conglomerate, but without any impressions of leaves. The soil changes much on the south side of the Tallahatchie river; the rich loam decreases, and the sand increases; the country becomes also much more hilly.

On a creek, three miles from the town north of Panola, there is a high bluff where the orange sand group encloses the pebble bed. The pebbles lie here in layers, alternating with layers of coarse red sand; both strata are stratified, and appear to dip N. E. to the same direction as those at Belmont.

In Sec. 28, T. 8, R. 7, about a mile north of the Tallahatchie river, outcrops of valuable stones were found on several hills. In some places these stones are aluminous, of different hardness; in other places they are silicious, varying from brittle sandstones to really hard cherty stones; both afford a very good material for building.

These ledges of rock lie evidently above the stratum of pebbles, and even much higher than the latter; their dip and extent could not be ascertained. Their thickness ranges from three to four feet; they lie most probably in most of the hills of that neighborhood, and must be of more recent formation than the miocene deposits which they overlie; or, at least, hardened later,—for those ledges of stones lie about in the middle of the hills of erosion, not at the base, as the following diagram exhibits:

[No. 39.]



The erosion extends farther down into the stratum *c c*, of the orange sand group, to *d*, which could not have been the case had the ledges of silicious and aluminous stones—some parts of which are really cherty and extremely hard—been formed at the time the erosion took place, or been as hard as they are now. The rocks are entirely void of all fossils, phytogene as well as zoogene, and it is most difficult to determine their comparative age. The overlying stratum *a a* is an amorphous loam, belonging to that above mentioned as overlying the orange sand and pebbles, whose origin is discussed later.

All through the western part of Panola county the above mentioned pebbles are found cropping out in gullies and creeks. The country becomes, southward, more hilly and broken, and the overlying fertile yellow loam disappears, especially more eastwards.

In Sec. 18, R. 8, T. 8, a well recently dug, very near the bluff along the bottom of Coldwater river, exhibited, first, a stratum of the often mentioned yellow loam, about eight feet thick; then a stratum of orange sand, containing the pebbles; below that a layer of grayish sand; then brown clay, very tenacious and plastic, and fit for pottery; in the lower part of which a great many sticks and leaves, and fine particles of sulphuret of iron, were found.

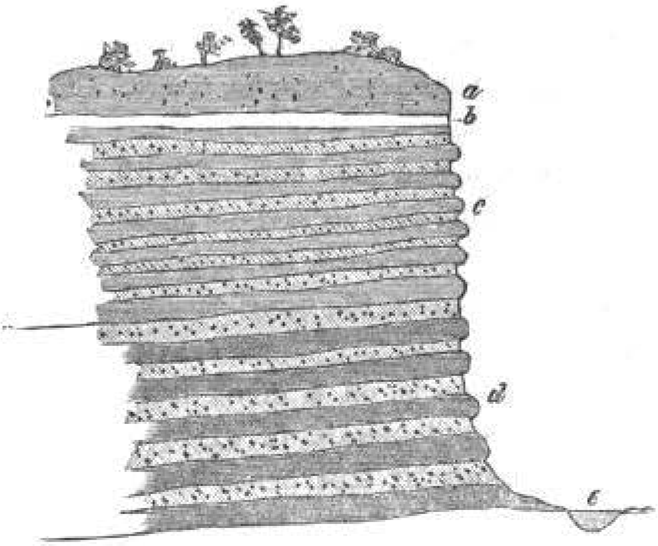
The pebbles contain here the usual palaeozoic fossils and impressions; they are nearly all quartzose.

The loess or bluff formation is there found in spots, containing exactly the same fossils and nodules as near Horn lake, and also nearly in the same quantity (71).

In a creek not far from the bluff, along the bottom of Coldwater river, a stratum of lignite, of a considerable thickness, crops out under a layer of micaceous slaty clay, several feet below the surface. The lignite, or brown coal, contains a great deal of sulphuret of iron, which lessens its value for fuel, but not for a manure. This lignite belongs to a group of the miocene formation, which lies below the orange sand group, and may properly be called the lignite group.

This lower group of the newer tertiary formation appears finely developed on Sec. 25, T. 7, R. 6, in Panola county. There, on the south side of a small creek, is a bluff of about thirty feet high, represented in the following diagram:

[No. 40.]



a. Represents a stratum of soil of the often mentioned yellow loam, mixed with organic matter.

b. A seam or thin layer of finely laminated white clay, from one-half to one inch thick.

c. A stratum of red clay, also finely laminated, and alternately interstratified with sand, about fifteen feet thick.

d. A stratum of black micaceous clay, again finely laminated, and also alternately interstratified with thin layers of grayish sand, extending down below the bottom of the creek *e*.

The sand is, in front, where the rain beats against the surface and runs down along it, washed out, and the whole bluff appears singularly fluted, in a horizontal manner, as the diagram indicates.

The lower stratum of black clay is exactly such as generally covers and encloses the lignite, which underlies here probably deeper down.

This bluff gives origin to a fine chalybeate spring, which will be mentioned later.

The bluff on the left side of the Tallahatchie river, in T. 5, R. 5, of Panola county, is nearly 30 feet in perpendicular elevation above low-water mark; it consists, uppermost, of a stratum of yellow loam, which is here the top formation of the orange sand group, of about 10 feet in thickness, interstratified with grayish sand and clay, and below this of about 15 feet of yellow sand interstratified with conglomerate of oxide of iron, rather unconformably underlying the loam. A little south of the ferry lies a large ledge of iron sandstone, coarse grained, but very compact and hard, characterizing the orange sand group.

On the E. side of Tallahatchie river the country is still more hilly and sandy, and the soil not only thin and barren, but too broken for general cultivation. The arable land is entirely confined to the larger valleys, and the bottoms of creeks and rivers on the Tallahatchie and Yokeney-Patapha rivers, Clear creek and other smaller water-courses.

The hills are now and then covered with fragments of the slaty iron sandstone, containing, in several places where the grain is fine enough, the before-mentioned impressions of exogenous leaves of the growth now found on the land, especially of different kinds of oak trees.

In R. 6, T. 8, there is, on a creek near a mill, an outcrop of a fine sandstone, a conglomerate of oxide of iron and orange sand, which appears about 15 feet below the top of a hill, and nearly as much from the base; it can, therefore, at the time the hills were formed by erosion, not have been in the state of hardness in which it is now found. It is divided in several layers; the uppermost is the hardest. The ledge extends entirely to the base of the hill, and is, as far as it is exposed to sight, of that thickness, and perhaps much thicker, extending still farther down into the ground. The sandstone contains neither fossils nor any impressions of leaves.

In a S. S. W. direction from Panola, on the road to Robinia, the stratum of pebbles appears about six feet under the surface. In Robinia this pebble stratum was penetrated by digging a well; it consists there of the quartzose pebbles containing silicified stems of encrinites, and impressions of them.

On Sec. 8, T. 27, R. 8, in Panola county, the orange sand group and the lignite group appear overlying each other in a hill. The top rocks consist of a stratum of the yellow loam of more recent formation, then follows a layer of yellow sand about 30 feet thick, containing the pebble stratum; the lowest four feet of this stratum have been converted by oxide of iron, having cemented the sand and pebbles together, in a conglomerate or pudding-stone; below this lies a stratum of lignite, or brown coal, appearing 15 feet above the base, and extending perhaps much deeper downwards. From below the lignite gushes out a very fine chalybeate spring.

The formation of this country appears best in a land-slide on the N. side of one of the hills represented in the following diagram:

[No. 41.]

a. The upper stratum represents the yellow loam of more recent formation, here, from five to six feet thick.

b. Is a stratum of orange sand interstratified with the pebbles, about 25 feet thick. The pebbles are in different layers.

c. Is a stratum of iron ore interstratified with pudding-stone at least 40 feet thick. The stratum of pebbles has here, therefore, the enormous thickness of more than 60 feet.

d. Is a stratum of lignite going down below the bottom of the creek *e*, being, therefore, at least 16 feet thick, and perhaps much thicker.

The talus of the hill covers the lignite nearly entirely, but enough of it could be seen to ascertain that it is of a very fine quality, conchoidal and glossy upon its fractures.

This lignite will make an excellent fuel, and there is an inexhaustible quantity of it; it underlies nearly all the hills, and crops again out about two miles eastwards, above a stratum of the pebbles about 70 feet under ground.

On the surface of the hills are found hereabout a great many fragments and some large trunks of silicified exogenous wood, which appears to be of caryae or hickory.

The lignite crops again out on Sec. 10, R. 8, T. 27. Also there it is of excellent quality, useful for all the purposes for which the palaeozoic coal is used.

About four miles from the town of Panola, on Sec. 30, R. 7, T. 9, a well was dug, and the pebble stratum cut through about 70 feet under the surface; below which charcoal, the remnants of cloth, and human teeth have been found, according to a general rumor (72).

Near this place, not more than about three miles westwards, the Tallahatchie bottom commences, and a chain of conical hills extend along it, nearly all of which are capped with the often-mentioned stratum of pebbles.

This stratum is here much more extensive, thicker, and more continuous than farther east, and it appears as if the current which carried the pebbles here had come in a direction from N. W. to S. E. Only those hills immediately along the bottom appear overlaid with pebbles, not the range behind them; the pebbles are there overlaid by the more recent yellow loam.

Some of the hills are also overlaid by the loess or bluff formation; but it appears here, as all along the Tallahatchie, Coldwater, and Yazoo rivers, only in spots.

In a S. W. direction, towards the Yokeney-Patapha river, the county is very hilly and only level near the river, which forms a bottom covered with its alluvium about two miles wide, in connection with the Tallahatchie and Mississippi bottoms. On the Yokeney river, in Sec. 26, R. 8, T. 27, a large ledge of hard and cherty sandstone crops out on the side of a hill about 50 feet under the top in a small creek. The ledge is about 100 yards long, and appears to underlie the whole hill. It seems to be perfectly horizontal, and dip and strike could not be ascertained. It is about four feet thick, extremely hard, almost too much so for any use; but in its rough state it can be used for building, and even for millstones.

This ledge of stone lies evidently above the stratum of pebbles. It shows no stratification and no trace of fossils.

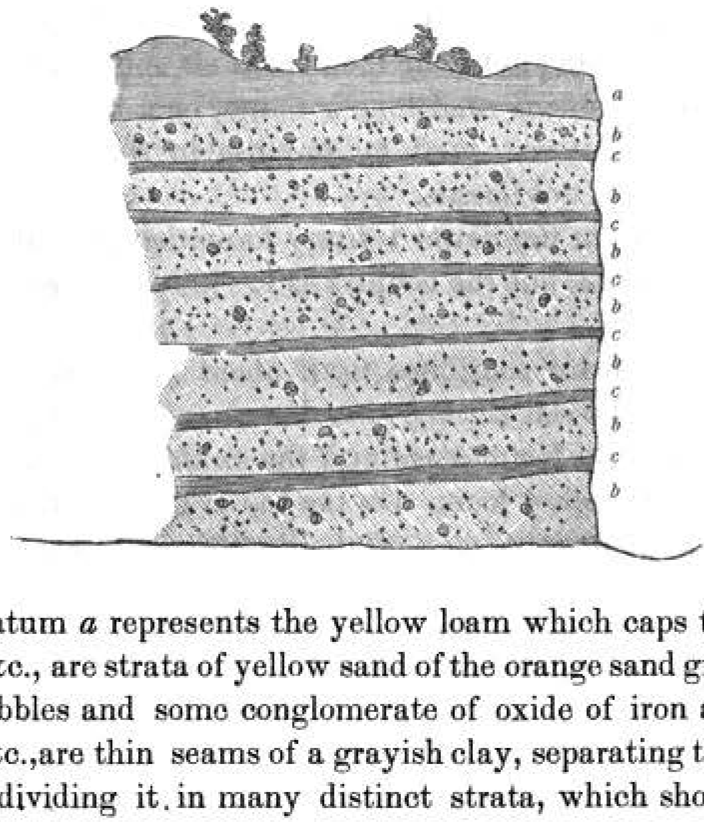
The Tallahatchie, Coldwater, and Mississippi bottoms, which are all connected, forming one and the same alluvial plain, are called, as high up as Tallahatchie county, "Coldwater bottoms." They are bordered by a chain of tertiary hills, every one of which exhibits the stratum of pebbles, there of the enormous thickness of from 40 to 60 feet, and in some places even more than that. The pebbles lie in the orange sand group, and the structure of these hills leaves no doubt that the pebble stratum is a member of it.

Ths hills along the bottom are from 70 to 100 feet high; they are all capped with the yellow loam of more recent formation; below this lies the orange sand, interstratified with the pebbles, extending to the base of the hills.

More than two thirds of the county of Tallahatchie, is occupied by the river bottoms; the eastern part is overlaid by the yellow loam, which is there very sandy and not fertile; the country is besides very hilly and broken.

About 12 miles S. of Charleston (in T. 23, R. 8, in Tallahatchie county), a small creek has washed a deep gully just between two hills; the slopes of which have slid down. They form, therefore, steep walls about 40 feet high, and exhibit a singular formation, especially visible on the north side. The following diagram represents a section of it:

[No. 42.]



The stratum *a* represents the yellow loam which caps the hill.

b, *b*, *b*, &c., are strata of yellow sand of the orange sand group, containing pebbles and some conglomerate of oxide of iron and sand.

c, *c*, *c*, &c.,are thin seams of a grayish clay, separating the orange sand, and dividing it in many distinct strata, which show a decided dip eastwards. On the opposite hill the talus is high, and the stratification not so distinctly visible.

The pebble stratum is found every where along the bluff of the bottoms; it lies in orange sand, frequently interstratified with a yellow clay.

Farther southward the stratum of the pebbles is not so continuous; the soil on most of the hills is thin, and the country very broken. The sides of some of the hills are, nevertheless, thickly overlaid by the fertile yellow loam, which has here exactly the color of the loess, or bluff formation.

In T. 19, R. 2, in Carroll county, on a hill, on the road to Greenwood, the loess or bluff formation appears again, not only characterized by its color, which it shares with the yellow loam, but also by the round concretions of carbonate of lime, exactly of the same shape and size as those found near Horn lake, and represented in diagram No. 37, but not by any of its fossils.

In the western part of Carroll county the orange sands are generally overlaid by the yellow loam, which is extremely fertile in some parts, but more sandy in others, forming only a thin and much less fertile soil; the country is, besides, very hilly and broken.

In the northern part of Carroll county, in T. 21, R. 18, on the road to Grenada, and not more than about six miles from this town, a very hard aluminous sandstone is found, on a hill. It is too hard for working it, but very good for any use in the rough state. It shows no signs of any fossils.

W. of Carrollton the newer tertiary formation is overlaid by very fertile yellow loam, but the country is too hilly and broken for agriculture.

This yellow loam continues until about nine miles W. of Carrollton, where the soil becomes less heavy and more sandy.

Near Emory, in Holmes county, the country is hilly, but overlaid by a fertile yellow loam. On the top of the hills lies the orange sand, overlying here the clay of the lignite group, which gives, on Sec. 24, T. 16, R. 3, E., origin to a fine acid spring.

In the western part of Holmes county the formation is about the same; the yellow loam overlies the orange sands, in some places, very thickly (and these are extremely fertile); in others, thinly only, and with a considerable admixture of sand; the latter soil is found especially in hilly and broken places, and is of much less fertility.

In T. 15, R. 2, there is a valuable sandstone; it crops out under a hill, in a creek. It is, as usual, of different hardness, the hardest of it appears like chert. It splits well, and is very useful for building-stone, and even for mill-stones. The hardest part may be used in its rough state. It contains no zoogene, but traces of phytogene fossils, which can, nevertheless, not be recognized.

In the western part of Holmes county the loess is found nearly everywhere along the bluff of the alluvial plain—here called the

Yazoo bottom. In some places the lignite group appears, containing strata of lignite.

In the S. E. part of Holmes county, near the beautiful village of Richland, the country is level; a fertile soil lies there over the orange sand group. Towards Lexington the country becomes more hilly, the soil lighter, and of a more yellow color. Some of the hills are very fertile, where they can be cultivated.

The orange sand group appears everywhere, containing sands of different color—sometimes a yellow loam, and sometimes clay of the same color. The pebble stratum, of which traces were found S. of Lexington, appears about seven and a half miles from Lexington, on the road to Carrollton (in R. 11, T. 16), in great thickness.

In many places the lignite group crops out in the eastern part of Holmes county, and contains valuable strata of lignite.

South of Lexington, towards Benton, in Yazoo county, the country becomes more level; the yellow loam overlies the orange sand group thickly, and forms an excellent soil for agriculture. In the northern part of Yazoo county the soil is exactly the same as in the northern part of Panola and the southern part of De Soto counties; it resembles the loess perfectly in color; it is, perhaps, not so uniform, and a little more compact. In some parts it contains a large quantity of concretions of iron, all of a roundish form, resembling large shot. In other places it contains a great many concretions of carbonate of lime, from the size of buck-shot to that of large bullets of an ounce in weight.

The stratum of pebbles is visible in many places, especially at the bottom of small creeks.

In the lower part of T. 12, R. 9 and 10, there are spots of a very black clay, occupying the spaces of from one quarter of an acre to several acres; these spots offer a singular appearance in the yellow loam, and are visible at a long distance. The black clay is very tenacious, of a greasy feeling; it is identical with the clay of the eocene prairies, and a sign that the eocene formation underlies here, and is only thinly overlaid by the miocene, and of the vicinity of the line separating the two formations. This black clay is indeed an outlier of the eocene formation.

The Yazoo bottom is bordered, all along, by high hills, of miocene formation, which not only exhibit, among the orange sands, the stratum of pebbles, but also the loess, or bluff formation.

This is especially the case immediately behind or E. of Yazoo city, on the road coming down from the hills. The loess overlies the hills, or rather leans on the hills, to a great depth, of from thirty to forty feet in thickness. It contains the characteristic fossils, consisting of helices (pulmonates) only. The hills bordering the Yazoo bottom approach, near Yazoo city, the river, to a few hundred yards, but recede again on both sides, N. and S.

Yazoo county offers a singular geological formation, quite different from all other counties of the tertiary formation. It is divided in two geologically distinct parts, by a chain of considerable hills, which come down from Holmes county, run through Yazoo county, in its whole extent from N. E. to S. W., cross Warren county in the same direction, and terminate immediately on the Mississippi river, near the city of Vicksburg, offering the singular feature of a chain of hills of two different formations—miocene in Holmes and the northern part of Yazoo county, and eocene in the southern part of Yazoo and in Warren county. These hills run nearly parallel with the hills bordering the Yazoo bluff, and divide the water-courses ; westwards of this chain the creeks run all into the Yazoo river, and eastwards into Big Black river.

Westwards of this chain of hills, between them and the hills bordering the Yazoo bottom, the whole country consists of very high hills and deep valleys ; the latter are frequently from eighty to two hundred feet deep, and very narrow ; and, consequently, the ridges that high, and running nearly all from E. to W., or at least nearly so. All the hills are covered with the yellow loam, which contains a great deal of lime—so much so that most all the springs and wells yield a water nearly too much impregnated with salts of lime to be useful.

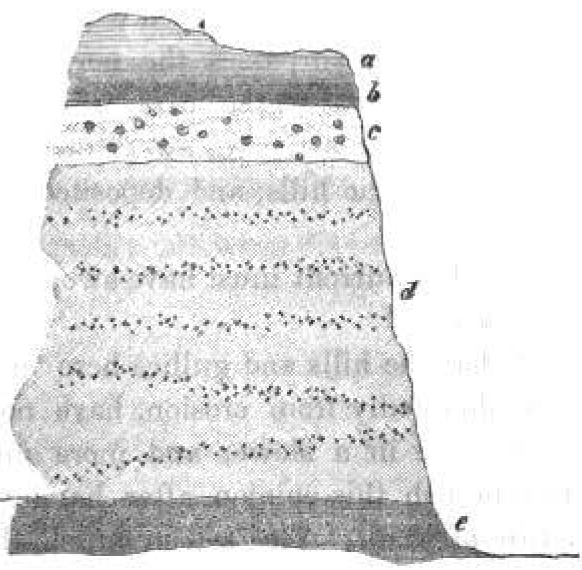
All the hills contain a most fertile soil on their top, as well as on their sides ; but they cannot be extensively cultivated, as there is no level surface. Hills and ravines are overgrown with a very luxuriant growth of white oak (quercus alba), post oak (Q. obtusiloba), poplar (lyriodendron tulipifera), sweet gum (liquidamber styriciflua), sassafras (laurus sassafras), and others. The sassafras trees are frequently from two to three feet in diameter, and especially the white oaks of an enormous size ; but many of these valuable trees are of no use, because they cannot be hauled easily to the ridges. All roads go along the ridges, and are, therefore, very circuitous, and on many places dangerous.

At a first view it appears as if a violent catastrophe—a formidable current—must have produced that singular configuration of the country; but a closer examination leads soon to the result that this has been done in a much slower and more quiet manner.

A careful examination of these hills or ridges gives the result that they are of the newer tertiary formation. Their surface is covered, even on the slopes, with the yellow loam; below this follows the orange sand group, containing the pebbles, which extend down very nearly to the bottom, often from one hundred to two hundred feet below the top. Near the bottom the pebbles consist mostly of an impure yellow (ochreous) quartz, mixed with jasper. This ochreous color they received in the stratum where they are imbedded, there being a very ochreous sticky clay near the bottom of the hills. In nearly all of the ravines there are little streamlets which, in rainy seasons, swell to considerable torrents. The water of those streamlets was tested, and found to contain some lime and sulphate of iron, which imparts to it a real chalybeate taste.

All of the hills and ridges are nearly of the same geological formation; the yellow loam overlies them to a depth of at least from twelve to sixteen feet; and, singular, then follows the loess. One of the hills, from which the slope has slid down, and which appears like a perpendicular wall, gave a fine view of their internal formation; the following diagram represents it.

[No. 43.]



The stratum *a* represents the yellow loam, pure and unmixed.

b. The same loam, which is mixed with an additional quantity of clay, and more compact, also of a more reddish color ; both strata, together, are from twelve to sixteen feet in thickness.

c. Represents the loess or bluff formation, underlying here the loam, and showing its earlier origin. This stratum is at least twelve feet in thickness (about six miles from the Yazoo river), and contains all the helices (pulmonates) generally found in it, but no aquatic shells ; it contains, also, concretions of lime, and a great many fossil bones, especially those of the mastodon giganteus—well preserved and unmistakable vertebrae of which were found by the author.

The stratum *d*, below the loess, represents the orange sand, here of a rather yellow color, containing the pebbles in many layers. This stratum is about one hundred feet in vertical extent.

The stratum *e* represents the ochreous clay, also containing pebbles, as above stated.

The clay was examined, and found to contain no lime, but a considerable quantity of iron ; before the blow-pipe it melted only a little on the fine edge ; it will, therefore, make most excellent and nearly fire-proof bricks, especially as it contains a sufficient admixture of silicious sand. It would be advisable to mix it, for that purpose, with some common salt, in order to volatilize and remove a part of the iron by burning the bricks.

The loess is not confined to some of the hills ; it is found in all of them, and penetrated wherever wells or cisterns are dug. This, then, is the cause of their great fertility, in which respect the south side, nevertheless, generally surpasses the north side, indicating, most probably, that the latest water current, which probably carried the loess there, came from the N., swept most of the older soil away from the N. side of the hills, and deposited it on the S. side, in the eddies.

At what period such a current must have swept over the country will be later discussed.

We have stated that the hills and gullies here in Yazoo county, which originate undoubtedly from erosion, have not been formed by a violent current, but in a slower and more quiet manner ; it will be easier to establish this opinion after having examined the geological structure of them. The soil in which this erosion has taken place is a very loose one, which washes easily ; the yellow loam and loess, especially, are of that nature, and wherever they appear, they have been much disturbed by erosion simply caused by atmospherical precipitations. This is the case here, and after the formation of gullies, first in the loam and loess,—the drainage of the country, having a tendency towards the Yazoo and Mississippi rivers, towards which the country slopes much from the central ridge in Yazoo and Warren counties,—the streams in these gullies become more considerable and powerful enough to excavate the whole of the underlying orange sand stratum with the pebbles; and the deepening of those gullies and ravines continues in this way still, however slow and imperceptible it may be.

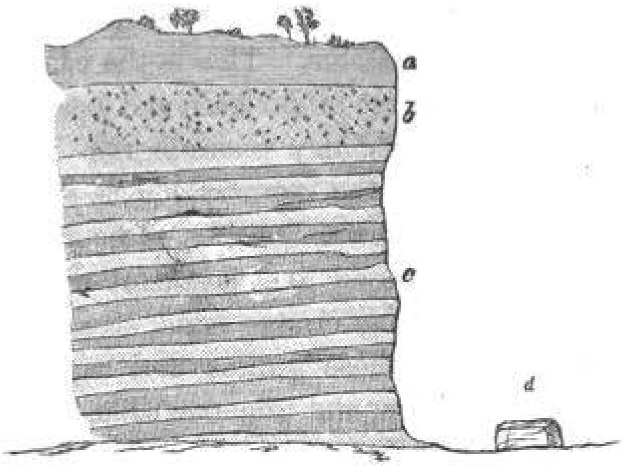
That those deep ravines have been formed in that way shows not only their course with the inclination of the country from E. to W., but especially their form. In the large ravines running from E. to W., smaller ravines are going from N. to S., which could not be so if a violent torrent had formed the ravines; in this case they would have their longitudinal extent all in the same direction.

This singular formation continues to the small town of Satartia, where the hills of the Yazoo bluff approach again the Yazoo river to within a short distance; the ravines become even still deeper, and the hills higher, but end immediately N. of Satartia.

On the road to that town, situated on the foot of the hills, and on the E. or left bank of the river, the loess overlies the hills, capping them and leaning on them as the uppermost stratum not overlaid by the yellow loam. It contains not only the usual helices, but also the same round concretions of carbonate of lime found on Horn lake, and near Greenwood, represented in diagram No. 37 (73).

Here, near Satartia, is the line separating the miocene from the eocene rocks; the last outcrop of the merely newer tertiary formation is represented in the following diagram.

[No. 44.]



a. Represents a stratum of the yellow loam about three feet thick.

b. A stratum of the pebbles lying in red sand.

c. A stratum of variegated sand of red and white color, interstratified with each other, and belonging to the orange sand group.

d. Represents a block of stone, perhaps one of the pebbles of the stratum *b*, and fallen out of it; it is 20 inches long, 16 inches wide, and 12 inches thick, and weighs several hundred pounds: it consists of an impure yellow quartz, and is decidedly of *foreign origin;* it may, therefore, indeed be called a boulder or erratic block, but not of the drift period; it is the largest one which ever came to our eyes in the State of Mississippi. It was found in the situation where it appears; it may or may not have fallen from the stratum of pebbles *b*, none of which approaches it in size.

How this large block of stone came there, will ever be an enigma; so much is certain, it is a "*stumbling-block*," as will be seen later, where its merits are discussed.

The N. E. part of Yazoo county, as far as it belongs to the newer tertiary formation, is hilly and broken, but not to such an extent as the western part, on the other side of the dividing ridge; it is, nevertheless, not as fertile, not being overlaid with the fertile yellow loam, nor with the loess. It contains a great many creeks of different sizes; their bottoms offer the best lands, and to this the cultivation is mostly limited.

The soil in this part of Yazoo county is thin, and underlaid extensively by a yellow sandy clay, of the orange sand group.

The northern part of Madison county, on the other side of Big Black river, resembles very much, in its geological formation, the N. E. part of Yazoo county; it is hilly and broken, and the soil thin and sandy. This part is quite different from the southern part, which belongs to the eocene formation, and has been mentioned in its proper place.

The whole of Atala county is occupied by the newer tertiary formation. The sands and clays of the orange sand group appear everywhere, and are overlaid, in many places, by a light and yellow sandy loam, especially in the northern part. The county is generally very hilly; and, in many places, the cherty sandstone, characteristic of the miocene formation, crops out. This is the case on the E. side of Big Black river, in T. 16, R. 6; the stone is here very hard, too much so for being cut, but nevertheless useful for building purposes.

Other outcrops are S. E. of Kosciusko, where it appears everywhere under the hills; some of the hills are entirely capped with it. In some places these sandstones are, as usual, cherty and very hard; in others, they consist of the red conglomerate of oxide of iron, and orange sand; in other places the slaty iron conglomerate appears, consisting of finer sand.

Outcrops of fine sandstone are found one mile W. of Burketsville, in the S. E. quarter of Sec. 13, T. 15, R. 6, E., on the top of a hill. The stone is here of different hardness, very fine for grind, mill, building, and monumental stones.

The same stone crops out again five miles E. of Rockport, under a hill; and again one mile E. of Rockport, and continues nearly to Rockport.

The W. part of Atala county, especially the S. W. part, contains a thin and barren soil, and the country is extremely hilly and broken. In some places the same aluminous stone crops out so frequently met with in the orange sand group, especially in Panola county; it is devoid of fossils, as always in the miocene formation.

This stone lies in the orange sand group, and occupies, most frequently, the uppermost position.

The whole of Leak county belongs to the miocene formation; but this county has not yet been sufficiently examined. In its N. E. corner it is hilly; the soil is very thin, sandy and barren, in many places. The miocene sands are very ferruginous, containing ferruginous conglomerate. Near the town of Edinburg the country becomes a little more level, but not more fertile.

Neshoba county belongs, also, nearly entirely to the miocene formation; a small portion, from the S. and S. E. part, is cut off by the line between the two formations, and belongs to the eocene.

On the N. W. side of Pearl river Neshoba county is very hilly, and the soil sandy and thin; S. E. of that river the country becomes more level, but still more sandy and sterile. In. T. 10, R. 13, about six miles from Philadelphia, an aluminous stone crops out, but it is too soft for use; it contains no fossils. This aluminous stone is, according to its petrographic character, very much like that found W. of Enterprise, in Clarke county, and S. of Marion, in Lauderdale county, and mentioned on pages 148 and 149; it contains no signs of fossils.

The whole appearance of the country and the strata indicate a change of the formation.

In the S. E. part of the county a slaty iron conglomerate was found, which is of so frequent occurrence in the northern part of the miocene formation. On a hill, near the line of Kemper county, an outcrop of a white aluminous earth, generally called "fuller's earth," exists where the surface soil and the orange sand was washed away.

A valuable sulphur spring is said to exist in T. 11, R. 11, and another one eight miles S. of Philadelphia.

Only a part of Kemper county belongs to the miocene formation, as the geological chart indicates; its southern part is more level and fertile than Neshoba county. A red loam covers the orange sand, especially upon the hills. To the town of De Kalb the hills exhibit the sands and clay of the orange sand group; the latter is especially of a red color.

Not far from De Kalb, on a high hill, in Sec. 27, T. 11, R. 16, the compact red iron sandstone crops out in large ledges. It is coarse-grained, formed of a very coarse silicious sand, cemented by oxide of iron, and varies in color from yellow to dark red, and even to a purple. It is not very hard, but increases in hardness when quarried, on exposure to the influence of the atmosphere, and is, therefore, a very valuable building stone.

Under the hill on which the stone crops out, there is a fine chalybeate spring, deriving the iron it holds in solution from the iron sandstone.

The same stone crops out in several other places around De Kalb, and furnishes abundant material for building.

In a deep and wide valley N. W. of De Kalb, and in the same Township and Range, a most valuable stratum of lignite crops out about 150 feet below the top of the hill. The stratum appears from three to four feet thick, it is covered by dark micaceous clay. It is probably much thicker continuing in the ground, which could not be ascertained.

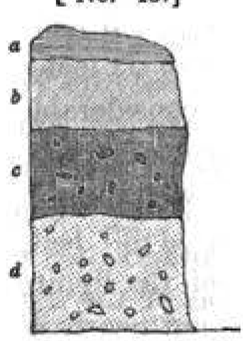
The dip of the stratum of lignite appears to be towards N. E. Above the lignite, a powerful spring of very limpid and pure water gushes forth, of the temperature of 64° Fahr. The lignite underlies the whole hill, and crops out on several places around it.

In a gully in the town of De Kalb, about three feet under the yellow sand of the orange group, a fine deposit of Fuller's earth appears.

The road from De Kalb to Louisville, in Winston county, leads over a range of hills extending from N. to S., the same which attains the high elevation of from 550 to 570 feet.

These hills exhibit the orange sand group, and are covered with a yellow sandy loam belonging to it. The town of Summerville, in Noxubee county, is situated on the ridge of these hills. East of this town there is a deep gully, washed by the rain water, running towards the eastern slope, within the last ten years. It is at least from 50 to 60 feet deep, and gives a fine view of the formation of the hills. A section of it is represented in the following diagram.

[No. 45.]



a. Represents a stratum of a yellow sandy loam about three feet thick.

b. A layer of yellow sand of the orange sand group, about 20 feet thick.

c. A stratum of reddish sand of the same group, of about the same thickness.

d. A stratum of coarse white siliçious sand, in some parts extremely coarse; its thickness could not be ascertained, as it extends under the bottom of the gully.

The two latter strata, *c* and *d*, contain nodules, and even veins, as it were, of the finest white clay, approaching kaolin, which would be of great value if there were a sufficient quantity of it. Besides this white clay, there is some carbonized wood, or lignite, found in the sand (74).

At the base of these hills there are some fine springs, affording water enough for a mill. The springs are of the temperature of 64° Fahr. The water was tested for lime, but showed scarcely a trace of it. The water of a well in the town of Summerville having a mineral taste, was tested, and found to contain some lime and a larger quantity of magnesia.

The hills around Summerville exhibit in many places the iron sandstone; a part of it is fine grained and slaty; another part resembles that near De Kalb, and is valuable for building purposes.

The country from the line of Noxubee county to Louisville, in Winston county, is very broken and hilly to within about 12 miles E. from Louisville, where it becomes more level. The soil consists of a light and rather sandy yellow loam. Nearer to Louisville the soil is more clayey. The bottom lands along Panther and Talahaga creeks are of great fertility. The alluvial soil mixed with vegetable mould is from three to four feet thick.

The arable soil around Louisville rests upon a stratum of red clay, which forms the subsoil; then follows a stratum of blue clay of the lignite group, from five to six feet thick; below this blue clay, lies a stratum of lignite of considerable thickness, at least from five to six feet thick; it is met everywhere in and near Louisville, where wells are dug. In a well dug by Mr. Josiah Atkison, the lignite was found at a depth of 35 feet, of a thickness of about five feet. An examination of the lignite gave the result that the carbonization of the wood is not nearly completed; the lignite will, nevertheless, make a good fuel, but be more valuable still for a manure, and as such most welcome and recommendable in Winston county.

Iron is said to be found in Winston county, in two different localities; the one is about 16 miles west of Louisville, in T. 13, R. 11, E.; the other 15 miles east, in T. 14, R. 14, E. The iron ore has not been examined.

The underlying lignite group, of the newer tertiary formation, gives origin to several valuable chalybeate springs. One of the best chalybeate springs in the State, is found about four and a half miles from Louisville (75).

Another, also, in the vicinity of Louisville, but neither as strongly chalybeate nor as copious as the one above mentioned, comes out from under a stratum of lignite, more than two feet in thickness, as far as visible, but perhaps much thicker.

The northern part of Winston county is hilly, but, nevertheless, fertile. The land on the hills appears least sandy, and better than the lower lands. The sub-soil of red clay improves the lands.

In Ocktibbeha county, the south-western half of which belongs to the miocene formation, the blue clay of this formation (a real Tegel of the German geologists) crops out on the Noxubee or Oka-noxubee river. About 14½ miles south of Starkville (in T. 17, R. 13), there is a bluff on the left, or south side of the river, of about 18 feet elevation above low water, which consists entirely of this blue clay.

The alluvial bottom of the river is nearly four miles in width, and of great fertility; with proper embankments to protect it against overflow, it would make a most valuable body of land.

Chocktaw county belongs entirely to the newer tertiary formation. It has not yet been examined. It is generally more sandy than Carroll county and mostly overlaid by the orange sand group, which appears there in huge masses, especially of red sand.

Calhoun county is, also, entirely occupied by the newer tertiary. The county is generally very hilly and broken; the most hilly part is in the north-western part, in the fork of the Looshaskoona creek, and the Yallabusha river. The country becomes a little more level along the line of Chickasaw county, where the very level and flat formation (known under the name of "flatwoods"), of the latter county, commences. The south-east part of the county is its best part for agriculture. The best lands are found along the Topisha creek.

The county is generally overlaid by the orange sand group, but the lignite group underlies it nearly everywhere, and crops out in many places.

Near Lafayette county, the orange sand hills of Calhoun continue; these hills, the sand of which is of different colors, orange, red, yellow, gray, white, &c., as it appears in the front view [No. 35,] are frequently overlaid by the slaty iron sandstone; the orange sand encloses often the compact and coarser ferruginous sandstone.

Near the town of Hartford, a stratum of fine greenish clay crops out, very useful for bricks and for the fabrication of earthernware. A pottery, on a small scale, is there already in existence.

The water of a well in that town, which is only about 30 feet deep, contains a large quantity of chloride of sodium, so much as to render it very saltish and unpalatable (76).

The town of Pittsboro stands upon a hill overlaid by the orange sand group, which is underlaid by the lignite group. The lignite crops out north-west of Pittsboro, in T. 24, R. 1, E., not a mile from town, about 45 feet below the top of a hill. It appears more than six feet above ground, but is apparently much thicker than that. It is of a fine quality, conchoidal and glossy upon its fractures, and nearly free from sulphuret of iron; it would, consequently, be a fine fuel; and is, also, invaluable in that county for a manure for the lands, which are very easily exhausted.

A beautiful spring, of clear and pure water, comes out from over the lignite and under the dark micaceous clay which covers it. The water is of the temperature of 61° Fahr. (at the temperature of the air of 96° Fahr.) The spring yields, at least, from 20 to 30 gallons of water in a minute.

By digging wells in and near Pittsboro, the inhabitants meet the lignite stratum everywhere, about 30 feet below the surface, and find it to be in some places of the unusual thickness of 30 feet; the latter is especially the case eastwards of the town, in which direction the stratum of lignite seems to increase in thickness.

This lignite stratum gives origin to valuable springs. A well, made in the town of Pittsboro, with an artesian bore, and bored down to a depth of 66 feet, is filled with water to within 35 feet from its mouth, and contains a valuable mineral water, to be mentioned later.

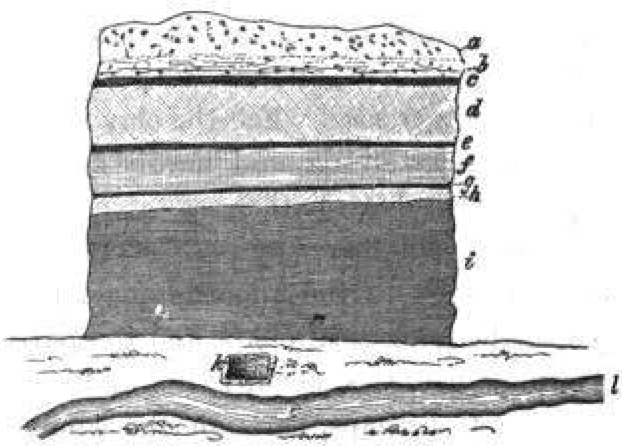
A spring near the above town, formerly called the Calhoun

Springs, but now neglected, yielded a water strongly impregnated with apocrenic acid, imparting to it a brownish color (77).

Yallabusha county belongs entirely to the newer tertiary formation, but has not been closely examined. It is generally overlaid by the orange sand group, which contains, in many places, its characteristic iron sandstones, real sandstones and aluminous stones, offering fine material for building purposes. This, for instance, is the case near the town of Grenada. About 11 miles north of this town, on the road to Coffeeville (in T. 23, R. 6, E.), a white stratum of aluminous earth, fuller's earth, crops out on the north side of a hill; the layer of which is about 20 feet thick.

Where erosions and denudations have taken place, the lignite group appears frequently. This, for instance, is the case about a mile S. S. W. from Grenada, on Sec. 13, T. 22, R. 4, E.; a hill has there slid down, which shows the geological formation, and is represented in the following front view:

[No. 46.]



a represents a stratum of red ferruginous sand or loam, passing imperceptibly in a stratum of plainly stratified red ferruginous sand,

b, being about 12 feet thick both together.

c is a seam of ferruginous conglomerate, 18 inches thick.

d, a stratum of greenish red sand, 10 feet thick.

e, a seam of ferruginous conglomerate, 12 inches thick.

f, a layer of red micaceous sand, 6 feet thick.

g, a seam of laminated micaceous clay, about 6 inches thick.

h, a stratum of yellow ferruginous sand, from 16 to 18 inches thick.

The above material belongs, apparently, to the upper members of the miocene formation—the orange sand group.

i, is a stratum of laminated bluish black, very micaceous, and ferruginous sandy clay of the lignite group, extending into the base. This stratum is the real alum earth, or alum clay, characterizing the lignite formation of Northern Germany. It is dark gray, in its fracture earthy and dull, but plainly stratified. Its principal contents are clay, sand, mica, and very fine carbonaceous particles. Besides, it contains bisulphuret of iron, free sulphur and humate of iron; if, therefore, exposed to the influence of the atmosphere, sulphate of iron and sulphate of alumina are formed, which are soluble in water, and impart to it its mineral quality. The spring in front of the bluff receives its contents, therefore, not as much from the water coming from below as from such which comes down from the bluff, the clay of which has an exceedingly acid and styptic taste and smell, and gives origin to this valuable acid spring, mentioned later, and situated at *k*, between the bluff and a little creek, *l*.

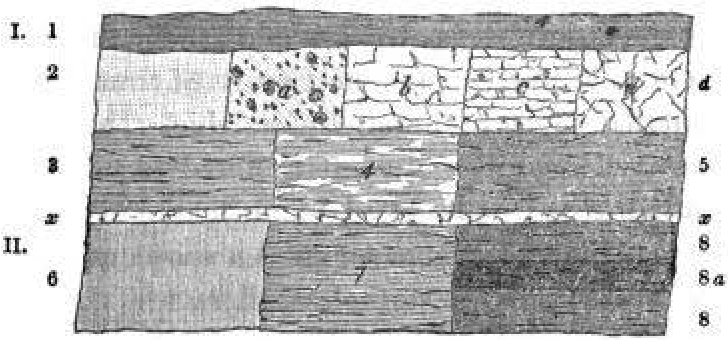
The clay of the stratum *i*, if stirred in water, renders the water immediately acid, ferruginous, and styptic; which qualities are not diminished, but rather increased when the clay is perfectly dry. The water of the spring is too strong, and hardly drinkable in an undiluted state, especially in dry weather.

It is still doubtful whether any part of Pontotoc county and how much of it belongs to the miocene formation. The eocene rocks exhibited in the geological chart, and the particular charts of Tippah and Pontotoc counties, occupy the S. W. corner of Tippah county; they extend, perhaps, through the whole western part of Pontotoc county, and, perhaps, even farther down—which must be the subject of a careful examination in future times.

THE DIFFERENT ROCKS OF THE NEWER TERTIARY FORMATION.

We have thus bestowed a rather superficial examination upon that formation which we have called newer tertiary, to distinguish it from the older eocene, to which it does most certainly not belong, and which we therefore have ventured to call the miocene formation. It is rather too early to put its different groups and strata together, because they are most probably not all known; but we will at least put those together that are known, and bring them in that stratigraphical position in which they naturally belong, as far as we are now able to judge.

[No. 47.]



I.—*Orange Sand Group.*

1 Represents the red loam overlying the orange sand, and going imperceptibly into it.

2 The orange sand, whose principal color is orange, but which varies, and shows all the different colors of front view No. 35.

2 *a* The subordinate stratum of the pebbles, often changed into pudding-stone.

2 *b* The subordinate iron sandstone.

2 *c* The subordinate sandstone, passing frequently into chert.

2 *d* The subordinate aluminous stone.

3 The white aluminous earth, or Fuller's earth.

4 Clay of different colors, principally red and white.

5 Greenish or bluish micaceous clay (Tegel).

II.—*Lignite Group.*

x x A seam of iron conglomerate.

6 Dark-colored sand.

7 Greenish or bluish micaceous clay.

8 Dark, mostly black, schistose or slaty micaceous clay.

8 *a* Its subordinate stratum of lignite.

The strata *a*, *b*, *c*, *d*, must be represented as subordinate to the orange sand only, because they occur lying in it exclusively; the three last ones, *b*, *c*, *d*, are nodules, or isolated ledges, and generally the same sand is below them as above. The stratum No. 3—the fuller's earth—occurs sometimes as a subordinate stratum in the orange sand, but mostly as a continuous stratum, and has, therefore, received the place as such; but it is still doubtful whether it belongs to the orange sand or the lignite group (78).

It is a most remarkable circumstance, that in so large and so extensive a formation no zoogene fossils whatever have hitherto been found; this is certainly most extraordinary, and, indeed, unaccountable. The formation is, doubtless, principally of marine origin; if nothing else, the stratum of pebbles would render this very certain. It cannot have been formed in a short space of time; it is probably from six hundred to eight hundred feet thick; but, according to our certain knowledge, it is several hundred feet thick—at least from three hundred to four hundred—and thoroughly stratified. Its deposition must, therefore, have required a space of time of many thousands of years; and, nevertheless, there are no traces of animal life to be found in it.

It is true, in the middle of large oceans there is very little, if any, animal life; but this formation cannot have had its origin entirely in the middle of an ocean; this is not only contradicted by the strata of lignite of so frequent occurrence in it, but, where it overlaps older formations, there at least must have been a coast; nevertheless, even there are no zoogene fossils to be found.

The only fossils found in this formation, and belonging to it, are phytogene; they consist in the upper or orange sand group:

1. In impressions of leaves of such plants and trees as are now growing on its surface, and some of which appeared first upon our globe after the miocene period. These impressions in slaty conglomerate of oxide of iron and sand are, therefore, of a later period; which is rendered more probable by the circumstances that the conglomerate containing the impressions is only found on the surface of the orange sand, and that such conglomerate is frequently found of recent formation. Besides, the orange sand group being, doubtless, a marine formation, how would it be possible that those leaves could have come to the bottom of the sea, at least in such quantities? The impressions must, therefore, have been

formed after the elevation of the sand group; and, indeed, nothing contradicts their being of very recent, even quaternary origin.

These phytogene fossils of the orange sand group consist also—

2. In petrified, generally, or rather exclusively, silicified wood, and which, as far as I have been able to ascertain, consists only in endogenous wood, some of which, of coniferous trees. This silicified wood must originate from the time of the deposition of the orange sand; it must have been drift-wood sunk to the bottom of the sea, and covered by sand, where it is now found.

3. In leaves, sticks, and acorns found deep under the surface in black or dark clay. These must have been preserved in a fresh-water deposit of later origin.

The fossils of the lignite group consist in lignite or brown coal in different states of carbonization, some of it perfectly carbonized, and conchoidal, and glossy upon the planes of the fractures; some showing the woody fibre still plainly, and dull upon its fractures.

No other fossils have hitherto been found in the lignite group; but this cannot be a proof of their non-existence, as only little attention has been paid to this formation.

It is, indeed, most probable that fossils will be found in certain localities of our lignite group, for the corresponding formations of Europe, and especially of Germany, contain a great many fossils.

In the alpine molasse formation, especially the strata of Oeningen, near the Rhine, are found 64 genera and 140 extinct species of plants; 310 extinct species of insects; 19 extinct species of fishes; and 12 extinct species of reptiles. In the lignite of Leiding and Brennberg very important fossil remains of quadrupeds were found; as, for instance, of acerotherium incisivum, hippotherium gracile, anthracotherium neostadense, and others, which characterize those lignite strata as not marine.

The fossil remains in the lignite strata of our own State can, nevertheless, not be as numerous as in those of Europe, otherwise some fossils would have already been found in them.

DETERMINATION OF THE NEWER TERTIARY FORMATION.

The determination of any geological formation, in the absence of all zoogene fossils, is exceedingly difficult; for these are especially the "medals of creation," and supply the date of a work whose Author is well known, and whose style is the same in all ages.

It is a fact we have found phytogene fossils to assist us—not the impressions of leaves in slaty iron conglomerate—not the leaves, sticks, and acorns found in black fetid clay; they, as we have shown, must and cannot be but of later date,—but only the silicified wood of the orange sand group, and the lignite of the lignite group:—these are also "medals of creation," but their inscription is in hieroglyphics which have not yet found their Champollion. Nothing remains, therefore, but the lithological character of the formation and analogy. These have led the author to the opinion that this newer tertiary formation is of the miocene age, and he has to give his reasons for it.

The principal reason why this formation was separated from the eocene, or older tertiary, and called newer tertiary, is the apparently entire absence of zoogene fossils, and especially of fossil marine shells, which is by no means the case in the eocene rocks; wherever they occur they abound in zoogene fossils of all kinds, principally in marine shells, and this is especially the case in this State.

A scarcity of fossils characterizes the miocene rocks everywhere, especially in Germany, where it is best developed and most carefully examined; marine shells occur there only in very few places, which seems to indicate peculiar circumstances under which those rocks have been formed. We think we can account for the absence of marine shells and zoogene fossils, in general, in the orange sand group in Mississippi, and refer, in this respect, to our discussion on the remarkable pebble stratum; but we can find no reasons why such fossils should not occur in the lignite group.

The miocene rocks, as already stated, are best developed in Germany: in its western part, near Maintz, on the Rhine; in its S. E. part around Vienna, in Austria; and in its N. part in Prussia, Silesia, Bohemia, Thuringia, and along the northern part of the Rhine.

It will be necessary to sketch briefly its characteristics, for a comparison.

The famous Vienna basin contains, as its upper stratum, sand of various colors, including shingle or pebbles; in some places, also, lignite. The pebbles are generally of a yellow color, derived from the sand in which they are imbedded.

The second stratum consists of greenish or bluish clay, generally micaceous, called Tegel. Below it lies frequently a kind of brackish clay. It contains also very extensive deposits of rock-salt, as, for instance, near Wieliczka and the Carpathian mountains—the most extensive deposits in the world, whose miocene origin was for a long time doubtful, but has been established by Murchison, and confirmed by the high authority of Dr. Bronn.

The Maintz basin contains, as its upper stratum, also, klastic rocks, *i. e.* such derived from older rocks, as ferruginous sand, and clays; below these lie the extensive strata of lignite of Wetterau, Vogelsberg, and Habichtswald; this is frequently underlaid by a dark micaceous clay, by sand and sandstone, and another stratum of the lower lignite.

The miocene of N. Germany contains mostly all the lignite found in that country. Its upper stratum consists of sand and clay, and very extensive beds of quartz shingle, mixed with mica-scales. The sand strata show a discordant parallel structure; their stratification is most perceptible where sand and clay alternate. Where the sands or clays are uniform, and of the same grain, the stratification is frequently not perceptible. The sandstone and the quartzit, or chert or hornstone, appear frequently as subordinate masses, sticking in the sand, the latter having been locally cemented by silicious, aluminous, or ferruginous solutions. Impressions of plants are not unfrequently found in it.

Such is the miocene formation in Germany (79). Let us now compare its features, for a moment, with those of our newer tertiary.

The miocene formation is the great depot of the lignite or brown coal; but little of it is found, in Europe, in the eocene formation of the Paris basin, only, as far as I know, and none in later formations.

As now our newer tertiary formation is full of lignite, and deposits of it found from the very line of Tennessee, to the line of the eocene rocks, this might perhaps be a sufficient reason for recognizing in it, at once, the miocene formation, were it not that our eocene formation farther southwards contains more extensive deposits of lignite, than ever have been found before in contemporary rocks. The extensive lignite strata would, therefore, not form *here*, in Mississippi, a tenable reason against its determination as a continuation of the eocene rocks, which would indeed be the case anywhere else.

But, besides this, there are a great many other corresponding features. Our newer tertiary formation consists in its upper member of merely klastic rocks, or fragments and detritus of older rocks, as sands, clays, pebbles, or shingle; which derive frequently a yellow color from the yellow sand, loam or clay, in which they are imbedded. In this respect it agrees with all the miocene formations of Germany. Its second stratum, which could perhaps have been separated from the orange sand group, consists of different alternating strata of clay, corresponding with the Tegel of the Vienna basin.

In Hartford, in Calhoun county, our newer tertiary gives origin to a salty spring, which may perhaps lead to the discovery of a briny spring, or even to a deposit of rock-salt; and in this respect it has at least some similarity with the miocene of Wieliczka (Weelitshka) and the Carpathian mountains.

With the miocene of N. Germany, our newer tertiary formation agrees, furthermore:

1. In its secondary ledges or nodules of aluminous stone, sandstone, quartzit or chert, and iron conglomerate.

2. In its aluminous earth, or alum-clay, found near Grenada, in Yallabusha county, and whose presence is also indicated by a similar acid spring near Emory, in Holmes county.

3. In the admixture of mica in nearly all its layers.

4. In the discordant parallel structure in some of the sand strata (compare front view No. 35, and diagram No. 41).

5. In the facts that the stratification is plainest where clay and sand alternate in different parallel layers (compare diag. 39), and that it is frequently very little, or not at all perceptible where the sand or clay is fine, of the same grain, and perfectly homogeneous.

Finding so many corresponding features, and such a striking similarity in the lithological character, the author thought to be justified in determining the newer tertiary of the State of Mississippi as a *Miocene formation*, and excusable, if continued and close examination should give a different result.

THE STRATUM OF PEBBLES, OR SHINGLE, IN THE STATE OF MISSISSIPPI.

The deposit of klastic material, which we have called pebbles, or shingle, plays a most important part in the State of Mississippi. and, as it has hitherto been mistaken for a relic of the diluvial or glacial period of our globe, with which it has, *indeed, no similarity at all;* and as such objection could again be raised against this report, in which it is represented as a stratum subordinate to the orange sand group, and, consequently, as coeval with it, and by far anterior to the glacial period,—it is necessary to show the utter fallacy of the above opinion, and the impossibility of its having any connection whatever with that pleistocene glacial period (80).

The pebble stratum of our State contains pebbles of very different sizes, from that of a small pea to that of a large goose egg, weighing a pound and more; some have even been found occasionally of a much larger size, of which particular mention will be made. The pebbles consist mostly of the krypto-crystalline varieties of quartz, or of the *chalcedonic* and *jaspery* varieties (according to Dana). The chalcedonic varieties are: chalcedony, cornelian, agate, and now and then a small sard. Agate it contains in large quantity, and generally of a very singular cavernous and contorted shape, indicating a stalagmitic porodine origin. Most of the agate is of the species called fortification-agate, from its striking angular lines. Other chalcedonic varieties are small fragments of onyx, sardonyx, and a large quantity of hornstone, or chert. Jaspery varieties of crypto-crystalline rocks are: jasper, in many places in large quantities and a different color; basanite, or lydian stone.

A part of the pebbles consists frequently, also, of phanero-crystalline, or vitreous quartz, as cairngorm, milky and ferruginous quartz; the latter are frequently, and in peculiar places, found in large quantities; in many places they are mixed with an alumino-silicious stone, halloylite, all of which appears to proceed from the metamorphic formation.

The different kinds of pebbles are not in the same state of attrition. The chalcedony, cornelian, or carneol, milky and ferruginous quartz, and basanite occur most generally much worn, perfectly rounded, and without any edges. The jasper, hornstone, and halloylite appear less water-worn, and bluntly angular. The agate is apparently much worn, but nevertheless mostly bluntly angular, on account of its peculiar contorted shape.

Many, especially of the chalcedonic varieties of pebbles, contain impressions of crinoidal stems, and pieces of such stems principally of rhodocrinus are found among them; others contain impressions of shells: of leptaena, orthis, spirifer, and terebratula; not unfrequently, also, fragments of agatized corals of the genera columnaria, favosites and chaetaetes, are found among them. Often, also, smaller and larger pieces of silicified endogenous wood are found among the pebbles, most of which are fragments of silicified calamites.

These fossils and impressions characterize that part of the pebbles certainly, as of palaeozoic origin; according to my observation they must be of devonian, some, also, of carboniferous origin. Other fossils are said to be found among them; as, for instance, trilobites (asaphus and calimene), which would prove a silurian origin. I have never found them, but it is probable that the pebbles derive their origin from the several palaeozoic formations, not from one alone, as their different material and state of attrition seem to indicate their origin from different periods and localities.

This shingle does not occur everywhere assorted in the same manner. In some localities it contains a large quantity of basanite, as, for instance, along the southern banks of the Mississippi river, and on some of its islands, from Natchez to the line of Louisiana; in other places it consists nearly exclusively of agate and jasper, as in T. 3, R. 8, in Pike county, on the New-Orleans, Jackson & Great Northern railroad (comp. diagram No. 22, page 134); in other localities it consists mostly of red jasper, in flat and bluntly angular pieces, intermixed with many and large flat pieces of silicified calamites, some of which are a foot-long and half as wide, as near Satartia, in Yazoo county, on Sec. 12, T. 9, R. 4, W., (comp. diagram No. 31, page 150). In many places the fossils and impressions of shells and corals are scarce, and in others entirely missing, as in R. 7, T. 8, in Panola county (comp. diagram No. 38, page 194). In some places the shingle is only mixed with fossils of silicified endogenous wood, especially fragments of calamites, and contain no vestiges of phytogene fossils. In some places the pebbles consist mostly of ferruginous quartz, as in Yazoo county, at the bottom of some of the high hills. (Comp. pages 205 and 206).

Sometimes a large part of the pebbles, especially those which are of softer material, take the color of the stratum in which they are imbedded; such is the case in the last mentioned place, in Yazoo county, near Belmont, in Panola county (comp. page 194), and in many other places. It is nearly always the case with the alumino-silicious pebbles.

Other changes appear in different places, which, nevertheless, do not appear to affect either the nature or continuity of this remarkable stratum.

Silicified wood, of the pebble stratum, seems to be most abundant in Clayborne, Copiah, and Hinds counties, of the S. W. part of the State of Mississippi.

The stratum of pebbles, or shingle, is found all over the State of Mississippi, wherever the orange sand overlies the geological formation; *nowhere without this.* It is best developed westwards of the 89° 30′ of longitude of Greenwich; eastwards of this line it is, as a general rule, of rare occurrence; and wherever it occurs, the pebbles are not in large quantity, and small in size. The chalcedonic variety of quartz is mostly wanting, or scarce, and the traces of organic life always. The two extremes of the State seem to make an exception.

In the extreme south, below the 32° of N. latitude, the shingle stratum seems to be continuous to the Chickasawhay and Pascagoula rivers. It occurs in Sec. 10, T. 7, R. 7, in Wayne county, and likewise in T. 2, R. 8, in Jackson county, and continues through Perry and Marion counties, but contains, to Pearl river, very few chalcedonic pebbles, and no traces of organic life, and the pebbles are mostly very small.

Westwards of Holmesville, in Perry county, near the 90° of Greenwich longitude, the stratum occurs in fine development, with few crinoidal impressions and stems of crinoidea; but eight miles W. of Holmesville it appears as an important stratum, consisting nearly entirely of chalcedonic and jaspery quartz, as has been mentioned above.

In Tippah and Tishamingo counties, also, the pebbles appear in a somewhat increased quantity. Strata of pèbbles are found in Sec. 33, T. 5, R. 1, E.; in Sec. 26, T. 1, R. 4, E.; in Sec. 19, T. 2, R. 5, E.; but they consist partly of white schistose quartzit, some jasper and aluminous sandstone, and are most probably of different origin. Pebbles of the character of the western pebble stratum are very scarce here; some are, nevertheless, found—in Sec. 34, T. 5, R. 10, E.; in Secs. 17 and 20, T. 5, R. 11, E.—in Tishamingo county, which appear to be the real orange sand pebbles; but the orange sand group contains, here, subordinate strata of so peculiar a nature—as, for, instance, the famous kaolin stratum, the silica, and the deposit of terra sigillata—that it is extremely doubtful whether these pebbles, although of the same petrographic character as the western pebbles, are of the same origin; besides, they are without a trace of organic life.

Pebbles are also found on Sec. 13, T. 2, R. 9, E.; but they differ entirely from the western orange sand pebbles, and contain, besides, principally *angular* fragments of hornstone.

Other pebbles are found in Sec. 34, T. 3, R. 10, E.; but they are flint pebbles, imbedded in white clay, and conglomerated with it; they are, therefore, decidedly of quite different origin.

From the 89° 30′ westwards, the pebble stratum increases in every respect—in thickness, in quantity of the pebbles, in continuity, and in size of the pebbles—until it becomes altogether best developed along the bluff of Coldwater and Yazoo rivers, from Horn lake to Vicksburg. There is no trace of it in the alluvial bottoms of the above and of the Mississippi rivers; and from Vicksburg to the line of Louisiana it is overlaid by the loess or bluff formation; but appears in fine development, not only on some islands in the Mississippi river—as on Diamond island, below Vicksburg, and on Natchez island; but also on the immediate bluff of the Mississippi river—as, near Natchez, on Rodney bluff, and others—and behind the loess or bluff formation, in Hinds, Clayborne, Copiah, Jefferson, Franklin, Wilkinson, and other counties.

The deposit of pebbles is the heaviest and best developed along the bluff of the Coldwater, Tallahatchie, and Yazoo river bottoms, where the shingle appears continuous, or very nearly so, and overlies a great many of the hills immediately bordering on the alluvium, as has been stated above in the proper places, and it continues thus all along the Mississippi river, from Vicksburg to the line of Louisiana.

The line where the pebble stratum is found best developed, and where it occurs regularly, is marked out on the geological map. Below the 32° of N. latitude this stratum increases in breadth, and extends still a little lower downwards, beyond the Chickasawhay and Pascagoula rivers.

The thickness of the pebble stratum varies also very much, and decreases from the Mississippi river, and the bluff along the alluvium, eastwards. It is nowhere of considerable thickness, eastwards of the line of its regular appearance; even southwards of the Chickasawhay river it is only of unimportant thickness, as diagram No. 23 shows.

In its proper territory, westward of the line marked out in the geological chart, the pebble stratum appears most frequently in many layers interstratified with the orange sand. Thus, for instance, it appears in Pike county, in T. 3, R. 8 (comp. diagram, No. 22). The pebble stratum appears here about 10 feet thick above ground, and is perhaps much thicker—three distinct strata of it are perceptible.

In Yazoo county, Sect. 12, T. 9, R. 4, W., the pebble stratum appears in two distinct layers, remote from each other. Near Belmont, in Panola county, in R. 7, T. 8, the stratum of pebbles appears fully 40 feet above the base of a gully; it contains the pebbles from the top to the bottom interstratified with the orange sand in many different layers, distinct from each other. (Comp. diag. 38, page 194).

On Sect. 8, T. 27, R. 8, in Panola county, the yellow sand containing the pebbles appears about 30 feet thick, enclosing the shingles in several distinct layers, also interstratified with the sand. Below this stratum lies a stratum of iron ore about 40 feet thick; also with this the pebbles are interstratified, and appear as pudding-stone, in different layers. The pebble stratum is, therefore, here, fully 70 feet thick. (Comp. diagram No. 40, page 197).

The hills along the alluvium of the Coldwater river, are from 70 to 100 feet high; many of them are capped with the pebbles, which extend in many layers downwards to the bottom. (Comp. page 200).

In Yazoo county, the hills along the Yazoo alluvium are from 100 to 200 feet high; they are overlaid with the recent yellow loam; under this is the orange sand, with the shingle, which continue in different layers to the base of the hills. (Comp. page 205, and diagram 42.) The stratum of pebbles must therefore be pronounced to be in the state of its highest development to 200 feet thick, and frequently they have been only met with at a depth of from 80 to 130 feet below the surface. Such, for instance, is the case near Taitsville, in De Soto county (see page 194); near Sledgeville, in Panola county, (see page 195); on Sect. 30, R. 7, T. 9, in Panola county, and in different other places.

In many places these pebbles lie on the surface of the orange sand, it is true, but in others they are overlaid by iron sand-stone, as, for instance, on Sec. 19, T. 2, R. 5, E.; on Sec. 5, T. 6, R. 10, E., in Tippah county, and in many other places. In some instances they are formed to pudding-stone, by the same iron sandstone as has already been mentioned, and this is found 60 feet below the surface, on Sec. 8, T. 27, R. 8, in Panola county.

But the pebbles are not only found under the iron conglomerate; in several places they are also met with underlying the aluminous and cherty sandstone, as, for instance, in Panola county, Sec. 26, T. 27, R. 8 (see page 195), and Sec. 28, T. 8, R. 7, and in other places.

In Yazoo county, on Sec. 27, T. 9, R. 4, W., the pebble stratum is even overlaid by a considerable stratum of lignite, or brown coal, (see page 168); and in Warren county, S. 1, T. 18, R. 5, E., by a high hill of a most singular tufacious limestone of stalagmitic appearance. (See page 163).

A mature consideration of these circumstances cannot but lead us to the conclusion, that the stratum of those pebbles must belong to the orange-sand, and be a subordinate member of it:

1. Because it is never found without the orange sand group.

2. Because it extends as far downwards, and is of the same thickness as the orange sand.

3. Because it is perfectly interstratified with it.

4. Because even other subordinate members of the orange sand group, as, for instance, the iron conglomerate, the aluminous, the sandstone, and the cherty stone, are found overlying it.

Having now seen that the orange sand group is a miocene formation, the pebble stratum must also be of the miocene age, and this is besides confirmed :

1. By a stratum of lignite overlying the pebble deposit, in Yazoo county. According to my knowledge, real lignite occurs nowhere of a

more recent period than the miocene, and consequently a stratum overlaid by such lignite must belong, at least, to an earlier part of that period, and cannot be of later origin.

2. By ledges of hard aluminous and sandstone, and even hornstone, overlying the stratum of pebbles, the formation and induration of which cannot be the result of a short time.

If the shingle or pebble stratum belong now to the orange sand of the miocene period and is itself of miocene origin, this is sufficient why it cannot belong to the glacial or drift period, which occurred after the pliocene period, and closes, according to our acceptation, as a pleistocene period, the tertiary age, or reign of mammals (as represented in Table I).

But there are other reasons why it is, if not impossible, at least in the highest degree improbable, that the pebble stratum could have originated from the glacial period as a diluvial formation:

1. The diluvial formations contain fossil remains of such animals and plants, most of which are now still in existence; such never have been found among the pebble stratum.

2. The singular and remarkable shingle stratum, occurs in our State only regularly west of a certain belt marked out on the accompanying geological map, and east of this belt only irregularly, decreased in quantity and size; this could not be the case with a deposit deriving its origin from a general cause. It is beyond all question that this pebble stratum should have derived its origin from transportation by icebergs; the material transported and deposited by such icebergs lies always, more or less, in heaps, and is much varied with respect to size; very small detritus lies always together with considerable blocks, whereas our stratum contains pebbles varying, comparatively, very little only in size. In different localities lie here pebbles of different sizes; smaller pebbles eastwards, and larger pebbles westwards—this can only be attributed to currents of different velocity, which are capable of carrying pebbles of a certain weight, and not heavier.

3. The thickness of the pebble stratum. We have seen this stratum is in some instances 200 feet thick, a vertical extent which the diluvial strata attain very seldom only, where they are best developed, which is on this continent, not lower than the 48° of N. lat. Boulders have never yet been found lower than 41° of N. lat.: below a line through the middle of Pennsylvania, Ohio, In-

diana and Illinois. Even as high up as Canada, along the St. Lawrence river, between Montreal and Quebec, the deposits of till of the diluvial period, are seldom thicker than, at most, 100 feet.

4. The perfect stratification of the pebble stratum, and the orange sand containing them. Drift deposits are characterized by *never* being regularly and distinctly stratified.

5. The different direction from which the pebble stratum must have come, and which will be considered later.

There is, indeed, no similarity whatever between the diluvial deposits and our pebble stratum, if it is not:

1. That both contain pebbles; but several other formations of our globe contain pebbles, which no body would on that account deem to be identical or coeval.

2. That among the pebbles in some places, blocks of stones are found, of which it is difficult to believe that they have been carried hither in any other way than by transportation upon, or in an ice-berg.

Such a block of stone was found among the pebbles, about a mile south of Satartia, in Yazoo county (see diagram 44, page 208). It is 20 inches long, 16 wide, 12 thick, and must, therefore, weigh several hundred pounds. It consists of pure yellow vitreous quartz; is bluntly angular, not like the other quartz pebbles.

Others of the same material were found not more than a few miles from the above place, in T. 9, R. 4, W. They are, also, rather angular, and one of them must weigh more than 100 pounds.

Another, a rounded white sandstone of considerable size, was found only a short distance from the sandstone stratum near Rocky Fort, in Pontotoc county. Its origin is easily explained: it was even not found among the pebbles of our stratum; and has, therefore, no connection with it.

Others are said to have been found; as for instance, seven miles north of Vicksburg, under Walnut Hills, a block of ferruginous quartz of ovate form, measuring three feet in length, and more than two in diameter; it is conjectured to have weighed about 500 pounds.

Nothing on the blocks of stone found by the author betrayed their diluvial origin; they were neither grooved nor scratched, nor had they very sharp angles; they were only obtusely angular, as so many of the smaller pebbles of the stratum, and all of them came from strata from 10 to 15 feet deep under the surface.

We know nothing of the block found near Vicksburg, but that it appears to be of the same material as the above-mentioned blocks. It was found very near the confluence of the Mississippi and Yazoo rivers, which could possibly account for its appearance where it was found; it may have been transported on board of a boat. But let us admit the blocks of quartz came to those places by natural means of transportation.

It is a fact that the easiest way of accounting for their appearance where they were found would be to call them boulders or erratic blocks, and admit their having been transported from regions unknown by icebergs. But would this be consistent with other circumstances? We think not. Boulders are generally not found on this continent below the 41° of N. lat.; they have never been found below the 40° of N. lat., and the above-mentioned ones were found nearly in the middle between the 32d and 33d degree of N. lat. They were, furthermore, found among material which is decidedly not diluvial; for, indeed, nobody, at least no geologist, will conceive the idea of calling a stratum of sand 200 feet thick, distinctly stratified and regularly interstratified with pebbles, diluvial or erratic!

These quartz blocks can, therefore, not be boulders; and we must try to account for their transportation in another way, at least more probable than that they are erratics dropped where they are found, by an iceberg strayed about 600 miles farther southwards than any other one, without any other signs of their adventurous voyage, and without having met with a fate similar to that of Icarus before they reached the spot of their deposition.

The manner of deposition of the pebbles, and their interstratification with the orange sand, seem to indicate that both originate from a long-continued marine current, which carried alternately sand, pebbles, aluminous matter, &c., now found interstratified with each other in different places.

According to the deposition of the pebbles and the orange sand, they must have been transported from N. W. to S. E.; the current must, consequently, have run in the same direction.

If we admit that this current lost in force and rapidity W. of the 90th degree of longitude, and extended in a more easterly direction under the 32d degree of N. latitude, this would explain why the pebble stratum is the heaviest near the Mississippi river, and along the bluff of its alluvial plain; why it occurs more seldom beyond that degree; why the size of the pebbles decreases there, and why that stratum extends beyond the 32d degree of N. lat., in a more easterly direction, nearly to or beyond the boundary line of Alabama.

The assortment of the pebbles in different localities can be explained by the different rapidity of the current in its different parts.

The difference in the material of the pebbles, and their different state of attrition, can easily be explained by their having been carried away from different formations and different localities.

The stream which carried the orange sand group with the pebble stratum to the locality where they are now found, may have been a marine current like that of the present Gulf Stream, which must have existed during many thousand years; otherwise the deposits accumulated by it could not be of the thickness of several hundred feet, as they really are.

That such a marine current should have the power of moving heavy masses from one place to another, will not astonish us, if we remember what an immense power a current of air has. Hurricanes throw houses down, prostrate whole forests, and carry heavy bodies for miles from one place to another. The water, a body of about 800 times more specific gravity than the air, must possess that power in a much higher degree.

Buat, a learned French philosopher and naturalist, has made an ingenious observation on the subject of the decrease of the specific gravity of bodies in water, and of the transporting power of this fluid, and he has found that water has the power of transporting—

At a velocity of		3	inches in one second,		fine sand.
"	"	6	"	"	common sand.
"	"	8	"	"	coarse sand.
"	"	10	"	"	gravel.
"	"	24	"	"	fine shingle.
"	"	36	"	"	coarse shingle.

A current running thirty-six inches in a second, which is capable of transporting coarse shingle, runs only at the rate of about three miles (more accurately, three miles less four feet) in an hour; it has, therefore, scarcely the velocity of the tidal wave in the ocean, which runs fully at the rate of three miles an hour, and not nearly the velocity of the Gulf Stream, which runs, in some places, nearly five miles an hour.

The shingle of our pebble stratum can now, in very few places, only be called coarse shingle; if this, then, can be moved and transported by a current running at the rate of three miles an hour, how large stones can then be moved by a stream running five miles in an hour? If we now suppose that the stream which transported the pebble stratum upon our territory may have run, under very favorable circumstances, but perhaps, in rare instances, favored by storms coming from the same direction, and spring tides, at the rate of seven or eight miles an hour, we find at once the possibility that blocks of quartz, of several hundred pounds, may have been transported, comparatively, perhaps, only a short distance from neighboring mountains, without resorting to a supposition much more improbable than this.

This supposition gains, evidently, strength from the circumstance that all the large blocks of stones found among the pebbles were of the same material of vitreous ferruginous quartz, and that those seen by the author were not exactly rounded, but decidedly obtusely or bluntly angular, worn somewhat in water, and showed not the slightest traces of being boulders transported by icebergs.

It gains, furthermore, strength from the fact that the largest boulders found in the State of Missouri are only five or six feet in diameter, and that all of them consist of granite and metamorphic sandstone—none, of the material of the quartz blocks found in Mississippi. The drift is, besides, quite of different nature in Missouri, and is even there only found as far down as the Osage and Meramec rivers. How should it happen that we should find it here, many hundreds of miles farther south, in a stratum of about two hundred feet in thickness? (81)

Northern drift *cannot exist* below the 35° of N. latitude at least; drifted material may be found, but its origin must be quite a different one. The rocks here in Mississippi, mistaken for northern boulders, are most probably carried down by the marine current, whose existence during the miocene period we believe to have been sufficiently proved, from the nearest mountains in Arkansas, to which the direction of that current points, and which, as we know, abound in vitreous quartz of all descriptions.

The supposition that a marine current or stream, like the Gulf

Stream, must be the cause of the appearance of the orange sand group with the pebble stratum, and that this stream must have had a velocity of at least, and sometimes much more than, three miles in an hour, accounts, also, for the total absence of zoogene fossils in that stratum.

In strong currents there is very little animal life; and the animal remains accidentally come into it, or originating from the few animals which, perhaps, may have existed in it, have, doubtless, been carried away entirely out of the bed of the stream, as all of them are of a much inferior specific gravity than the pebbles and stones.

The bed of the Gulf Stream must, after thousands, or perhaps millions of years, when elevated above the level of the ocean, afford a similar appearance; but it will easily be identified and determined by sunken artificial remains of a sufficient specific gravity not to be carried away, and originating from a wonderful being, probably not yet in existence during the miocene period, whose realm extends over oceans as well as continents.

ROCKS OVERLYING THE MIOCENE FORMATION.

THE oldest of the strata or rocks overlying the miocene appear to be, decidedly :

1.—THE LOESS, OR BLUFF FORMATION.

It is only found along the bluff of the alluvial bottoms of the Coldwater, Tallahatchie, and Yazoo rivers, from Horn lake to the mouth of the Yazoo river; from there it forms a continuous and considerable formation, which we will discuss as a proper postpliocene formation, and show its quaternary origin, posterior to the diluvial or glacial period, with which it can hardly be in any connection.

2.—THE FRESH-WATER DEPOSITS IN THE ORANGE SAND.

The existence of such basin-shaped fresh-water deposits in the orange sand group are rendered doubtless :

By the deposit found in Sec. 36, T. 1, R. 3, E., on Big Hill, on the Charleston & Memphis railroad, in Tippah county (see diagram No. 36, page 191), and by the oak leaves, sticks and acorns found likewise in this formation, and mentioned on pages 191 and 192.

These fresh-water deposits may be pleiocene, pleistocene, or postpleiocene, and the different deposits even from different ages; sufficient attention has not yet been paid to them. From the appearance of large quantities of oak leaves, of acorns and sticks, we are inclined to take them for a postpleiocene formation; but this can only be considered as a mere superficial supposition, which we would, by no means, have understood as a decided opinion.

3.—THE LOAM OF DIFFERENT COLORS.

The miocene rocks are frequently, or rather most generally, overlaid by a stratum consisting of a mixture of clay and sand, which we have called loam. It is not always of the same quality, and differs generally according to the different material that surrounds it in different localities. It is never abruptly separated from the underlying stratum ; it extends imperceptibly into it, in such a manner that it is impossible to draw a distinct line of separation.

In those counties of the State of Mississippi, along the alluvium of the Mississippi river, that overlying stratum consists, as we have remarked in many places, of a yellow loam which extends imperceptibly into the underlying stratum, be this sand, clay, or even the loess. It participates there, evidently, of the loess or bluff formation, heaped up along the bluffs of the alluvial plain ; and frequently one of the loess fossils or concretions of carbonate of lime, such as characterize the loess, are found in it.

In the range of counties east of the above designated counties, in Marshall, Lafayette, Yallabusha, Calhoun, Chocktaw, and even several of the eocene counties near the line of the miocene, that upper stratum often met with, consists of a red loam, and extends also imperceptibly into the orange sand, of which it participates much, and from which it derives also its color.

In Tippah, Tishamingo, the upper part of Pontotoc and Itawamba counties, that upper stratum consists again of a yellowish loam, participating, in many places, of the alluvial deposit of the rivers and creeks.

This upper stratum has, in some few places, the appearance of an overlying diluvial formation, and has been most generally mistaken for drift or altered drift, which, nevertheless, it cannot be.

Diluvial deposits have come from a distance, and are the detritus of rocks entirely different from those which they overlie. They do not participate much either of the color or of the ingredients of the surrounding rocks, and are most generally distinct in every respect, and the line of separation from the underlying strata, is very plain and distinct. They consist most generally in a sandy material, mixed with gravel and pebbles ; and in higher latitudes they contain erratic blocks, which increase in frequency of occurrence and magnitude the farther we advance northwards.

Those boulders appear first about under the 40° of N. Lat. : here, on the Continent of America, more than 10° farther southwards than on the Continent of Europe, and much more than that on the Continent of Asia ; they are thus a certain proof that since the beginning of the quaternary age of our globe, at least, this Continent has been much colder, in corresponding latitudes, than that of the Old World.

The first boulders, or erratic blocks, are found on this continent in the latitude of the lower part of New-York, on Long-Island, Staten-Island, in the corresponding part of New-Jersey, the middle part of Pennsylvania, Ohio, Indiana, Illinois, and the northern part of Missouri, between the 40th and 41st degree of north latitude.

The boulders are there rather of a small size, and scarce; but I believe they increase not only north, but also eastward, in number and size. There are some considerable boulders on Staten, Long, and Manhattan Islands, such as I have never perceived farther W. in the same latitudes.

The deposits of the drift, and altered drift, or the diluvial deposits, consisting of sand, gravel, and pebbles, and sometimes of loam and clay, are there also common; but, according to my observation, only met with in certain places, not in continuous layers.

In Connecticut, Massachusetts, New-Hampshire, Vermont, Michigan, and the northern part of Illinois, the thickness and frequency of the diluvial deposits, as well as the boulders, or erratic blocks, and their number, appear much increased, and in Canada East these boulders appear in such quantity, and of such large size, that in many places their removal is necessary in order to make the lands arable. The diluvial deposits, or the till stratum, is found of a thickness of from 10 to more than 100 feet, but even there the latter is, according to my own observation, by no means continuous; it appears only in certain places, nowhere in such a manner as the red and yellow loam in the State of Mississippi exists, spread over many hundreds, nay thousands, of acres, in an uninterrupted succession.

In Lower Canada, from the line of Vermont to the St. Lawrence river, where I have examined the diluvial deposits, in order to find out their similarity or dissimilarity with the red and yellow loam of Mississippi, they bear no resemblance whatever to the latter. Not only the material is entirely different, but also the manner of distribution.

The material is there a mixed one; a part derived from the immediate vicinity, and other parts from different distances. All, or nearly all, those diluvial deposits are more or less mixed with water-worn pebbles, which are, in Mississippi, nowhere found as belonging to the red and yellow loam. But the greatest difference exists in the distribution. The diluvial deposits in Lower Canada are found of a thickness of from one or two feet to a hundred feet, and in many places it is not found at all; in such places the soil is entirely derived from the underlying older rocks, in a large part from schistose, hornblendic and talckose slate; from serpentine, granitic rocks, silicious and hornblendic limestone and others (82).

The thickness of the red and yellow loam, which must be well distinguished from the stratified orange sand groups and from the red sandy strata of the glauconitic group of the cretaceous formation, is of a more uniform thickness—no where exceeding 15 or 16 feet.

A continuous and uniform diluvial deposit, such as the yellow and red loam of Mississippi, I have found nowhere overlying the ground in the drift zone, nor have I found a trace of such a uniform stratum of pebbles like that found in Mississippi, and also a part of South Alabama.

The stratum of loam overlying the miocene rocks has, therefore, no resemblance whatever to any diluvial deposit, and is most certainly not of diluvial origin; it is too uniform in its lithological character, contains nowhere pebbles belonging to it, and nowhere a trace of fossils, nor does it contain particles of foreign origin; it is altogether derived from strata in the immediate neighborhood. It is different only in different localities, and goes invariably imperceptibly over in the underlying stratum, with which it is entirely blended in the line of contact.

The loam participates, in many places, even of the ingredients of the postpleiocene loess or bluff formation, and overlies it in many localities, as we have seen, which excludes, of course, the possibility of its being a diluvial deposit, if the loess be of postpleiocene origin, which seems to be beyond all question.

I have much reflected upon the origin of this stratum of loam, which is red in some localities and yellow in others, and bestowed a close and minute investigation upon it; and, separating this stratum well from the miocene orange sand group, and in other localities from a stratum of red sand found in the cretaceous formation, belonging to the green sand group of that formation, I hesitate not to assert:

That this red and yellow loam is nothing else but a stratum of quaternary origin, still in the process of formation, and formed and forming, in the locality where it is found, by atmospheric influence, by the detritus from the underlying and neighboring rocks, swept there, in the form of dust, by the wind, washed there by the water of *the atmospheric precipitations, and mixed,* in situ, *with decayed and disintegrated organic matter—an atmospheric formation, as it were* (83).

If we consider it as such, its participation of the underlying and neighboring strata, its insensible transition into the older rocks below it, its different quality in different localities, its destitution of all vestiges of fossils, especially palaeozoic fossils, its voidness of all pebbles, and its quality of a finely divided substance—are but natural consequences.

4.—THE FLUVIATILE ALLUVIUM.

In many places the rivers and creeks have formed large and considerable deposits of that quaternary formation called alluvium, or silt. Such deposits are often of considerable extent, as, for instance, along Coldwater, Tallahatchie, Yokeney-Patapha, Yallabusha, Big Black, Pearl, Noxubee, Wolf, Tombigbee, Amite, Leaf, Pascagoula, and other rivers and creeks.

The alluvial silt of those rivers consists of the detritus of the different formations found along the banks of those rivers and creeks, mixed with a great deal of organic, especially vegetable, matter.

The soil formed by such silt is the more fertile the farther the rivers and creeks run in a formation containing fertilizing matter. The largest alluvial plain is found along the Mississippi river, the Father of Waters; it will form an object of our particular consideration.

THE DILUVIAL DEPOSITS, OR DRIFT, IN MISSISSIPPI.

Having now examined all the different geological formations older than the drift or diluvium, a formation of a period immediately antecedent to our present quaternary age, and which, ac cording to our opinion, must be considered as a period preparatory to the human age, or reign of man, and, consequently, as the closing period of the tertiary age—as a pleistocene period—it is here the place to discuss what traces that period has left in our state.

The orange sand group, overlying all the older formations, can, as we have sufficiently demonstrated, not be a diluvial formation. The pebble stratum, so intimately connected and interstratified with the orange sand, can, consequently, certainly not be a diluvial deposit, if the orange sand group be none.

Boulders, or erratic blocks of the diluvial period, which have never been found even here on this continent below the 40th degree of N. lat., cannot be, as an exception to a general rule, in the State of Mississippi, and are not there; the few large blocks weighing from a hundred to several hundred pounds, although of foreign origin, are certainly not of diluvial importation, as it has been sufficiently shown.

The loess, or bluff formation, only found along the Mississippi river, and in small quantity also on other rivers, must be a fluviatile formation, and cannot be a diluvial one; it has, besides, its origin decidedly in times posterior to the diluvial period, as we shall show and prove later.

The different loams of yellow and red color which overlie the miocene rocks, and even the postpleiocene loess, cannot be a diluvial deposit, as we believe to have sufficiently proven.

Other formations are not found in the State of Mississippi which could possibly be mistaken by the most inexperienced for northern drift, as the above formations have frequently been.

With the utmost confidence we can then proclaim, *that the drift, or glacial period, with its miraculous floods, floating icebergs,*

and glaciers, has left no trace whatever in the State of Mississippi.

The present State Geologist, Professor G. C. Swallow, of Missouri, has already pronounced that the traces of the northern drift are limited to the northern part of Missouri, and we are confident that the geological surveys of Kentucky and Tennessee will most probably, and of the Carolinas, Georgia, Alabama, Florida, Arkansas, Louisiana, and Texas, most certainly, give the same result.

THE MIOCENE FORMATION CONSIDERED IN A NATIONAL ECONOMICAL, AND AGRICULTURAL POINT OF VIEW.

1.—NATIONAL ECONOMY.

In this respect the miocene formation offers neither many, nor very important resources; it remains behind all the older formations.

1. The *extensive stratum of pebbles* deserves a place among the resources; it affords an excellent material for the improvement of public roads, streets in cities and towns, and paths, and has been acknowledged as such by the authorities and inhabitants of the city of New-Orleans, who have bought and hauled many ship-loads of those pebbles for similar purposes. There are also many among those pebbles, as, for instance, the fine agates, cornelians, sards, sardonyx, &c., which would willingly be bought by lapidaries.

2. The deposits of lignite, or brown coal, are certainly of the greatest importance. Such deposits are found nearly in all the different counties; as, for instance, in Marshall county, especially in the southern part, on the Tallahatchie river, in Pontotoc county; in Lafayette county are most extensive deposits, especially on the Tallahatchie and Yokeney-Patapha rivers; in Panola county, for instance, on S. 18, T. 29, R. 8, on S. 10, T. 27, R. 8, and in other places in Calhoun county, near Pitsboro, in Yallabusha, Carroll, and especially in Holmes county, where very important deposits are found; in Winston county, near Louisville, S. 27, T. 16, R. 10 E., Sec. 14 and 22 of same T. and R. Probably the whole of a range of hills on the head waters of Noxubee river is underlaid with deposits of lignite; besides these, there is lignite in other localities as this, in Yazoo, and other counties.

This lignite is not only useful for fuel, but especially for manure, in which respect we refer to note 62.

3. Of considerable importance are also the many strata, seams, and nodules of rock which occur in this formation. The most important strata hitherto discovered are in Atala county; for instance,

a mile W. of Burketsville, in W. half of S. E. quarter of Sec. 13, T. 15, R. 6, E., very fine sandstone crops there out on the top of a hill; it is in different places of different hardness, and of a grayish color; it is useful for grind, mill, building, and monumental stones. The same stone crops again out E. of Rockport, under a hill, and continues nearly to Rockport, on Big Black river.

The same kind of sandstone crops also out on the same river, in the N. W. part of Atala county; it is there extremely hard and cherty, but nevertheless useful. In some places of Atala county, the iron sandstones appear in the orange sand.

Similar sandstone crops out in Holmes county on different places (which are not yet examined all); it is also there useful for building purposes, although cherty. One of these localities is in T. 15, R. 2.

A useful iron sandstone crops out in Panola county, T. 6, R. 8, on a creek about 15 feet under the top of a hill. It appears in different layers; the uppermost is the hardest. It is of a red color, good for building-stone, and can be quarried in blocks large enough for any purpose.

Another outcrop of valuable stones is in the same county, on Sec. 28, T. 8, R. 7, on several hills. In some places the stone is aluminous, of different hardness; the hardest is very good for building purposes; it is of a yellow ferruginous color. In other places the stone is silicious, a real sandstone; it passes into chert, which is extremely hard, but splits well. This sandstone is also very useful for building.

Another outcrop of the cherty sandstone is on the Yokeney river, on Sec. 26, T. 27, R. 8, on the S. side of a hill about 50 feet below the top, in a small creek. The ledge appears about 100 yards long, but probably the stone underlies the whole hill. It seems to be perfectly horizontal, and a dip could not be ascertained. It is about four feet thick, and difficult to work on account of its hardness, but nevertheless useful for mill-stones and for building purposes.

Near Grenada, in Yalabusha county, a hard aluminous sandstone crops out on a hill; it is nearly too hard for working, but nevertheless useful for building purposes, especially where it it can be used in the rough state, for instance, for foundations of buildings.

A very good iron sandstone, of a rather coarse grain, is found near De Kalb, in Kemper county. It is of a dark red color, rather soft when quarried, but hardens quick when exposed to the atmos-

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phere. It is easily worked, and very good for building purposes. This iron conglomerate is found in nearly all the miocene counties, and is very useful indeed.

A very extensive stratum of a white silicious sandstone is found on S. 20, T. 7, R. 1, near Rockyfort, in Pontotoc county; it is in some places soft enough to be crumbled to pieces, and in others it is a real hornstone, as hard as flint; it is in many places most useful for building purposes.

4. Of importance are the many strata of *fine clay* found nearly everywhere in this formation. The clay ranges from the ordinary clay, or loam, for the fabrication of bricks, which is nowhere wanting, to the fine refractory fire-clay, useful for fine pottery, and fire-proof bricks. Such clays are found in great quantity in Marshall county, and have there already been put to use; a pottery exists near Holly Springs, and furnishes good earthen ware.

Similar clay is found in Panola county, in several places, as, for instance, Sec. 18. T. 8, R. 8.

Very fine clay for fire-bricks, is found in Yazoo county, at the base of the hills between the bluff along the alluvium and the ridge of hills crossing the county, from N to S. This clay is also very useful for pottery.

A very good clay is found in Calhoun county, near Hartford; a pottery exists there already which furnishes very good earthen-ware.

A fine plastic clay is found on Sec. 17, T. 2, R. 3, E., in Tippah county. It is of a whitish color, and already used in a pottery which furnishes fine earthen ware.

5. This formation contains in many places deposits of *fuller's earth* (84). The finest and best was found from 40 to 50 feet under ground, by digging wells on the campus, at the University of Mississippi, near Oxford, Lafayette county. It is there perfectly white, without any grit, and can be used for writing and marking, like chalk.

Another deposit of this earth is found on the road from Macon, in Noxubee, to Philadelphia, in Neshoba county, on the W. side of the Hashuka creek.

A fine deposit lies very near the town of De Kalb, in Kemper county, in the red sand of the orange-sand group; and also in Neshoba county, very near the line of Kemper county, in the S. E. corner of the county.

A very large deposit of a rather coarse article is found about 11 miles N. of Grenada, on the road from Coffeeville. It crops out on the N. side of a hill, and is about 20 feet in thickness. It contains a large quantity of mica-scales.

MINERAL SPRINGS.

6. Of great importance are the mineral springs with which the miocene formation abounds. A few of them only have been examined and tested.

A most important spring is found on Sec. 13, T. 22, R. 4, E., one mile S. S. W. of Grenada, in Yallabusha county (see page 215, diag. 46). Its temperature is 24° Centigr., or 75.2° Fahr. The water is nearly clear—a little yellowish; its odor, ferruginous chalybeate; its taste, acid, and extremely astringent and styptic. Its reaction is very acid, reddening blue litmus paper immediately.

Its contents are chlorine, sulphuric acid (a large quantity), iron (a large quantity in form of protoxide) and alumina, both of the latter; are in the state of sulphate. The water has an astonishing effect in all affections of the bowels, the organs of digestion, hemorrhage, cutaneous diseases, etc., and is most recommendable in that respect.

A similar spring on Sec. 24, T. 16, R. 3, E. Its temperature is 16° Centigr., or 60.8° Fahr.; Spec. grav. 1.038. Its contents: carbonic acid, sulphuric acid, lime, magnesia, iron, alumina, and iodine, in small quantity. This spring is also a very good one, and much resorted to.

Another most excellent chalybeate spring is in Winston county, a short distance (four and a half miles) from Louisville; probably one of the best springs of this kind in the State (see page 213 and note 75). Not far distant is another one, also a chalybeate spring, but neither as copious nor as strongly chalybeate as the one above mentioned.

Two sulphur springs are found near Philadelphia, in Neshoba county; the one is in T. 11, R. 11, and the other eight miles south of Philadelphia.

A very fine, rather alkaline spring is found in Yazoo county, one mile east of Yazoo city—Sec. 5, T. 11, R. 2, W. Its temperature is 17° Cent., or 62 Fahr. Its contents: carbonic acid, sulphuric acid, chlorine, a small quantity of protoxide of iron, a small quantity of lime, magnesia a very small quantity, soda in considerable quantity, and alumina.

A good chalybeate spring is between Oxford and Pontotoc, in Lafayette county, known under the name of the Lafayette springs.

A good spring, containing carbonate of iron, is found near Oxford, on the railroad to Holly Springs, on the N. W. quarter of Sec. 9, T. 8, R. 3, W.

A good sulphur spring is said to exist in Panola county, near the Central Academy, about 17 miles west of Oxford, in Lafayette county.

An excellent mineral spring is in the town of Pittsboro, in Calhoun County. It temperature is 63° Fahr.; that of the atmosphere being at that time 100 of such degrees.

Its contents are: sulphuretted hydrogen, sulphate of lime, carbonate of magnesia, carbonate of iron, and chloride of the alkalies.

ELEVATION OF THE SURFACE OF THE MIOCENE FORMATION.

The ridge at the head of Chickasawhay creek, in Noxubee county, is of an elevation of	570	feet	above the ocean.
The western part of the town of Canton, in Madison county	150	"	"
Three miles further, near the line of township 10	156	"	"
Two miles further north from there	208	"	"
On the line of T. 12, W. bank of the Big Black river,	158	"	"
On Big Cypress creek, towards Lexington	156	"	"
North of Little Black river	188	"	"
Five miles north of Little Black river	280	"	"
A hill six miles south of Little Sand creek	390	"	"
Immediately " " " "	256	"	"
North of " " "	227	"	"
A ridge north of Big Sand creek	312	"	"
The line of Yallabushaand Carroll counties	293	"	"
South of Yallabusha river, in township 12	371	"	"
North of Terry's creek	280	"	"
The ridge south of Ockachikama creek	295	"	"
The ridge north of Spring creek	356	"	"
Coleman's Ridge	428	"	"
North of Olockalopha creek	355	"	"
The summit of Free Bridge pond	428	"	"
North of Brown's mill-race, in Lafayette county	367	"	"
The summit of Toby Tubby creek	from 478 to 486	"	"
Three miles north of Hurricane creek, on a ridge	550	"	"
Dividing ridge between Hurricane creek and Tallahatchie river	480	"	"
On the line of Marshall and Lafayette counties	340	"	"

University of Mississippi, near Oxford	330 feet above the ocean.		
Summit of Wilson's ridge, Marshall county	555	"	"
Summit of Lumpkin's ridge	690	"	"
Town of Holly Springs—highest elevation in the State of Mississippi	710	"	"
State line of Mississippi and Tennessee, under the 35° of N. lat., near Wolf river	495	"	"

The gradual elevation from the town of Canton, in Madison county, to the line of the State, amounts to 345 feet. The town of Holly Springs, in Marshall county, is the highest point in the State of Mississippi; the elevation from the University of Mississippi to Holly Springs, at a distance of 32 miles, amounts to 380 feet (85).

2.—AGRICULTURE.

The territory of the miocene formation is generally not very fertile; it takes, in that respect, only about a fourth rank among the geological formations of the State, and is only superior to the territories of the carboniferous and eocene formations.

The territories of the cretaceous formation, the alluvium of the Mississippi river, and that of the loess or bluff formation along the Mississippi river from Vicksburg to the line of Louisiana, are far superior; nevertheless, this formation contains most excellent lands. First of them ranks the black soil of the table-lands in the northern parts of Tippah, Marshall and De Soto counties. This soil has not yet been carefully examined; it is most probably a fresh-water formation of pleistocene or postpleiocene origin.

It consists of a mixture of a large quantity of vegetable matter with silt and clay, and is of equal fertility with the most fertile soil in the State, the alluvium of the Mississippi river, with which it must be classified together.

It is superior to the prairie soil, because it less clayey and heavy, much easier cultivated and much safer. In an average of 10 years, it will certainly yield about twice the amount of corn and cotton which the prairie soil yields.

This soil is now still fresh and in a fine state of fertility, in which it is easily kept by a prudent and careful agriculture.

As a manure for this land, the sandy eocene and cretaceous marls would be much better than any vegetable manure, because of the large quantity of vegetable matter which that soil contains, and on account of the lime which these marls contain, and which the land requires.

The soil second in order, is that found along the bluff of the alluvial formation, from Horn lake down to Satartia, in Yazoo and from there to Madison county.

This soil is of a yellow color, similar to that of the loess or bluff formation, and formed of a mixture of this postpleiocene deposited with the red loam overlying the miocene rocks. It is, therefore, best and most fertile where it is most mixed with the loess. It is decidedly of later origin than the loess, for it overlies this in Yazoo county and many other places.

The yellow loam, as we have called it, is, indeed, a most excellent soil, consisting in a finely divided, pulverulent mass, generally mixed with very fine silicious sand, and is, therefore, very easily cultivated.

It is entirely confined to the western part of the State, because the principal ingredient, the loess, is there only found. It is of the the best quality in the southern part of De Soto, the northern part of Panola, in Madison and Yazoo counties, being there most mixed with the loess.

It is also found in Tallahatchie, Yallabusha, Carroll and Holmes counties (principally in the western parts of the latter three), but it is there more mixed with the red clay of the miocene formation, and not of that high fertility as in the above named counties.

In Yazoo county, that soil is probably of the highest fertility, but the county is too hilly for agriculture ; only in comparatively a few places this impediment allows an extensive cultivation. Besides, the most fertile soil is generally found on the top of the hills and on their southern declivities, and the northern slopes are less productive.

Notwithstanding these impediments to agriculture, that fertile soil can be turned to a most profitable use. There is, indeed, scarcely any soil better adapted for the cultivation of fruit trees of every kind, as peach, fig, apple, pear, apricot, and other trees, and indigenous grapes ; and the hills, which are an impediment to agriculture, favor the cultivation of such trees ; they vary the situation and allow a selection of sunny and shady, hot and cool places, and render the fresh air necessary for the growth of any tree, more accessible.

That yellow loam is of great fertility, especially for cotton, the particular Southern staple article, as it contains a large quantity of lime requisite for cotton; but it is not very retentive of moisture; it suffers much of drought and is easily exhausted. It requires, therefore, a careful management, and fallowing and manure in proper time to keep it in constant fertility. As a manure for the soil, vegetable mould, or vegetable manure in general, would be best qualified. The lignite found in so many places. very near and even not very deep under the soil, would, indeed, be of great advantage for it, and cannot be too highly recommended, as it conveys a large quantity of carbonaceous and organic matter into it The lime is, also, easily exhausted by a continual cultivation of this soil in cotton; a plant which requires a large quantity of lime for its growth, and it ought to be supplied in time after a long cultivation. This can be done by marl.

Other very good soils are the alluvial deposits of the rivers and creeks, which are, in many places, extensive, and of great fertility, but quite different in the different localities, and cannot be generalized.

Next in rank is the soil formed by the *red loam* of the miocene formation; it overlies the sands and clays, in many places, from a few inches to several feet, and passes usually insensibly in a red sandy clay, which then forms the subsoil.

This soil is of a middling quality, and very productive by a good management, but easily exhausted. It is better or inferior the more or less it is mixed with vegetable mould. It is generally thin on hills, having been washed down. As the subsoil is generally a very good one, it is capable of great improvement. The fine marls found in the State are the very best manures for it; next to them, organic manures. Repeated marling will render these soils, where they are deep enough, equal to any in the State. This soil contains, originally, little lime; and this ingredient is therefore easily exhausted, by continual cultivation in cotton. Marling will soon restore it; if other manures are employed, lime ought to be added.

The inferior soils of this formation are formed by a mixture of the sands and clays of these rocks, and the addition of vegetable mould. They are generally very thin, but very improvable, if the subsoil be clay and not sand. In the first case, subsoiling and manuring with vegetable matter will resuscitate the soil and improve it much.

The fine marls of the State are admirably well adapted for these soils ; but it must be remembered that clay marl has to be selected for sandy soil, and sand marl for heavy clay soil.

The lignite will also prove to be a good manure, and is nearly everywhere at hand.

The sandy soils of this formation, which are little mixed with clay and vegetable matter, and rest upon a substratum of sand, are very sterile, and not capable of much improvement ; they are generally characterized by a nearly exclusive growth of dwarfish and crippled scrubby black jack (quercus nigra).

The forest growth on this formation is nearly the same as that on the eocene formation, with the exception of the long-leaf pine (pinus palustris), which is never found on it. Also those forest trees and shrubs are wanting which require the vicinity of the ocean, or of any sea, as, for instance: the live oak (quercus sempervirens), the palm tree (chamaerops palmetto), the palmetto leaf (sabal palmetto, seratum, etc.) The hanging or gray moss (tillandsea usneoides) is seldom found on this formation, and only near the line of the eocene. The magnolia grandiflora is scarce, and also only found near the line of the eocene.

IV.—QUATERNARY FORMATIONS.

1.—POSTPLIOCENE FORMATIONS.

Among the postpliocene formations of the State stands foremost the prairie formation of the cretaceous as well as eocene territories. We have anticipated their consideration, and refer here to the divisions of this report of the cretaceous formation, page 109, and of the eocene formation, page 163. There remains, then, for our examinaton—

The Loess, or Bluff Formation.

This formation is most probably nowhere in the United States so well developed as here in the State of Mississippi; it is, then, to us that our geologists will look for a minute description and determination of these most interesting and singular rocks whose nature and origin is yet so much in darkness. Unfortunately, such a description cannot be given now, because little or no attention has as yet been bestowed upon it, and we must confine ourselves entirely to generalities.

This formation appears first in the northern part of Mississippi, very near the line of Tennessee, on Horn lake, and extends, in interrupted bluffs only, along the hills which border the large alluvial plain, to the mouth of the Yazoo river. In this district it appears only here and there, but is of the same character as farther south, and contains the same fossils—gasteropodous pulmonates or land-shells, mostly of the genus helix; it contains, also, concretions of carbonate of lime, but not of the same character with those concretions found in the bluff formation between Vicksburg and the line of Louisiana. The concretions of the loess along the alluvium have been represented in diagram No. 37, and described on page 193, to which we here refer. Those concretions found from the mouth of the Yazoo river, or from Vicksburg, to the line of Louisiana, will be described later.

From the mouth of the Yazoo river to the line of Louisiana the loess or bluff formation forms, or lies on, a very nearly continuous range of hills of a different altitude, of from thirty to more than three hundred feet in perpendicular elevation, and of from ten to twelve miles in width, which are steep and abrupt towards the Mississippi river, but sloping towards the east; in which direction the loess becomes by degrees thinner, and runs at last entirely out, the soil being for some distance, beyond ten or twelve miles E., mixed a little with this fertile loam, and the orange sand and pebble stratum, covered by it entirely, westwards, near the Mississippi river, reappear.

The loess, lehm, or bluff rock, is of a chrome yellow color, very light and of a porous structure, containing much lime; it is perfectly amorphous, and without stratification lines, effervesces strongly with muriatic acid, contains, S. or below Vicksburg, porous and frothy concretions of very white carbonate of lime, differing widely from those N. of Vicksburg up to Horn lake; occasionally some small and water-worn pebbles are found in it, but usually only some coarse sand, consisting of round grains of transparent vitreous milky or red quartz. A quantitative analysis of a specimen of this loess, taken from Wilkinson county, about seven miles from the Mississippi river, gave the following result:

Specific gravity=2.715

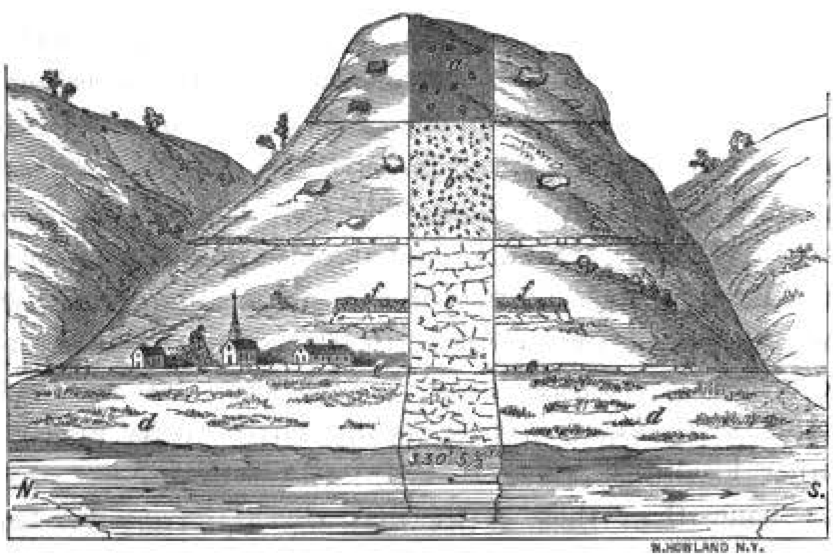
Peroxide of iron	4.626	soluble matter.
Alumina	2.456	"
Carbonate of lime	15.045	"
Carbonate of magnesia	5.393	"
Magnesia	0.267	"
Sulphate of lime	0.135	"
Silica	0.079	"
Potash	0.489	"
Soda	0.369	"
Coarse sand	6.522	insoluble matter.
Fine insoluble matter	64.155	"
Loss by ignition	1.054	
	100.636	

In the lower part of Wilkinson county the country, overlaid by the loess or bluff rocks, is very hilly; it becomes a little more level near Fort Adams. The loess covers the country nearly altogether; in some few places the tertiary sands and clays are visible. The loess extends from the very top of the hills down to their base and is from forty to sixty feet thick. It is everywhere full of fossils, but none but gasteropodous pulmonates, or helices, of the following species, could be discovered: helix tridentata, h. elevata, h. profunda, h. perspectiva, h. alternata, h. concava, etc.; all of which are still found alive. These helices are frequently found arranged in horizontal lines, showing a kind of stratification, entirely imperceptible with respect to the rocks themselves. No gasteropodous branchifers, nor acephalous lamellibranchiates, or aquatic shells of any kind, were found in the loess, however careful an examination was bestowed upon it.

The hills in the country overlaid by the loess formation are generally of erosion, for the loess washes very easily, and deep ravines and gullies are found everywhere. A range of hills, extending from Fort Adams towards S. E., seems, nevertheless, to make an exception. These hills have no constant dip, and strike on places where extensive land slips had taken place. The dip was frequently examined and found alternately towards S. S. E., E. and N. N. E.; a general dislocation appeared, therefore, to have taken place.

One of that range of hills is Block House Hill, near Fort Adams, which is represented in the following wood-cut:

[No. 47.]



a, on the top of the hill, represents the loess; it is 73 feet $7\frac{1}{2}$ inches thick. This hill is evidently upheaved from the base of the town. It is full of helices of the above named species.

b, a stratum of the orange sand group, of yellow color, with the pebble stratum; 87 feet $\frac{3}{4}$ inches thick.

c, aluminous stone of yellow ferruginous color, too soft for any use. It goes down to the water-level of the river, and appears, a low water, 169 feet $9\frac{1}{4}$ inches thick.

d, the bank of the Mississippi river, at that time, 23 feet 6 inches above the water-level.

The hill is elevated consequently, 330 feet 5½ inches above low-water mark.

e represents the basis of the town, 306 feet 11⅓ inches below the top of the hill.

f designates the remains of the fundamental brick wall of the old fort, 214 feet 5¼ inches below the top of the hill.

That this hill has been elevated after the deposition of the loess, appears to be very evident from the circumstance that the loess lies only on its top and no where else. An upheaval must, therefore, have taken place after the deposition of that loess at a recent time. The same is the case with other hills of that range, whereas the hills behind this range show the loess from the top to the bottom.

Such phenomena need not astonish us in the Mississippi valley, after the tremendous catastrophe in 1811, near New-Madrid, and all along the coast of Missouri, Kentucky and a part of Tennessee.

The examination of the loess is only a very superficial one ; it is, consequently, too early to attempt a determination of the origin of the loess and the time of its formation ; but, according to all appearances, it is a late postpleiocene formation, as all the helices are now alive which are found in it.

Other fossils found in the loess are : fossil bones of the mastodon giganteus and other mammalia ; but only single bones occur, no whole skeletons or even parts of the animal are seen lying together.

These, of course, indicate that the loess cannot have been deposited before these animals were in existence, but not how long afterwards, as the bones were evidently carried away by the water from other localities.

Other bones than those of the mastodon, I have never found in the loess, but it is said they have been found in it ; for instance, the bones of the American Tapir (tapirus americanus), the megalonyx, and others.

We can even not yet decide whether the American loess or bluff formation, which has received its name from the similarity of its lithological character with the loess or lehm of the Rhine, in Germany, and from the circumstance that it is only found on and along the bluffs of rivers, is really identical with the German loess or lehm.

The similarity of our bluff formation with the German loess or lehm, with respect to their lithological character, is perfect, it is very true, but their palaeontological characters are different. The German loess contains, especially, fossil fresh-water shells, as paludina, planorbis succinea, and others, and a few helices; our bluff formation contains nothing but terrestrial helices—no fresh-water shells. In its palaeontological character, the loess agrees, therefore, just as much, and perhaps more, with our prairie soil.

The loess or bluff formation is not only found here in the State, along the alluvial plain and Missisippi river, but also in a few places along the Homochitto and Big Black; it is evidently a formation originating through the agency of the rivers along which it is found, and can, consequently, not be older than those rivers. Even this circumstance speaks for its comparatively recent and quaternary origin, and it would appear unnatural if we would attribute it to a catastrophe which, not to speak of the Mississippi, small rivers could not have endured without a complete obliteration, if it had extended to the State of Mississippi. But even the large Mississippi river could not have outlived such a powerful catastrophe of long duration.

The loess, or bluff formation, forms a most excellent soil; decidedly one of the most fertile in the State; its terrritory was, therefore, selected for the first settlements in the State. But it is remarkable, a careless and unnatural agriculture has so completely worn out a part of this fertile soil, that it does no more effervesce with acids; the continual cultivation in cotton has exhausted the lime nearly completely. Fresh soil, of the same field, where it had not been cultivated on account of declivity, and of another place, which had been worn out, were tested: the first effervesced strongly, the latter not at all (86).

The territory of the bluff formation extends to about 12 miles east from the Mississippi river, and contains an area of most excellent soil, but which would be of much greater value were it not for the many hills and gullies which occur everywhere. But even these hills are covered with that most fertile soil, and this, where it is inaccessible to agriculture, can be used to manure and resuscitate the exhausted fields on the bluff formation.

2.—THE ALLUVIUM OF THE MISSISSIPPI RIVER.

Nothing but the outlines of the alluvium of the Mississippi river have hitherto been examined, and the report on it must, therefore, be confined to generalities.

The alluvial plain between the bluff east of the Coldwater, Tallahatchie, Yallabusha, and Yazoo river bottoms, is, in an agricultural respect, one of the most important formations, not only in the State of Mississippi, but in all the Southern States: nay, more than that, even in the United States.

Where it commences in this State, at the State line, under the 35° of N. lat. (87), it is very little more than 10 miles wide, but it widens rapidly, the Mississippi river turning S. W., and is, 30 miles southwards, where the dividing line between De Soto and Panola counties strike the bluff, just opposite the town of Helena, in Arkansas, about 36 miles wide. Thirty-five miles farther down, opposite the town of Charleston, in Tallahatchie county, it is about 58 miles wide. Opposite Carrollton, in Carroll county, the alluvial plain reaches its greatest extent in width; it is there 68 miles wide, and narrows from there first slowly, but at last rapidly; opposite Yazoo city, it is, nevertheless, still more than 40 miles wide, but it ends near Vicksburg, where the tertiary hills extend to the bank of the Mississippi river. This alluvial plain is, in the State of Mississippi, more than 160 geographical, or 184 statute miles long, and contains more than 7000 square miles, of the best land which our globe is able to produce. It is still a wilderness; the prejudice of its unfitness for cultivation has only lately subsided, and the axe of the woodman scarcely begun its ravages; but after the lapse of another century, whatever the delta of the Nile may once have been, will only be a shadow of what the alluvial plain of the Mississippi will then be. It will be the central point—the garden spot of the North American continent—where wealth and prosperity culminate; but this rich plain, formed, as it is, by a river unsteady in its bed, will always be subject to the destructive inroads of that river, and no human power will be able to put boundaries to its ravages.

The whole alluvial plain is not the work of several rivers, it is the Mississippi river alone which forms it. The Coldwater, Tallahatchie, Yallabusha, and Yazoo river bottoms are only part of the Mississippi river bottom, and formed exclusively by this Father of Waters.

The Mississippi river must always have shifted in its bed, as it does now ; the many oblong lakes, formed exactly as the bed of the Mississippi, and lying, in many instances, parallel with it, are a certain proof of it. They were all once parts of the bed of the great river, but having been abandoned by the unsteady stream, the inlets and outlets of these old channels were filled up with river silt, and are now isolated lakes.

It is still uncertain whether the large alluvial plain, on both sides of the Mississippi river, is formed entirely by the shifting of the river from one side to the other ; and whether every part of it has been once the channel or bed of the river, or whether it has entirely or partly been formed by the inundations of the river, and only a small part of it, immediately along the banks of the river, by its shifting.

There are reasons for the adoption of either of those opinions. The whole alluvial plain is a perfectly level territory, of from sixty to seventy miles in width, and certainly one thousand miles in length. This territory, now nearly as level as the surface of the ocean, must have once been undulated and hilly, as both sides of the country beyond the bottom. It is scarcely possible that the overflowing of the river could have levelled the country in such a manner, which generally happens only once a year, when the snow and ice of the mountains, where the Mississippi and Missouri have their sources, melts ; and at no other times, as the waters of all the other tributaries flowing into the gigantic river are, comparatively, only unimportant, and produce scarcely any difference in its water level.

Such an occasional overflow, which occurs not even once a year, could not have swept down the hills and filled up the valleys ; besides, the lakes on both sides of the river, which have evidently been once parts of the channel of the river, show that it must have shifted considerably from one side to the other. If we consider, then, how the river shifts now constantly ; how, in a few years, many square miles of country are washed away on one side, and new alluvium of the same area formed on the other, we would scarcely doubt that the whole of the alluvial plain was not formed by a shifting of the unsteady river, during the many thousands of years of its existence. But there is a strong reason against this theory. The whole alluvial plain appears as a channel of an immensely large river, in the old bed of which the present bed of the Father of Waters occupies only comparatively a very insignificant channel.

The annexed diagram, No. 48, will illustrate this assertion.

It appears, then, as if once an immense quantity of water had rushed down in this gigantic bed and formed it, for it is a singular fact that the Mississippi river bottom has nearly everywhere the same width, of from sixty to seventy miles; where it narrows on one side of the river, there it widens on the other, as the diagram shows. From Memphis to Vicksburg, on both of which places the tertiary hills approach the bed of the Mississippi river to its immediate banks, the alluvial plain widens in the State of Mississippi very much; so much so, that from its eastern bluff to the banks of the river, a distance of about sixty-eight miles, in a straight direction, intervenes. All along this part of the river there is very little of the alluvial plain in Arkansas and Louisiana; scarcely any where that plain is widest in Mississippi; above and below that part there is a large alluvial plain on the right or western side of the river. Were the whole alluvial plain formed by the shifting of the river from one side to the other, it could not be so regular; the river would have certainly shifted in one place more than in the other, and the bluffs on both sides of the plain would not be nearly parallel.

It is, therefore, most probable that both causes have co-operated in forming the large alluvial plain, and that the large quantity of water coming down in the river at the time of its highest waterstand, which requires always nearly the same space to flow off, has been principally active in shaping that alluvial plain as an immense channel of a river, nearly of equal width everywhere, as we now find it. A more minute examination will, perhaps, shed more light upon this subject.

This much seems certain, that the alluvial plain in the State of Mississippi, from its northern boundary to Vicksburg, has been nearly entirely formed by a shifting of the Mississippi river in its

DIAGRAM NO. 149.

bed; a glance upon the diagram No. 48 will show this. There are not only lakes everywhere between the eastern bluff of the alluvial plain and the river, the remnants of an old bed of the Mississippi, but the earlier existence of the bed of that river, near the eastern bluff, appears to be indicated by the water courses of the Coldwater, Tallahatchie, Yallabusha, and Yazoo rivers, which form nearly a straight line from Memphis to Vicksburg. Those rivers ran, most probably, once, immediately into the Mississippi river; but this river shifted westwards, barred the mouths of those tributaries, perhaps, during the dry season, in the Southern States, in the months of May, June and July, when they have very little water; the large Mississippi continued high, as it now generally does in those months (the time of its highest water-stand falling generally late in the spring—at the end of May or beginning of June—when the snow and ice on the northern and western mountains generally melt), and forced those tributaries to continue their course in the old bed, which, of course, must then have filled up by degrees, leaving only a channel wide enough for the flowing off of the quantity of water carried down by the three first named rivers, the Coldwater, Tallahatchie, and Yallabusha, which formed then the Yazoo river (88).

It is, perhaps, too early to discuss from what period the Mississippi river and its alluvial bottom derive their origin; its banks and the adjacent country are too little explored;—but this much appears certain, that the river, however immense it may be, compared with other rivers of our globe, cannot have outlived the catastrophe of the eocene and miocene periods, as far as it extends along the State of Mississippi, and can, therefore, not have originated during the miocene period. The catastrophe of the diluvial or glacial period not having extended as far south as the State of Mississippi, as we have seen, this would not have interfered with the mighty river here, but it would certainly farther north, where the diluvial strata overlying the older strata, and the large quantity of partly immense boulders, or erratic blocks, are a certain proof that the ocean must have swept over those countries for a long period at the time of their deposition. The river, immense as it is, can, therefore, not have outlived such a catastrophe, and dates its origin, consequently, from a later time than that of the diluvial period.

NOTES AND ADDITIONS.

1. The azoic formations are those which originate from a period during which there was no organic life, neither vegetable nor animal, on our globe, neither on the dry land, nor in the ocean. The granite and metamorphic rocks are such formations. Table 1 shows their position.

2. The transition or protozoic formations, are those in which the remains of vegetable and animal life appear first in most singular forms. The silurian and devonian are those formations. Formerly another transition formation, the cambrian, was admitted to exist, and is still found in many compends of geology. Sir R. Murchison, and other eminent geologists, have sufficiently proved that neither a cambrian nor any other protozoic formation, lower than the silurian, is in existence; and that the rocks formerly attributed to the cambrian formation, belong to the silurian system. The Table showing the position of the geological formation, exhibits the situation of the azoic and transition formations, the cambrian formation being left out.

3. The term *rock* is not used in this report in the common sense of the word, indicating a stone or indurate mineral body; it is used in a geological signification, and means any aggregation of mineral mass, whether hard or soft, loose or agglomerated.

3-*a*. It appears to me even more than probable, that the depression of a part of the continent of America, situated now where the Gulf of Mexico rolls its waves, occurred after the deposition of the eocene formation; for a portion of the borings taken from an Artesian well attempted to be bored in the city of New Orleans, at a depth of between 500 and 600 feet, and sent to me for examination, shows that the alluvium of the Mississippi river rests immediately upon the eocene rocks. If the depression had taken place earlier, the alluvium would rest upon an older formation, and upon a newer, had it occurred later.

4. I intend by no means to indicate that the Mississippi river originates from the period of the upheaval of the miocene rocks above the waters of the ocean. It may originate from a much later period; it cannot, at least the lower part of it cannot have had its origin in an earlier period; the upper part of that river has its bed in much older rocks; it runs all

along Missouri and Illinois, first through the carboniferous, then, farther N. along Iowa and Wisconsin, through the lower silurian, and lastly, through Minnesota, through the primary rocks of the granitic and metamorphic systems. The possibility is therefore not excluded, that the upper part of the Mississippi river may have existed in an earlier time than its lower part. If so, it must have been in a very different condition from what it is now. The origin of the Mississippi river, as we find it now, seems to me not very doubtfnl. It has been ascertained by all the geologists who have made surveys around the great northern lakes—first, by my lamented friend, Douglass Houghton, the former State geologist of Michigan; then, by the United States geologists, Foster, Whitney, and Owen, and others—that those lakes must have had, at an earlier period, a a much higher water-level; and that by some rupture or dislocation of their shores, by means of a mighty geological catastrophe, a considerable portion of the waters of these immense inland seas ran off, as all agree, through the channel of the Mississippi river. Considering these circumstances, it appears to me most probable that the powerful torrent caused by those waters, gave origin to the large Mississippi river, as we find it now.

If we regard the chart of the Minnesota territory, or, better still, that annexed to the geological survey of Wisconsin, Iowa, and Minnesota, executed by Dr. D. D. Owen, and his able corps of assistants, we find that the Upper Mississippi river bends exactly W. of Sandy lake, decidedly towards the most western portion of Lake Superior, where the St. Louis empties its waters in it, and forms a large bay, as it were.

The distance from the Mississippi river to the large bay, at the mouth of the St. Louis river, which may be considered as a narrow continuation of Lake Superior, is only about 25 miles in a straight direction, and the river is still in connection with Sandy and Prairie lakes—the distance of the latter from the lake, or rather from the St. Louis bay, is only 10 miles; Big Lake still intervenes between the two, and leaves in that direction only about six or seven miles of land between Lake Superior and the Mississippi river.

The upper part of the Mississippi river appears, therefore, to have been in an earlier period, a tributary to Lake Superior. When the shores of Lake Superior were ruptured, its waters, having taken the Mississippi river for their principal channel, dug out the bed of the large Mississippi river, as we find it now, to the sea.

The many lakes now found between the mentioned point of Lake Superior and the Mississippi river, and along the river to where it takes a southern course, not less than one hundred in number, the westward course of the river, immediately from Sandy Lake, seem to corroborate that opinion.

The Geology of the State of Mississippi offers nothing which contradicts it. The confluence of several large rivers with the Mississippi seems not contradictory; they may be of later origin.

If the Missouri river existed before where the Mississippi flows now, its channel has been adapted in the above-mentioned way for the reception of the water of both rivers and their tributaries..

5. The alluvial deposit below the city of New-Orleans, as it has been ascertained by the boring of an artesian well, now in operation, is *more* than 500 feet thick. Borings taken out of the well, and sent to me for examination, show that, at the depth of 500 feet, the alluvium of the Mississippi river was not yet penetrated. The boring from a depth of 570 feet is characterized by fossils, evidently eocene; the rocks containing them must, therefore, originate from the eocene period; and, consequently, the alluvium of the Mississippi river has a thickness of between 500 and 570 feet, and rests immediately upon the eocene rocks.

6. The fluviatile formation here alluded to is the loess or bluff formation, which appears only in unconnected tracts above Vicksburg, but is perfectly continuous from there to the line of Louisiana, and occupies there a considerable area.

7. I am not unacquainted with the fact that several eminent geologists close the palaeozoic age, or *reign of fishes*, immediately before the carboniferous formation, including in it only those systems which we have called transition formations, the silurian and devonian.

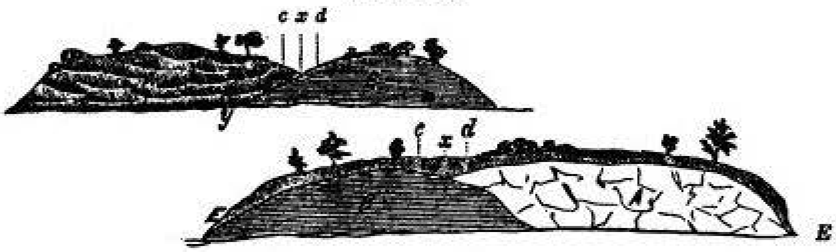
These geologists argue, that the appearance of the first air-breathing animals during the carboniferous formation ought to entitle this formation to the rank of the first formation in the mesozoic age, or the reign of reptiles, as they call it, and as it may justly be called.

It is an undeniable fact that before the carboniferous period no air-breathing animal seems to have existed on the face of our globe; the ocean was the only seat of animal life, and that a few species of marine reptiles appeared first during the carboniferous formation; but it seems more suitable to found a division upon an interruption of the similarity of the whole animal creation, and this appears first after the permian period.

The appearance of a few species of reptiles during the carboniferous formation, is only an exception from a general rule; and if such an exception could justify the beginning of a new age, the mesozoic age, or reign of reptiles, ought to be closed before the oölitic formation, and the reign of quadrupeds to commence there, because a few species of quadrupeds of the marsupial (or opossum) order appeared first during the oölitic period; but this also was only an exception, and as the mass of reptiles date their origin from the triassic period, so do the mass of mammal quadrupeds from the eocene or lower tertiary; and, therefore, it seems to be there where the division lines are to be drawn.

8. In treating of the different formations it seems more systematical to begin with the oldest and proceed to the newest, because the older is always the foundation and origin of the newer. It appears also necessary to give, besides the geological map, a detailed description of the boundary lines of the different formations, because a report on the geology of a State ought to be a popular work, clear to everybody, and the chart might not be generally understood; the one is, therefore, the explanation of the other. It must also be remarked that the bordering of the different formations cannot be done with anything like geometrical accuracy. When two geological formations of different ages come together, the newer always overlaps the older, as it is explained in the following diagrams:

[No. 50.]



A is here the newer, *B* the older formation; *A* overlaps *B*, from *y* to *x*; at *x* the two run insensibly together, so that even in their original state there is some difficulty in distinguishing *A* from *B* in *x*; the original character of both formations, is nowhere maintained; disintegration has taken place in the course of the many years which have elapsed since their deposition; the strata or layers of the one have always been washed into the other, and both have been completely mixed up in and near the point *x*, and it is, therefore, very difficult to draw the limits between the two formations. One geologist might put it to *c*, another to *d*, and each can have good reasons for his opinions.

Frequently two such neighboring formations have been overlaid by a third one, as the second diagram shows. This one has again been partly removed by disintegration, denudation and erosion, or washing by atmospheric influences, and both have been partly mixed up with the top-soil of the formations *A* and *B*, which makes a limitation of the different formations still more difficult. Geological bordering of the different formations, without boring or digging down in the ground, and without close examination, is impracticable, without sufficient means and assistance, and even unnecessary; and must always be taken with some allowance.

9. The southern and south-western limits of the carboniferous formation, up to T. 7, R. 9, in Itawamba county, and consequently those of the adjacent formations, are not definitely determined, for reasons stated in the introduction.

10. Although the carboniferous formation is so thickly overlaid by tertiary rocks, in its western part, it would be wrong and against the nature of things to admit here the existence of any other formation.

The overlying rock can only belong to those rocks which overlie the cretaceous and carboniferous formations, in their whole extent; older rocks than those could only belong to an older formation than the cretaceous, and such rocks are not found here.

11. A small part of another formation may intervene between the cretaceous and carboniferous formations, and extend from the N. E. corner of Lowndes county, upwards to the point where the carboniferous formation crosses the line of Mississippi and Alabama; it has been impossible to settle the question.

12. The boundary lines of the eocene formation are by no means exact; they need correction. Even the northern boundary line, which was laid out in a great hurry, to complete the geological chart of the State, is very nearly, but not entirely, correct. The western line, from Vicksburg down to Louisiana, could only be taken as little more than a guess-work. It has not yet been sufficiently examined.

13. The eocene formation extends farther E. over the southern parts of Alabama and Georgia, into Florida.

14. The coasts of the Gulf of Mexico have not yet been examined; it is uncertain if any or how much of such alluvium exists there. Its existence is only most probable, at least in most places, along the coast and islands belonging to the Mississippi; they have, therefore, preliminarily been colored as alluvial.

15. It is still somewhat doubtful whether this formation is really miocene, as will be shown later.

16. Petrographical and palaeontological description is a description of the different rocks, layers, or strata, contained in these formations, and of the fossil remains found in them. That this description, and especially that of the fossils, cannot generally be a very exact one, is evident, as this report is only a preliminary one, and the survey not completed. The close examination and determination of fossils, or the scientific part of the survey, must, of course, always be the last, and give way to the practical portion.

17. Hornstone, generally called chert, is a variety of quartz often classed with the chalcedonic varieties, as, for instance, by Dana; it is compact and fine, resembling flint, but more brittle and splintery than the latter. The fracture is conchoidal and smooth. Its color varies; generally it is gray, but also yellow, green, red, and brown. It is not confined to the older geological formations; we shall have an opportunity of speaking of it even as an eocene and miocene rock.

18. The pyrites, a composition of 46.7 per cent. of iron, and 53.3 per cent. of sulphur, or a bisulphuret of iron, are generally not tetrahedral but octohedral and dodecahedral. They contain often, besides sulphur and iron, some gold, silver, manganese, cobalt, and arsenic, but only very small quantities of the precious metals.

19. Only two of the large number of species of productus are found in any other than the carboniferous formation: in the lower triassic, and there only in Europe. The carboniferous formation is the lowest in which the genus productus occurs, wherefore its appearance here is important. I found the productus first on a range of hills of sandstone, capped by limestone, between Big Bear creek and Cedar creek, in T. 6, R. 11. And a very fine specimen of productus (most probably punctatus), I obtained in Buzzard Roost, Alabama.

20. This red sand, still more general and in larger masses above the more western formation, in Mississippi and Tennessee, has been appropriately termed by my friend, Prof. James M. Safford, the State Geologist of Tennessee, in his Geological Reconnoissance of the State of Tennessee, the "orange sand;" and as this sand is common to both States, it is proper that it should have the same name in both States, wherefore, I have willingly adopted that name. The orange sand will be later more accurately described.

21. Glauconite is a silicate of iron, or a combination of protoxide of iron and silicic acid or silica. Very frequently it contains, also, a small quantity of potash, sometimes from 5 to 15 per cent. Its proportion of silica varies from 43 to 45 per cent; that of oxide of iron form 19 to 27 per cent, and the water combined with it from 4 to 8 per cent.

22. Not only whitewashing the walls of houses, but also the cheeks of the fair sex. If any whitewash must be used for that purpose, this is, indeed, a most recommendable substance; it is not in the least injurious to the skin. The fair ladies of Tishamingo ought to take a patent for the ingenious invention.

23. This locality was reputed to contain a valuable and even rich mine The iron ore was mistaken by some Georgia miners for copper ore, perhaps for stilpnosiderite, the grains of cairngorum stone for gold, and the mica for silver. The owner of the place could scarcely be convinced that no copper was to be found there; he pretended that he melted repeatedly pure malleable copper from it, and repeated this assertion after having been shown by a blow-pipe analysis, that there was not a trace of copper in the ore. At last, after having been asked by the Assistant Geologist, how he proceeded in melting copper from the ore, he confessed "that he applied blue vitriol" as a flux, and the mystery was at once elucidated. Blue vitriol is *sulphate of copper*, and the copper of the latter was reduced by heat, and appeared in its pure metallic state as a regulus of copper.

A silver mine was also said to exist on Sec. 29, T. 3, R. 9, E., but this tale had a different origin. The silver in a pure metallic state, in small grains had been dug (as it was pretended) out of sand on a low bank of a creek, and that too in the cretaceous formation.

It was afterwards ascertained that the former owner of the place desired to sell it; in order to increase its value, he loaded small grains of silver in his gun, and shot in the sand, on the bank of the river; he asserted then, that this sand was argentiferous (silver-bearing); but as he, nevertheless, did not succeed by this ingenious trick to sell it, he indemnified himself by stealing a negro, and vamosed into Texas.

24. When I came on my geological tour, in the the spring of 1855, to Fulton, in Itawamba county, I heard there that some young men from Georgia had been prospecting in Itawamba and Tishamingo counties; that they had later been mining near Warren's mill, T. 4, R. 9, E., Sec. —, and after having succeeded in finding valuable ore, that they had then closed their mine there, and were now about to sink a shaft near Mr. Odum's, not far from Jacinto, in Tishamingo county. All my incredulity and my doubts could not convince the people that it was not so. I was assured that the miners found valuable ore, and that some metal had been melted out of it in a blacksmith's shop.

I then concluded to go to the very place and convince myself of the truth or untruth of the assertion. From Jacinto, I repaired, therefore, to Mr. Odum's, and found there three young men, from Georgia, hard at work to sink a shaft into tertiary rocks, which cover the carboniferous rocks very thickly.

Full of astonishment, and sympathy for the poor young men, whom I saw squandering their time and money, I asked them "What they desired to find there." Their answer was, "That they knew very well what they were about."

Abrupt and rebutting as the answer was, I took no offence from it, but tried to convince them that their labor was in vain. But my labor was also in vain; it served only to make the inexperienced miners suspicious, and to convince them that my intention was not an *honest* one, but that I tried to deprive them of the profits of their industry.

Finally I told them that I was the State Geologist, that I had taken the trouble to come there on purpose to inform them of the *impossibility* of any success, and that I had no other intention, least of all an interested one.

Even this seemed, at first, to have no effect, so firmly were they convinced of their ultimate success.

At last, after having deliberated among themselves, one of them seemed to have gained confidence; he came to my camp, and told me that one or two of them had been engaged in mining copper ore, in Ducktown, Tennessee, and that, as the surface formation there was exactly the same as on the spot where they were now about to sink the shaft, there must necessarily be valuable copper ore.

I assured him that that was not a correct conclusion, that the surface formation was most frequently in no relation to the underlying formation.

In order to convince me of my error, he told me that they had already succeeded in finding a valuable mine, for which they had been offered a considerable price.

He showed me a piece of bisulphuret of iron, or iron pyrites of that kind which is very deceptive, and generally called "mundic," trying to make me believe that that ore was found in their mine, in the neighborhood.

I replied to him that that ore was not found in this State, and that even if it had been found here, it was of no value whatever, shining and deceptive as it appeared.

Seeing that he could not mislead me, he confessed that the piece of mundic came from Ducktown, but that they had found, near Warren's mill, where they had made a tunnel, or rather a gallery in a hill, a similar, more valuable ore, from which they had succeeded in melting valuable metal.

He then showed me a piece of *brass*, assuring me that that metal had been melted from the ore found in their mine, at Warren's mill, which they now had closed, in order to work it later, as soon as they had succeeded in finding ore in the place where they were mining now.

Finding me again incredulous, and unwilling to believe that *brass*, an alloy of copper and zinc, could have been melted from any *ore*, he brought me a witness, a most honest and honorable gentleman, who would have sworn, I believe, that that piece of brass had been melted from the ore found in the gallery at Warren's mill, and who, upon the strength of his belief, had taken an interest in the operations of the young and inexperienced miners.

My refutations seemed to make an impression upon this gentleman; he asked me to accompany him to Warren's mill, and to examine myself the gallery whence the ore had been taken. I consented, and the next morning we started for the El Dorado.

Arrived at Warren's mill, I found a gallery from forty to fifty yards long, which had been dug, with heavy labor and great perseverance, in a tertiary hill overlying the mountain limestone group of the carboniferous formation.

The gallery was carefully closed, but opened soon after my arrival; entered, and a piece of the valuable ore taken out of it, and presented to me, as the very ore out of which the brass had been melted, in a neighboring blacksmith's shop, in an iron ladle.

What I suspected was actually true. The ore was nothing else but a crust of iron pyrites collected in and around a piece of fossil wood of the lignite group of the newer tertiary formation, in the micaceous clays of which the gallery had been excavated, and supported inside, all along, with heavy timber.

I assured the silent partner of the mining expedition that brass could not be melted out of any ore, least of all, out of common deceptive *fool's gold;* but he insisted upon the truth of his assertion, and referred me to the blacksmith who performed the wonder, although I showed him by means of the blow-pipe the truth of my assertion.

I thought surely the blacksmith must be better informed, and be the wag who deceived the inexperienced mining company.

I believe I was mistaken; the blacksmith appeared and asserted in the most serious manner that the piece of brass which I held in my hand had been melted from the same ore of which a large piece was also in my possession.

Finding that nobody else had been present when the wonder of melting brass from "fool's gold" was performed, I had to renounce the pleasure of finding out the wag who imposed upon the unsuspecting mining company, by putting a piece of brass in the ladle pregnant with fate.

As even the testimony of the serious blacksmith did not quite convince me of a transformation of sulphuret of iron and carbon by heat into brass, I inquired, further, if the metal had been found in the ladle after ignition of the ore. And here I hit the nail upon the head. The answer was—no! The metal must either *have gone through the iron ladle,* after having been heated by a strong blast for nearly an hour, or, as the ladle had been heaped with the ore, it must have run over the ladle. "The brass was found in the fireplace among the ashes and cinders, which were carefully examined for hidden treasures after the fire had been extinguished."

Here is certainly an example how persons in pursuit of their desires can deceive themselves.

How long may that brass, melted most probably from some piece of iron with which it was in connection, have been in that fireplace, which only greediness for treasures caused to be carefully examined to the very bottom!

The piece of brass was found, and, improbable as it was, the desire that it should be so, brought it in connection with the melting—indeed *not* melting, but burning, of the lignite and bisulphuret of iron.

The narration of this amusing mining story may not strictly belong to a report on the Geology of Mississippi; but this Report is a popular work, and as so many deceptions of a similar character, especially with respect to sulphuret of iron, occur, as even more frequently than once in a month, pieces of "fool's gold" have been sent to me for valuable ore, or I have been invited to inspect them, I cannot deem it unsuitable to insert it here as a warning, and to add: that, although the Mississippi Mining Company dissolved after my effort to instruct its members in regard to the futility of their undertaking, the main supporter having withdrawn, the mining did not stop. I did not succeed in convincing the inexperienced young Georgia miners that the geological formation of Mississippi was not that of East Tennessee, and that *appearances* were no *realities*.

When, more than a year afterwards, the Assistant Geologist, Dr. Hilgard, came to Tishamingo county for a more minute examination than I could bestow upon it in a tour for obtaining a general view of the geological character of the State, he found the shaft at Odum's sunk to a depth of more than 60 feet in the tertiary rocks, and the young miners still on the place, pretending steadfastly:

"The treasure was there, if a fellow only knew how to find it!"

25. Breccia and pudding-stone are frequently used as synonymous, meaning, in general, conglomerates of rocks cemented either by silica, lime, or oxide of iron. In mineralogy and geology a conglomerate is called *breccia*, if it consists of angular fragments of rocks; but *pudding-stone*, if it consists of round and smooth pebbles. In this manner the term is used in this report.

26. The analysis of the silica will be found later where the carboniferous formation is considered with regard to agriculture and national economy.

The Assistant Geologist says of it:—"With nitrate of cobalt it assumes a grayish tinge before the blow-pipe; with soda it fuses into a transparent bead, and no excess of the re-agent precipitates any alumina; still, at a certain proportion, the bead turns always opaque on cooling.

"Salt of phosphorus does not dissolve it, nor does the bead show any tinge of iron, even whilst hot; it must then be silica nearly pure." And indeed so it appears in my analysis.

27. The merit of the discovery of the terra-sigillata, belongs to the Assistant Geologist, Dr. Hilgard. I have not visited the place. An outcrop of "red chalk" which I found not far from Eastport, and from the outcrop of silica, is nothing else but another outcrop of the silica, colored by oxide of iron, light, or rose red, and is therefore of no economical value. Dr. Hilgard says, "the red veins and stripes observed at Aker's, were the symptoms of an incipient transition from kaolin to terra-sigillata;" with which opinion I cannot but agree.

The red clay, or terra-sigillata, appears not to be confined to the locality at Sec. 30, T. 2, R 11, E, another outcrop is said to exist at Mr. McMackin's, about six miles from Eastport. The outcrop has not been found, but the locality justifies the assertion.

The bluff, at a mill there, consists of the common deposit of pebbles, imbedded here in a whitish clay, which cements the pebbles, and is traversed by ferruginous veins, which probably represent the kaolin.

28. To admit, as has been done, the existence of the eocene formation, between two older formations, as a formation of segregation, as it were, in a narrow strip, is perfectly against the nature of things. How could it have come there? Perhaps by subsidence and deposition during the eocene period. Why, then, has it not been deposited all over the older formation, as the newer tertiary? Why is it, then, only confined to a narrow strip? It certainly cannot have been upheaved along with the older formation, for that would have required an insertion between them. Another striking proof of the non-existence of the eocene, is the absence of all zoogene fossil remains with which the eocene abounds everywhere, and generally in all its parts, wherever it appears. In the formation here in question we find only phytogene fossils, and even no indication of zoegene ones.

29. Having shown that there is another formation consisting in a whole series of rocks, which we have even divided into two very important groups, that overlie the carboniferous formation, and covers it, with the exception of a very few places, the question obtrudes itself on those unacquainted with the science of geology, "How has this been done?" and in a work for popular use, I deem it incumbent upon myself to give an explanation.

The formation overlying the carboniferous rocks, originate as well from deposition by water, as the latter; it follows, therefore, that the carboniferous rocks must have been again submerged under the surface of the ocean, and this has certainly been the case.

The distribution of land and water on the surface of our maternal globe, does not always remain the same; changes are continually going on; on some parts of it the land is continually subsiding, and the ocean encroaching upon it. In other parts the land is rising, and the ocean receding.

These changes are sudden and instantaneous when caused by earthquakes. For instance, in 1819 a violent earthquake occurred in the Delta, or at the mouth of the Indus, in Asia, whose effects extended over a large tract of the country, more than 400 miles in every direction; a considerable portion of the Delta of the Indus was suddenly depressed, and the fort and village of Sindree, before the earthquake on dry land, stood, all at once, in the sea, whose waves washed over them.

On the 9th of November, in 1822, a tremendous earthquake took place on the coast of Chili; after the earthquake the whole of the country, from the foot of the Andes to a great distance out into the sea, was found upheaved; the rise amounted from two to four feet, and a great deal of land was laid dry.

Such accidents occur frequently, and work often great changes with respect to the distribution of land and water on our globe. More frequently these changes proceed slowly and imperceptibly, but are nevertheless more effective than the former.

So, for instance, the eastern coast of Sweden has, from time immemorial, been rising, and the ocean receding; the upheaval is so slow that nobody can perceive it; it amounts to about four feet in a century, but has, in the many centuries of its continuance, had such an effect, that whole submarine rocks, and many banks of shells have been elevated above the level of the Baltic, and that for more than fifty miles in the interior of the land, marine shells, of such genera and species as live now in the neighboring ocean, are found at an elevation of more thau 500 feet above the water level.

In other places the land is continually sinking; this, for instance, has been the case, since about 400 years, with the eastern coast of Greenland.

On many coasts, for instance on the eastern coast of England, and especially on the coast of Nova Scotia, immense submarine forests have been found, which are a sure indication that considerable changes have taken place, and that large tracts of land have been submerged by the ocean.

But for such proofs of a continual change with respect to the limits between oceans and continents we need even not go beyond the territory of the United States.

The New-Jersey geological report shows that the Atlantic Ocean is there steadily and rapidly encroaching upon the land. At Cape-Island the surf has washed away the land for more than a mile inward, since the revolution, or since about 80 years.

Along the shore around the bay at Cape May the salt marsh wears away at the rate of more than eight feet in a year. It is mentioned that one of the beaches along the coast is now one hundred yards more inward than twenty years ago. It is also the opinion of the inhabitants of the eastern coast of New-Jersey that the tide rises now higher there than formerly.

Such changes have also occurred with respect to the territory now occupied by the State of Mississippi. All of that part which had been upheaved at different times, as we have seen, has been again submerged about the middle of the tertiary period, and has been again upheaved at the end of the miocene or middle tertiary period, with the addition of all that part which is now overspread by the miocene rocks.

The carboniferous formation was also depressed, and during the time of its depression all the tertiary rocks overlying it now, and which we have just described, were deposited upon it by the waters of the ocean.

30. The strongest disintegrating influence upon building stones, exerts the

frost; it turns the moisture inside of the stone into crystalline ice—prevents in that way its escape, and as the freezing and crystallizing of the water causes a considerable expansion, it breaks and cracks the heaviest and strongest stones. A good building-stone must, therefore, not imbibe much water. A careful stone mason should always test the building-stones before using them. This is easily done by soaking one of them, or only a fragment of it, in a solution of sulphate of soda, or glauber-salt, and exposing it for a few days to the drying influence of the atmosphere. The sulphate of soda imbibed by the stone crystallizes then, and has the same influence as the freezing water. A stone which stands this test, will also stand frost well.

31—(By a mistake again printed 30). The limestone of the carboniferous formation is sufficiently pure for burning quicklime, and easily calcined, especially if put moist in the kiln, and if recently broken.

The steam proceeding from the mixture, by application of heat, facilitates the necessary escape of the carbonic acid.

The purity of the carbonate of lime, or limestone, employed for burning lime is easily tested. Perfectly pure limestone loses by application of or solution in strong acids, 46 per cent. of carbonic acid gas; the less pure the limestone is, the smaller the loss; if it loses only 23 per cent., it contains only 50 per cent. of carbonate of lime, and 50 per cent. of impurities. Similar experiments can be made by exposure of the carbonate of lime to a strong heat and calcining it; good material will lose *much* in weight, bad material *little*.

32. Those limestones which contain from 8 to 25 per cent. of alumina and silica do not slack when burnt, but as soon as the lime burnt from them is pulverized, it absorbs water without increasing in bulk or evolving heat, and gives a kind of mortar which hardens in a few days under water, but acquires never much solidity by exposure to the atmosphere.

The following are some analyses of limestones fit for hydraulic cement:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Carbonate of lime......	97.0	98.5	74.5	76.5	80.0
Carbonate of magnesia..	2.0	—	23.0	3.0	1.5
Protocarbonate of iron..	—	—	—	3.0	—
Carbonate of manganese.	—	—	—	1.5	—
Silica and alumina......	—	—	—	15.2	18.0
Oxide of iron..........	1.0	1.5	1.2	—	—

The first three give a very poor material, only the two last ones afford a good hydraulic cement. The Eastport aluminous limestone will fully rank with the two last. All good hydraulic cement must necessarily contain, besides lime, alumina and silica; all other contents are not necessary. Such cement may, therefore, be artificially made, by adding to good lime such material as will impart those requisites, for instance, impure kaolin, slate clay, etc.

33. From that normal composition the kaolin varies frequently, without, nevertheless, being less useful and valuable. The analysis of the principal kaolin of Europe gives the following result:

	KAOLIN FROM:				
	Schneeberg.	Meissen.	Meissen.	Passau.	St. Yrieux.
Silica	43.6	58.6	46.46	43.65	46.80
Alumina	37.7	34.6	36.37	35.93	37.30
Peroxide of iron	1.5	—	—	—	—
Magnesia	—	1.8	1.22	1.00	—
Carbonate of lime	—	—	1.47	0.88	—
Potash	—	2.4	—	—	2.50
Water	12.6	—	13.61	18.50	13.00

I would have analyzed the kaolin of this State, in order to compare its quality with the above kaolins, had I not been deprived of the means of performing the analysis. Our kaolin has, nevertheless, been tested before the blow-pipe, and burned to porcelain ; it proves to be of a fine quality.

The most valuable mines in Europe are in Schneeberg, in Saxony ; the product of the mine is used in Berlin, in Prussia, and there converted, by the Prussian Government, into precious porcelain. A set of this porcelain, presented by the King of Prussia, after the wars with France, in 1816 or 1817, to the Duke of Wellington, was valued at 75,000 Prussian, or 55,500 U. S. dollars. It would scarcely have been dearer had it been of gold.

Other mines are near Meissen and Passau, in Saxony. The kaolin mined there is carried to Dresden, the capital of Saxony, and there changed into the finest porcelain existing. The profits of the manufactory are a revenue of the King of Saxony, and yield large sums. The porcelain of Berlin and Dresden is carried all over the known world.

Another mine of kaolin is in Fürstenberg, in the duchy of Brunswick. The kaolin is there inferior, and yields a bluish porcelain, but the manufacture gives, nevertheless, a large income.

Another mine is near Limoges, at St. Yrieux, in France ; the kaolin from there is carried to Sèvres, near Paris, in France, where it is manufactured into very fine aud famous porcelain, which is, nevertheless, inferior to that of Germany.

Other mines are in Cornwall, in England ; the kaolin proceeding from them is used for a coarser and cheaper kind of porcelain. The manufactures in England yield immense profits. The Wedgewood manufactures alone are said to occupy 60,000 workmen in Staffordshire.

The English porcelain is called *hard porcelain ;* that from the continent of Europe, *tender porcelain.*

For the fabrication of porcelain not only the kaolin is necessary, but also an addition of feldspar, flint-powder, and chalk. A very usual proportion is from 63 to 70 per cent. of kaolin, from 15 to 22 per cent. of feldspar, about 10 per cent. of flint, and 5 per cent. of chalk.

These ingredients can be easily had in Tishamingo county; for flint, the hornstone found above or near the kaolin will serve; feldspar can be had in Alabama and Tennessee; and the proportion of chalk being insignificant, can easily be procured.

A porcelain manufactory in the U. S., or in our Southern States, especially in Tishamingo county of this State, where there is fuel in abundance, and where, if wood should be wanting, coal can be easily procured from Alabama and Tennessee, and where the means of transportation, by water or railroad, are at hand, must be very profitable. All our fine porcelain comes from Europe, and is paid for very high.

Kaolin is found in some of the Northern States, especially in the New-England States and New-Jersey; but if it were of any value for fine porcelain, Yankee ingenuity would have long ago turned it to profit.

34. In another place I have already stated, that the carboniferous formation, after having been deposited by water, was upheaved above the level of the ocean, and converted into dry land. After having remained in that state from the end of the palaeozoic, or primary fossiliferous age, to the middle of the tertiary or kainozoic age (Table I. will give an idea of the period, and the different formations meanwhile deposited), it was again depressed, toward the middle, or perhaps end, of the miocene or middle tertiary period.

The waves of the ocean rolled again over it, and wrought immense changes. Parts of the carboniferous rocks were washed away, hills and dales formed, by the violence of currents, ledges of rocks broken up and changed into detritus, constituting a new kind of soil; foreign material, the detritus of distant geological formations, was carried hither, and the whole surface of the original formation overspread by a new formation, from under which it only reappears where that cover has been removed by atmospheric influence, and the effect of running water.

Thus it happened that the lignite group first appeared; the countries submerged under the surface of the ocean were overgrown by trees; these were uprooted and broken down by the waves and currents of the ocean, and floated as drift-wood in all directions and to all distances to which the ocean extended. From the drift-wood, and the surface soil in which the forest trees grew, the dark clay and lignite, and the aluminous sands, were formed.

After the exhaustion of that material, the underlying rocks were broken up, and gave origin to the orange sand group, containing less clay and more sand, and hard material—the consequence of its disintegration from rocks which had not been disintegrated before.

Among this material, the orange sand and the pebbles, interstratified with it, were carried thither, and among the latter their alternates, one of which is evidently the kaolin.

It is not only difficult, but nearly impossible, to determine now whether the kaolin was carried hither by the waves of the ocean as kaolin, or as fragments of the feldspathic rocks, of which it is the detritus. *Whence* it came, is equally as difficult to determine; hardly from Tennessee or Alabama, as feldspathic rocks are there scarce. There is more granite in Georgia than in any other neighboring Southern State; but I rather suspect that it came from another—a N. W. direction. The reasons for this opinion will later be stated.

35. Terra-cotta, or, literally translated, "baked earth," is originally a clay made of pipe or potter's clay, mixed with fine-grained sand and pulverized fragments of porcelain-ware, or potsherds; its preparation is originally an Italian invention, as the Italian name indicates. Red clay of Fayenza was used for the purpose, but it is now imitated in England, and most of the terra-cotta ware comes from there.

36. The ingredients which are used for the fabrication of glass, besides silica, are: potash, soda, lime, oxide of lead, oxide of iron, and manganese, and sometimes charcoal. The lime, oxide of iron, and charcoal, can be procured on the place; the potash, soda, lime, oxides of lead and manganese, can easily be had. There is an abundance of fuel in the immediate neighborhood of the deposit of silica; and if that should be exhausted, the Tennessee and Alabama coal-fields are very near.

37. The remarks on the agriculture of the county of Tishamingo have only reference to that portion of it occupied by the carboniferous formation; the other portion is occupied by the cretaceous formation, and will later be considered, with respect to its agriculture. I cannot omit to mention that, concerning the agriculture of Tishamingo county, I have received most valuable information from its able representative in the Legislature of the State, Hon. M. Suratt, and J. Berry, Senator from Tippah, to whom my sincerest thanks are due.

38. It is very possible that many of those pyrites have been changed from animal or vegetable bodies into sulphuret of iron. The sulphuret is generally found collected round fossil wood, and is met with in large quantities in the strata of lignite, which proves that organic matter promotes the formation of sulphuret of iron; and if this be the case with vegetable matter, it must be much more so with animal matter.

39. At the time of the deposition of the green sand of the glauconitic group, a tropical climate existed still in our latitudes, and most probably

much farther northwards; and the forest growth consisted entirely, or at least mostly, of endogenous and coniferous trees. The endogenous trees have all disappeared; our forests exhibit none but exogenous trees, that grow from without by forming annually a new layer of wood below the bark. The coniferous trees, the pines, cypress trees, cedars, firs, spruces, tamaracks, and others, are still in our latitudes, and extend as far northwards as any trees are capable of growing. The greatest variety of coniferous trees is even found in more northern climates, in Canada, Nova Scotia, Newfoundland, and even high up in Labrador; but those coniferous trees are not the same that grow in tropical climates.

40. The occurrence of such flint nodules, however small they may be, appears to me important, on account of the similarity of the strata with the upper cretaceous chalk in England, which bears flint nodules in great abundance and of large size.

41. Near Columbus, in Lowndes county, in the public garden of Dr. Rapp, which is considerably lower than the town of Columbus, an artesian well has been bored entirely through the green sand of the lower cretaceous formation, which extends there downwards to a depth of about 400 feet.

Below the green sand is there found a fine plastic clay of a greenish blue color, with red streaks, which is entirely foreign to the cretaceous formation, and bears exactly the same lithological character as the variegated clay, "marnes irrisées," of the poikilitic rocks. Interesting as the subject is, I have not been able to investigate it more minutely. It appears to me an indication that there exists between the cretaceous and carboniferous formation an intermediate one, perhaps the permian.

This supposition gains strength by an observation I made a few years ago in the county of Greene, near the town of Eutaw, in Alabama. A powerful stratum of variegated clay goes there under the green sand of the cretaceous formation, which does not belong to the cretaceous formation, nor has it any similarity with any rocks of the carboniferous formation north of that locality, and is probably an intermediate formation between the carboniferous and cretaceous. It crops out frequently between those two formations as variegated clays, of many different colors, red, blue, green, gray, &c.

Not far from that locality, perhaps some ten miles in a straight direction southward, were found in the bed of the Black Warrior, or Tuscaloosa river, on a sand-bank, just above a very deep place, three specimens of a ceratites, resembling, according to a communication from Professor L. Agassiz, the ceratites syriacus found by L. v. Buch in the Caucasus, which, being the first ceratites found on the continent of America, I have called *ceratites Americanus*. This ceratites has, most probably, been washed out of a formation underlying the cretaceous formation, for it has never been found in the latter.

The ceratites being especially a fossil of the triassic formation, it is possible that this formation underlies the cretaceous, and crops out between it and the carboniferous rocks in the "marnes irrisées," or variegated clays, so characteristic of it.

42. For the acquaintance with Plymouth Bluff, the only place where both cretaceous groups—the lime as well as the glauconitic groups—can be seen together, and for its palaeontological treasures, I am indebted to Dr. William Spillman, of Columbus, who has most thoroughly explored this locality, and made a perhaps complete collection of the fossils it contains.

The Doctor had the kindness of communicating to me the following list of his cretaceous fossils, of which those marked with an asterisk have been found in Lowndes county, and most of them probably near Plymouth Bluff.

Actaeonella (formerly tornatella or volvaria).
*Anomia tellinoides.
* " argentaria.
*Ammonites carinatus.
* " syrtalis.
* " lobatus.
* " nodosus.
* " placenta.
" conradi.
" ramosissimus.
" angulatus.
Anthophyllum atlanticum (1).
*Baculites asper.
* " compressus.
* " arculus.
* " labyrinthicus.
Belemnites americanus.
Bulla.
Bullina.
*Buccinum (2).
*Cardita.
Cucullaea lingula (3).
" cardita.
" vulgaris.
" antrosa.
Crassatella vadosa.
" two undetermined species.
Cidaris.
Callianassa (4).
Cerithium nodosum.
*Coprolites (5).
*Dentalium rugosum.
*Exogyra costata.
Fasciolaria (6).
Fusus, 3 different species
Gastrochaena.
*Gryphea incurva.
* " convexa.
* " mutabilis.
*Hamulus onyx.
* " alatus.
*Hamites torquatus.
* " arculus.
*Inoceramus alveatus.
* " inflatus.
* " triangularis.
* " proximus.
* " biformis.
* " barabeni,
* " scalaria.
Ichthyosarculites (7).
" quadrangularis.
" coricatus.
" cornutus.
*Lucina (8).
Marginella (9).

Melina (10).
*Mytilus.
*Nucula.
Nucleolites.
*Nautilus circulus.
* " angulatus.
* " dekayi.
* " spilmani.
*Natica petrosa.
*Ortrea ambigua.
* " plumosa.
* " panda.
* " cretacea.
* " falcata.
* " cornuta.
* " crenulata.
Pholas cithara.
Plagiostoma.
*Pyrula richardsoni.
* " trochiformis.
" 2 undetermined species.
Phorus leprosus.
* " umbilicatus.
Pinna.
Pholadomya occidentalis.
Pteroceras.
*Pecten quinquecostatus.
* " membranosus.
* " quinquenasius (?)
*Placuna scabra.
" a species not determined.
Rostellaria, 4 different species.
Radiolites undulatus.
" aimesei (?)
Scaphites reniformis.
Spatangus, 2 different species.
*Serpula.
*Trigonia thoracica.
*Turritella vertebroides.
*Terebratula harlani.
*Teredo tibealis.
* calamus.
Venus.
*Voluta fusiformis.
* " spillmani.
* " 2 species not determined.

Fossil Teeth.

*Saurocephalus lanciformis.
*Oxyrhina mantelli.
*Sphyraena.
*Lamna.
*Otodus appendiculatus.
*Enchodus cretaceous.
*Corax appendiculatus.
*Carcharias productus ? (11)

REMARKS OF THE AUTHOR.

1. The anthophylla belong principally to the Oolitic formation, and the occurrence of this phytocoral in the cretaceous formation is somewhat doubtful.

2. The buccinidae are very scarce in the older formation, and occur mostly all in the tertiary rocks; the buccinum here mentioned as cretaceous, is probably a turbo.

3. The name of cucullaae of Lamarck has been changed into arca, under which name they are better known.

4. Callianassa, now generally called *pagurus*, a cretaceous fossil of the order *macrura*—a crab with a long tail, which occurs frequently in the white carbonate of lime of the lime group, especially near Pontotoc.

5. Dr. Spillman alludes probably to the coprolites of the mosasaurus, of which I found in his collection fine specimens.

6. The fasciolaria here mentioned, is most probably a fusus; the fasciolariae, differing from the fusi, by having from one to three oblique folds on the columella, occur only in the tertiary rocks. Or the specimen of Dr. Spillman may have come from tertiary rocks.

7. Probably ichthyodorulites, lanceolate bones from the fins of fishes.

8 Very rare in the cretaceous formation, especially belonging to the tertiary formations.

9. Marginella is no cretaceous fossil; it occurs only in tertiary rocks, as all other cypreadeae to which it belongs. The fossil has probably either been erroneously determined, or comes from eocene or miocene rocks.

10. There is no melina, according to my knowledge; it must be melania, now generally called eulima. (If a coral, it must be melonia).

11. Carcharias, or generally now carcharadon, is, according to Prof. L. Agassiz, of Cambridge, a tertiary squalus. He describes 14 from the tertiary rocks, and some from uncertain localities. The fossils not marked with an asterisk are also all from the State of Mississippi, and have been found in Noxubee, Monroe, Chickasaw, Pontotoc, Tippah, and Itawamba counties.

The importance of Dr, Spillman's collection of cretaceous fossils for the palaeontology of the State of Mississippi, will be evident from the above list. The doctor has most kindly tendered to me, not only his cabinet, for my use, but also his valuable assistance, for which I feel deeply indebted to him. It has hitherto been impossible for me to devote much time to the palaeontology of the State, but for the final report on the geology of the State, the cabinet of Dr. Spillman will be a real treasure, and save much time and labor.

43. The strata could not lie conformably to or parallel with each other if they had been disturbed by any catastrophe, as an upheaval, a subsidence, an earthquake, or others.

44. Dr. Wm. Spillman, who had the kindness to conduct me to this remarkable place, has given it the name of *Shark's Defeat*, on account of the thousands of shark's teeth which are continually found there.

45. The lower part of T. 6, R. 4, of Tippah county, is remarkable for singular formations. On Sec. 36 there is a *natural tunnel*, about 25 yards long, which serves as a bed for a little rivulet. It is about 25 feet below the brow of the hill. At the W. end it is from 6 to 7 yards wide, but only about 4 or 5 feet high, and becomes lower where it narrows. Near the same place there are several other small caves and holes, all in the easily washed cretaceous formation.

46. It was here that Gov. Jos. Matthews found the marl, and recognized it; and so the honor of being the discoverer of the rich marl-beds in Tippah county belongs to him.

47. The Assistant Geologist says of a well of Dr. Agnew, on Sec. 27, T. 6, R. 5, in Tippah county: "Its water is most powerfully impregnated with carbonate of lime, so much so, as to give it an alkaline taste; it blues red litmus-paper, completely, in ten minutes (effect of the alkaline earth, the lime), and incrusts everything it touches with lime, and becomes turbid soon after being taken from the well. Oxalate of ammonia almost turns it thick with the precipitate of oxalate of lime. It is quite a *medicine* to take, and not a homeopathic one either; nevertheless, it is used

for all purposes, except for making soap-suds." For that purpose, of course, it could not be used, on account of the large quantity of carbonic acid which would combine with the alkali of the soap, decompose it, and liberate the fatty matter.

48. Coprolites of a mosasaurus are the petrified excrements of that large marine saurian or lizard, which is about 24 feet long. It is the only one which had survived, at the time of the cretaceous formation, the large number which existed from the triassic to the oolitic period, and the last of them.

Marine saurians are not now in existence; the cetaceans, or the whale tribe, seem to have taken their place. The only fair representative of those immense marine monsters, is the crocodile, a species of which is our alligator; it is fluviatile and not a real inhabitant of the ocean. It is only found in estuaries of the sea, and now and then, although very seldom, on the coast.

The coprolites of the mosasaurus have somewhat the shape of a palaeozoic fossil of the transition formation, the orthoceratites, for which it has been mistaken.

49. A singular accident happened here in Chickasaw county, on Sec. 19, T. 12, R. 4, several years ago, which confirms the geological principle, that carbonate of lime is the quickest petrifier.

In the year 1845, a Mrs. Irby died, and was buried at Mr. Baker's place, and this was done entirely in the carbonate of lime. In 1850 the corpse was, for some reason unknown to me, exhumed, and found to be entirely petrified, perfectly preserved, and as heavy as stone. Having been for some time exposed to the atmosphere, the corpse commenced, nevertheless, to decay, and was afterwards reinterred. The phenomenon is easily explained. The corpse was not only interred in, but also entirely covered with carbonate of lime, and the water of atmospheric precipitations, percolating through the ground, dissolved a portion of the carbonate of lime, and saturated the corpse with it. The corpse, nevertheless, decayed after an exposure of some time to the atmosphere, because the petrifaction was not completed internally. A remarkable circumstance was, that some other corpses buried along side of the petrified one, were, on examination, not found to be petrified; this was most probably the result of their not having been covered with carbonate of lime, but with the red sand overlying there the lime group.

50. Dr. William Spillman, of Columbus, who has closely examined the cretaceous formation in Lowndes and a part of Ocktibbehah county, assures me that the dip of the cretaceous strata from N. N. E. to S. S. W., amounts to about 25 feet in the mile. He has observed the boring of a great many artesian wells, and conversed with the borers, and has in

that manner ascertained that every mile further S. S. W., or S. W., the hole must be bored, on an average, 25 feet deeper: this agrees perfectly with the dip of the strata at Plymouth and Barton's bluffs, which were ascertained as well as possible.

51. Ganoid fishes are such as are provided with hard and bony scales; as, for instance, our garfish. Placoid fishes are those which are provided with chagreen instead of scales; as, for instance, all the sharks.

52. Mollusks, or molluscous animals, are such as have no bones in their bodies—soft animals. They are divided into cephalopods, such as have their organs of locomotion around the head; gasteropods, such as have their organs of locomotion on their belly; and acephals, those without a head.

53. Real chalk occurs in Germany only on the island of Rügen, in the Baltic sea, where it appears in immense bluffs on the coast, and forms a magnificent and picturesque scenery.

54. The cidaris has not been mentioned among the cretaceous fossils. I received it through the kindness of Col. R. Bolton, of Pontotoc, who has paid much attention to the palaeontology of the cretaceous formation, and is in possession of valuable fossils. He is also the first discoverer of the pagurus, or callianassa.

55. The extent of the cretaceous formation here, on the continent of North America, is so great, much more so than in Europe, even comparatively, that the petrographic character cannot but vary very much. The great cretaceous system of the United States commences immediately below New-York, in Monmouth county, of New-Jersey, where it appears first in very important deposits of green sand of the glauconitic group (terrain turonien of France, and pläner of Germany). It extends, southwards, all along the Atlantic coast, over Delaware and Virginia—furnishing in all those three States the fine green sand manure which is of so great benefit to them. From Virginia it extends into North Carolina, South Carolina and Georgia, but is in those States frequently so overlaid by tertiary formations, especially the eocene, that it disappears mostly, cropping out only in a few places. In Georgia it seems to disappear entirely, and reappears only in its western part, near the line of Alabama, extending from there, in a wide belt, through Alabama into Mississippi. In Mississippi it is most probably divided in two branches; the one extends, as the annexed geological map exhibits, in a N. W. direction into Tennessee. The other disappears under the eocene formation, and re-appears only in Texas, where it extends over a large territory, and can be traced to the mountains of New-Mexico, and, perhaps, with interruptions, to the territories of Kansas and Nebraska.

The boring of an artesian well in the State penitentiary, in Jackson, is of great importance with respect to the knowledge of the continuation of the cretaceous formation from East Mississippi to Texas; it will disclose whether the cretaceous formation underlies there the eocene or not.

The petrographic character of our cretaceous formation differs much from that of Europe; it seems as if we had only the upper part of the European cretaceous formation, and in that, neither the chalk of England, nor the quader of Germany are found.

The palaeontological character of both cretaceous formations in Europe and America, differs also considerably. Lyell examined 60 fossils of the cretaceous formation in New-Jersey, and found among them only five identical with European cretaceous fossils. Forbes found 15 identical. F. Römer found among 44 species of fossils of the lower cretaceous formation of Texas, 11 identical with European species, and six others analogous. In the upper Texan cretaceous formation, he found among 36, only three identical and seven analogous.

56. The paludinae, the prevalent and most characteristic fossils of the whole prairie soil, extend downwards to the lower part. In this lower part, especially at the base, small cretaceous fossils are frequently found, but they are only washed in the prairie soil and do not belong to it.

57. Artesian Wells.

Artesian wells depend upon the internal constitution and arrangement of the diferent strata of the crust of our earth, and can therefore not be bored everywhere, and, as in this State, frequently money and time are wasted, in attempting to bore such wells, where the arrangement and constitution of the geological strata are not suitable. and where there is no prospect of success. It will be most useful to explain the theory of boring such wells, and indicate the localities where artesian wells can be successfully bored.

Artesian wells are such as are not only bored with an artesian bore, but the *water of which rises above the surface* of the ground in which they are bored, and which yield a continual stream of water without any artificial means to raise it. If we call every well bored with an artesian bore, an artesian well, whether the water rise above the surface or not, we may say artesian wells can be bored everywhere, for there is scarcely a place on the surface of the globe where water cannot be found, unless the ground consists of solid rocks, which exclude all water; but bored wells whose water does not rise spontaneously above the surface are of little use; the water must be pumped up, or dipped with a tube, provided with a valve, and as the whole is only a few inches wide, they yield very little water at a time.

Real artesian wells, which are of such very great importance in dry countries, for agriculture, as well as for the arts, have been in use in

France and Italy, and most probably also in China, and other oriental countries, for several centuries, but have only been introduced in other countries, as into Germany and England, about 60 or 70 years ago. The first of them bored here in the United States are of a much later date.

The application of an auger for the boring of such wells which we now call artesian, but which might, with more propriety, be called Syrian, Egyptian, or Chinese wells, occurs first in the oldest historical times.

Ayme-Bey, a Frenchman, in the service of the Basha of Egypt, has restored bored wells in the deserts and oases of Egypt, constructed about 4000 years ago.

Our Holy Bible mentions wells in the deserts of Syria and Arabia, which were most probably bored wells, and date since the earliest patriarchal times. Such wells are those of Israel, of Bedsabe, the well of abundance, and others.

Olympiodorus of Alexandria, who lived about 500 years after Christ, speaks of wells in the oases of from 600 to 1000 feet in depth, which send forth their water like rivers, and were used for the irrigation of fields.

The Bishop of Tabrasca, a missionary in China, in early times, relates that the wells of Ou-Tang-Kiao, are several hundred feet in depth and very narrow, and serve to procure salt water. In the same province are several thousand of these wells, in the narrow space of about 150 square miles; several of them are from 1500 to 1800 feet deep, and have a diamter of only five or six inches. Some of these wells exhale inflammable gas, and are called *fire-wells.*

The oldest bored well in France is found in Lillers, in the province of Artois, in the yard of an old convent. It is said to originate from the year 1126.

The first records concerning artesian wells are found in the work of Professor Modena in Italy, published in 1691, and in that of Belislar, on the science of engineering, published in 1729.

The early existence of bored wells in the province of Artois, and the facility with which they are bored there, has given origin to the name of *Artesian Wells.*

A great many of such wells exist now everywhere on the continent of Europe, as well as on this continent; and as they are desirable everywhere, on account of the facility with which their water is procured, the prin ciple on which they are bored ought to be generally known.

The boring of an artesian well, depends mainly upon three things:

1. Upon the physical constitution or nature of the ground where a well is to be bored.

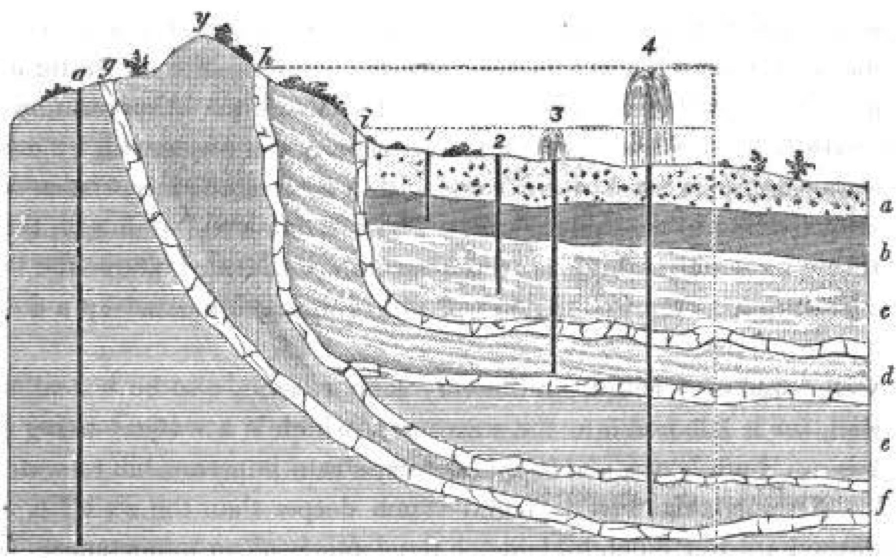
2. Upon a perfect knowledge of that ground; and

3. Upon the skillful direction of the boring.

With respect to the nature of the soil where an artesian well shall be successfully bored, it is necessary that certain different geological strata alternate with each other; a water-bearing stratum, and two strata impenetrable by water, are necessary, and they must be so situated that the water-bearing stratum is in the middle of the two strata impermeable to water; but these three strata must at the same time not lie horizontally—they must have a considerable dip or inclination to one side.

The following diagram will illustrate the subject:

[No. 51.]



Let the strata *a*, *b*, *c*, *d*, *e*, *f*, be all water-bearing strata—that is, strata which are composed of loose material, such as sand, gravel, pebbles, etc. A well bored at 1 will not be a real artesian well, whose water rises above the surface, for two reasons:

1. Because the strata lie perfectly horizontal, and have no appreciable dip to one side.

2. Because the three strata, *a*, *b*, and *c*, are not separated from each other by other strata, impermeable to water, and the water is too much diffused in them.

A well bored at 2 will have no better success, it is bored deeper, and extends downwards into the stratum *c*; but this, although also water-bearing, has neither a dip, nor is it surrounded by impermeable strata.

Both wells (1 and 2) may give, and certainly will give, water; but it will only rise a few inches or feet in the tube; it must, consequently, be raised by artificial means, pumped or dipped, and the wells are, therefore, of very little use.

It is different with a well bored at 3; this will be a real artesian well., It is bored into the stratum *d*, which is not only water-bearing, but has also, on both sides, above and below, strata impermeable to water, represented in *h* and *i*; and not only that, but also the third requisite is not wanting:—this stratum has a considerable dip, or inclination towards the place where the well is bored. The principle on which this well furnishes water is the following:

The aqueous precipitation from the clouds, or the water which comes down from the clouds as rain, dew, snow, or hail, falls upon the surface from *h* to *i*, and percolates partly to the bottom of the stratum, where it cannot escape, because it is kept in that water-bearing stratum *d*, by two strata impermeable to water, *h* and *i*; the stratum *d* will, therefore, be gradually saturated with water, and the water in the upper part of the stratum, as well as the atmosphere, exert a considerable hydrostatic pressure upon the water in the lower part of the stratum. As soon, now, as an artesian hole is bored through the stratum *e*, the water will, by means of the pressure, exerted in accordance with a hydrostatic law, rise as high as it falls, tending to an equilibrium. The artesian well No. 3 will, therefore, throw its water as high as the stratum *d* is elevated above the level of the stratum *a*, as represented on the diagram, and indicated by a dotted line.

A well bored at 4 will, from the very same reasons, also be a real artesian well, for it is bored into the stratum *f*, which is a water-bearing one, and has on both sides, above and below, strata impermeable to water, *g* and *h*. Although the well is bored much deeper than the well No. 3, it will throw its water much higher, for the depth is of no importance. The water derived from the precipitation from the clouds enters into the water-bearing stratum *f*, between *g* and *h*, at a much greater elevation than *i*; and, according to the above quoted hydrostatic law, "that the water rises exactly as high as it falls," the water of the well No. 4 will rise as much higher than that of No. 3 as *h* is elevated above *i*, exactly as it is represented in the diagram.

From the foregoing practical illustration we may then derive the following theoretical principles:

All water in the crust of our earth is derived from aërial precipitations, from rain, dew, snow, hail, etc. The water which falls in this way annually upon the surface of our globe would, if it remained upon the surface, rise to the height of from 6-10 to 65-100 of a French meter (being 3 feet and 3. 7-10 inches), and amount for each square of one kilometer, or 1,000 meters, to a volume of from 600,000 to 700,000 cubic meters. A part of this water flows over the surface of the soil, more or less fraught or impregnated with the detritus carried away from the geological strata over which it flows, by friction or dissolution.

Another part of that precipitation disappears by evaporation in the atmosphere; and a third part, lastly, is absorbed by the soil, in which it sinks down to a certain depth, depending upon the geological condition of the different localities where the absorption takes place.

The water absorbed in this way circulates in the interstices, fissures, and pores of the different formations, according to their looseness or compactness, sometimes freely and without any tension, and forms there springs, which appear, especially in wet seasons, remain for some time, but disappear at last, until they are fed again by repeated precipitations from the clouds. Sometimes the absorbed water penetrates to the internal strata of our earth, slowly and gradually, and keeps them continually supplied with water, other precipitations following before the water of previous rains is exhausted: in these cases springs are formed which last for ever, and give an uninterrupted supply of water.

In some localities the water absorbed by the soil forms subterraneous reservoirs in caves and basins, which it fills entirely; it remains, then, perfectly stagnant. The overflow of such subterraneous reservoirs finds its way to the surface of the soil, forming there springs, ponds, or swamps, according to the condition of that surface.

When a stratum of sand, gravel, pebbles, or other loose material, is separated and isolated, as it were, by other strata, or even seams of a material impermeable to water, it is a water-bearing stratum, a vast reservoir, giving an abundant supply of water as soon as it is perforated by a vertical bore-hole.

The cause of this rise of the water above the mouth of the bore-hole, or above that point where it is reached by the auger, has already been alluded to. An artesian well is, as it were, the shorter shank of a bent tube, the other longer shank of which is continually supplied with water from a reservoir (the clouds), above the mouth of the longer shank; or, as it can be explained in another manner, the water rises in the auger-hole of an artesian well in consequence of a hydrostatic law, according to which the water, tending to an equilibrium, rises as high as it falls.

Such is the theory; we will now examine its application.

In tubes of a small dimension, with polished surfaces, theory and practice, or application, will agree to a scarcely perceptible difference; the rise will even, by means of a capillary attraction, exceed a little the fall. In large conducting tubes that difference between the elevation of the water in the reservoir, from which it flows, or which feeds the conducting tube, and that point to which it rises, differs sometimes considerably, according to the dimensions, conditions, and forms of the conducting tubes.

There is evidently a certain relation between the total pressure of the water and that affected by it in the conducting tubes. The first is represented by the elevation of the point of influence in the tube, above the point of effluence; the second is calculated according to the real velocity of the water with which it flows out of the mouth of the tube; the real quantity of the issuing water amounts frequently only to one-third, or even one-quarter, of that which ought to issue according to calculation. This difference is owing to the impediment caused by friction in the tube.

It is, therefore, evident, that if this impediment causes such a considerable anomaly, or if the movement of the water be so much retarded by friction in conducting tubes, this must be much more the case in the irregular canals in the subterranean formations of the earth, which are so much barred by detritus, veins, conglomeration of all kinds, &c. This enormous impediment renders it possible that an artesian well does not afford water rising above the surface of the ground through which it is bored, although the point of effluence is far below the point of influence, and, although, according to theory, it ought to yield an abundance of water.

Instead, therefore, of admitting that, according to a theoretical hydrostatic law, the water bored up by an artesian auger must rise as high as it falls, or to the elevation of the point of influence, the effect of that law should be practically expressed: that the water must rise in proportion to the pressure, minus the effect of the friction, and the decrease of the volume of the water caused by absorption, and fissures in the rocks through which a part of the water runs in different directions; which, of course, must diminish its velocity considerably.

The elevation to which the water rises in a bored hole, or through a bored hole, amounts, therefore, to an average one, not only between the elevation of the points of influence and effluence, but also between the distance of the bored hole from the point of influence compared with the distances of the points where parts of the water are lost.

Provided now the water-bearing stratum in which an artesian well is bored is considerable enough, the well will give a perpetual supply, and the water, drawn from the stratum in that way, continually be replenished by renewed precipitation; but if too many artesian wells are bored in the same water-bearing stratum, and an unproportional volume of water taken away, as has frequently been done, the water must diminish and cease to flow, as the reservoir is inadequate for their supply.

Such an accident has recently happened in Columbus; after the boring of one or more new artesian wells, one of the principal artesian wells of the town ceased almost entirely to give water.

The above explanation will, at the same time, convince us, that the second point, "the knowledge of the physical constitution of the strata, or ground in which an artesian well shall be sunk," is absolutely necessary.

It must first be ascertained that there is, on the place where an artesian well is to be bored, a water-bearing stratum; that this stratum has on both sides strata impermeable to water, and that it has a sufficient dip, or an inclination towards the well, sufficient to allow the hydrostatic pressure, or the tendency of the water to an equilibrium, to overcome all impediments, and force the water to rise above the mouth of the bore-hole.

For instance, if a farmer living at x of the diagram, should conclude, because his neighbors 3 and 4 have fine artesian wells, it must be easy for him to have a similar one, he would be much mistaken; he could bore, as the diagram shows, much below the bore-hole of the well 4, and, nevertheless, he would never be successful, for the water-bearing stratum runs off from his farm, and dips towards the opposite side, a fact which only a practical geologist can ascertain; and all that can be done at x is to bore a well in which the water rises only a few inches or feet, and even for that purpose the well must be a very deep one.

A similar case occurred about four years ago in Eutaw, Greene county, Alabama. There being artesian wells all around Eutaw, and one, south of it, not more than half a mile from the court-house, the town authorities concluded to bore an artesian well in the town, near the court-house. Eutaw being exactly situated on a considerable elevation whence the water-bearing strata incline N. and S., the well was bored just in the opening of the stratum at the point y of the diagram; it consequently could not furnish water above ground, and the boring was relinquished after having arrived at a depth of more than 800 feet, whereas the artesian wells in the neighborhood of Eutaw are only from 180 to 300 feet deep.

Before an artesian well is bored, a practical geologist, well acquainted with the country, ought, therefore, always to be consulted, especially if no such wells have yet been bored in the same geological formation. This is not necessary in countries where experience has shown that artesian wells can successfully be bored everywhere; but it is absolutely necessary where such is not the case, and it will save much expense and labor.

Had a geologist been consulted before the boring of an artesian well at New-Orleans was begun, I believe he would have advised not to attempt it, for it appears to be almost impossible to meet with success in a situation and geological formations as there are found.

New Orleans stands upon the alluvium of the Mississippi river, which is there about 550 feet thick (between 500 and 570 feet). This alluvium has already been perforated, and found to rest immediately upon the lower tertiary formation—the lower eocene. The thickness of those rocks must be estimated according to analogy, at from 800 to 1000 feet, and there is no prospect of finding a stratum suitable for an artesian well, in the tertiary rocks.

If the cretaceous rocks happen now to underlie the eocene, at New-Orleans (which is by no means certain, though probable, as they appear in all surrounding States), a water-bearing stratum suitable for an artesian well will certainly be found in the lower part of them, in the glauconitic group; the upper lime group contains no water; but in order to come to such a stratum, the whole lime group, or the upper part of the formation, must be bored through, which cannot be estimated to be less than from 700 to 800 feet thick; a depth of the well of from 2000 to 2,350 feet, will therefore be required; but the boring to such a depth insures by no means a real artesian well, the water of which rises out above the surface; another requisite must exist—the strata, at least the water-bearing stratum, must have a sufficient dip towards the bore-hole, and the existence of such a requisite in a flat country as Louisiana, and especially the environs of New-Orleans, which offer scarcely a hill within 100 or 150 miles, is extremely doubtful.

Even if such a dip should exist, it is more than probable that its effects are counterbalanced by the obstacles and impediments, and the escaping of large quantities of water. We have seen the elevation to which the water rises in a bored hole, or through a bored hole, amounts to an average not only between the elevations of the points of influence and effluence, but *depends also upon the distance of the bored hole from the point of influence.*

That distance is very great in New-Orleans; the friction and loss of water must therefore be proportional, and also very great, and the impediments immense; even if a considerable dip exists, its effect would most probably be counterbalanced by those impediments.

The example of Charleston, S. C., will doubtless be quoted in favor of New-Orleans. It is true, an artesian well has there successfully been bored, with great expenses and labor, by boring down about 1800 feet. But the geological situation of Charleston cannot be compared with that of New-Orleans. Charleston does not stand on the alluvium of any importance, but on the eocene; and compared with New-Orleans, more than 500 feet of boring through that alluvium have been saved, and besides, it was well understood that the eocene rests there upon the cretaceous formation; also the requisite of a sufficient dip to force the water above ground, could be relied upon, the strata having there a more decided inclination directly towards the sea-coast, which is much more uncertain in New-Orleans.

The example of Charleston ought, therefore, not to have decided for, but much rather against, an attempt at boring an artesian well in New-Orleans, as it would be foreseen that the well would have to be bored just as much deeper as the alluvium extends downwards—from 500 to 557 feet; which will very nearly treble the expenses and the time of boring, without increasing the probability of meeting with success.

Should the opulent city of New-Orleans persevere and accomplish this purpose, the honor will probably be hers of having bored the deepest artesian well in existence; the result will be known in eight or ten years.

It is furthermore necessary that the boring of an artesian well should be directed with skill and intelligence, not only to prevent accidents which may often prove detrimental to the whole undertaking, but delay the operation, and increase the expenses considerably. It is most important to apply tubes of the required and suitable size, where they are necessary to keep the water uncontaminated, and prevent the wall of the bore-hole from caving; and to select the most necessary and convenient instruments, especially when accidents have happened, which are nearly unavoidable, if the hole has to be bored very deep.

It is not the place here to give minute instruction in the performance of the boring of artesian wells; suffice it to say, that in different countries a great deal of attention has been paid to the important work of boring such wells, and different systems have been invented.

The oldest of those systems is probably *the Chinese system*, which consists in the application of a very heavy ramming bore, moved by means of an extensible rope; it works by percussion.

The next is the *Artesian, English, and German system*, in which the rope is replaced by an iron pole. In the *Prussian system* the iron pole has been replaced by easier managable wooden ones, mounted only with iron. This system agrees with that adopted in the United States.

The *French system* consists in the application of the Chinese bore on the end of a *safety-tube,* which is sunk in the bore-hole together with the lower, the working part.

In another system a hollow bore is used, consisting of single pieces, that can be screwed together and unscrewed, like the poles, and in which the thrusts are executed by means of a rope.

Another system has lastly been invented, by Mr. Fauvelle, a Frenchman; according to this, hollow poles are used, serving as a guide, not only for the working part of the instrument, but also for a forcing-pump, with which the borings are taken out.

Having seen that for a successful boring of an artesian well it is necessary that water-bearing strata should alternate with other strata impermeable to water, we perceive that not all geological formations of our globe are favorable for artesian wells.

Some formations—for instance, all those of the quaternary and tertiary ages—consist almost altogether of loose water-bearing strata; they seldom contain stone, but where ledges of stone are met with, they are generally local, and very little continuous. The same is the case with several other formations—the wealden, the drift formation, etc. Particularly favorable for the boring of artesian wells is the cretaceous formation, that is to say, the lower glauconitic group; the upper or lime group contains no water-bearing stratum.

That glauconitic group consists mostly of green sand, or sand in general, at least in the United States, which is separated in different strata, either by hard seams of indurate sand, cemented by lime and silica, or of seams of oxide of iron, mixed with sand.

Wherever these strata can be bored into, artesian wells can be established. This is, in our State, especially the case in Lowndes and Ocktibbeha counties. The strata have there a sufficient dip or inclination, and the upper stratum of white carbonate of lime is either entirely wanting, as on the left or eastern bank of the Tombigbee river, in and near Columbus, or it is not too thick, as in a southern and western direction from Lowndes county, in Ocktibbeha and Noxubee counties.

Columbus, as we have seen, is about 221 feet above the level of the ocean; the northern part of the cretaceous formation, very nearly 400 feet, which gives on one side a sufficient elevation, and on the other a sufficient depression. Artesian wells in Columbus and its vicinity have to be bored to a depth of from 300 to 400 feet only, and are, therefore, not very expensive.

From Columbus the cretaceous formation inclines S. W., at the rate of about 25 feet per mile; artesian wells W. of Columbus have, therefore, to increase in depth at that rate.

Below or S. of Columbus, in Noxubee county, it has been attempted to bore artesian wells, but without success; the lime group of the cretaceous formation being there more than 600 feet thick; but artesian wells can certainly be bored there, provided the auger is sunk deep enough; a depth of from 800 to 1,000 feet will there be required.

In the northern region of the cretaceous formation, in the upper parts of Pontotoc and Itawamba, and in the eastern part of Tippah, and the western part of Tishamingo counties, wells are bored in many places, which give fine water, but they are not strictly artesian wells; the dip or inclination there is not sufficient; the water does not rise above ground, and must be pumped or dipped up.

To bore artesian wells in any other part of Mississippi is either subject to great difficulties or entirely unfeasible, as the rest of the State is overlaid either by tertiary or alluvial formations.

In the alluvium of the Mississippi the boring of artesian wells offers at least enormous difficulties, and is, indeed, impracticable, as the attempt made in New-Orleans will probably show. This formation consists of fragments and detritus, carried away from different formations and rocks of different ages and periods; its contents are: sand, gravel, pebbles, clay, and vegetable mould. The looseness and permeability of these strata permit the water to extend itself to all sides and to circulate freely; it is, therefore, too much diffused, and there is neither a suitable water reservoir, to feed an artesian well, within the reach of the auger, nor is there dip enough; and even if a water-bearing reservoir was opened by the auger, the water could not rise above the mouth, or even to the mouth, of the bore-hole.

In the tertiary formations in general, but especially in the State of Mississippi, nearly the same condition takes place. They consist mostly of loose and permeable rocks, and contain mostly sand, gravel, pebbles, marl, loam, &c.; wherever stone or impermeable strata are found there they are very little continuous. In no part of the tertiary formations, neither in the eocene nor miocene, water-bearing strata confined between two impermeable strata can be expected; consequently, the source of artesian wells cannot be looked for within these formations.

In order to bore an artesian well in these tertiary formations, they must be bored through, and the auger sunk in the underlying rocks. If these be the cretaceous rocks the success is most probable, provided the auger can be sunk through the upper or lime group, in the lower or glauconitic group.

This is possible in the territory of the eocene formation. We have seen that the eocene of Mississippi is the lowest part of that formation, perhaps partly an equivalent of the nummulitic rocks. Its thickness cannot be estimated at more than about 800 feet. If, now, the cretaceous rocks underlie that formation,—which is very probable from its being surrounded by them on all sides; they crop out on the line of Alabama, and again in Texas and Arkansas—the auger must also be sunk through the upper part of those rocks which have a thickness of about 800 feet; the boring to a depth of 1600 feet renders, therefore, the finding of a water-bearing stratum suitable for the source of an artesian well probable.

It is most important that it should be known whether artesian wells can be successfully bored within the large territory of the eocene formation in Mississippi. The Legislature has, therefore, ordered that an attempt shall be made, and, since about a year, the boring of such a well has been commenced in the yard of the State Penitentiary, in the capital of Jackson; decidedly the most convenient place, because the work can be accomplished by convict labor, and no other real expenses are caused by it but for the purchase of the instruments and the tubes which are necessary to secure the walls of the bore-hole

That the water coming from the cretaceous formation underlying the eocene has fall enough and will rise above the surface of the soil, is more than probable, because of the considerable dip of the strata from N. W.

to S. E., and because the distance from the point of the infiltration is not too great.

If the boring of an artesian well in Jackson prove successful, which will only be known after the lapse of three or four years, the example can be followed up by all that part of the State situated south of a line between the towns of Canton, in Madison, and Marion, in Lauderdale counties, or below that line which is marked out on the accompanying geological map of the State as the boundary line between the eocene and miocene formations; a country, a large part of whose inhabitants now use cistern water, on account of the large quantity of carbonate of lime held in solution by the well-water, and in many of the counties on account of the scarcity of even that water during the summer months.

To bore an artesian well, N. of the line above-mentioned, in Marshall, De Soto, Lafayette, Panola, Yalabusha, Tallahatchie, Carroll, Calhoun, Holmes, Yazoo, Atala, Winston, Leak, and Neshoba counties, in the territory of the miocene formation, appears, if not entirely impossible, at least unfeasible and impracticable.

Neither the miocene nor the eocene rocks contain water-bearing strata suitable for the source of an artesian well. The miocene rocks rest, without doubt, upon the eocene, as that part of the latter formation shows which crops out in the western part of Tippah county. The miocene formation must be estimated to have a thickness of from 700 to 800 feet, the eocene from 800 to 1000 feet, and that part of the cretaceous formation which has to be perforated by the artesian auger before a water-bearing stratum can be reached in the glauconitic group of the cretaceous formation, from 700 to 800 feet; the artesian auger must, therefore, be sunk to a depth of from 2200 to 2600 feet, before water, rising above the surface of the bore-hole, can be expected.

That a hole can be sunk to that depth is unquestionable. It has been done thousands of years ago; why should it not be done in a time in which arts and sciences are much more advanced? But it is extremely doubtful whether the dip is such as to overcome all the impediments, and carry the water above the level of the bore-hole; and it is very certain that the enormous work, not yet accomplished in modern times, would require a space of time of ten years, and an expense unproportional to the advantage of artesian wells, even in the extremely doubtful case of the very best success.

58. An example of how much the admixture of the orange sand with the post-oak soil improves the latter, was afforded me in the State of Alabama, in Greene county.

By examining a plantation lying along a ridge of hills, I found a large field of some twenty or more acres of post-oak soil, lying exactly on the slope of a hill covered with rather coarse orange sand, gravel and pebbles; the rain water running from the hill had washed a great deal of the sand, gravel and pebbles upon the post-oak soil, whose surface was nearly covered with it. The owner of the plantation was fearful that his land was ruined, but, nevertheless, he plowed the silicious material under, planted the land in corn, and made an average crop of 75 bushels of corn from the land, which before was believed to be very inferior.

59. The Rust in the Cotton Fields.

A disease of the cotton plant, now very prevalent in our cotton fields, especially in the prairies of Mississippi and Alabama, is the rust. Its nature has a long time been very doubtful, but it is no more so; an examination under powerful microscopes has shown that it is a parasitic fungus—a cryptogamic plant—called in natural history, *aredo*, by which the cotton plant is entirely covered, and which abstracts from it so much of its constituent parts necessary to its existence, that the plant must either die or become so diseased that it is unfit for the production of the seeds and their envelop—the cotton wool. A chemical analysis of this aredo has shown that its principal ingredient is phosphate of iron, a combination of phosphoric acid with oxide of iron.

An analysis of the cotton stalk, by Prof. Lawrence Smith, M. D., now of the Louisville Medical College, consequently by a reliable chemist, shows us that the cotton plant contains 9.1 per cent. of phosphoric acid, and 0.4 per cent. of iron. Phosphoric acid, as well as oxide of iron, is necessary for the growth of the cotton plant, and if either, all or only a large part of them, are subtracted from it by the parasitic aredo, it must either die or at least be rendered diseased and unfit for the production of its seeds and their envelop.

It is, indeed, very important for our agriculturists to ascertain what is the origin of the most disastrous disease of the rust, or aredo. So much appears certain, that the original disease of the plant is not caused by the rust, but the first appearance of the rust is a consequence of a diseased state of the cotton plant; the rust increases after its first appearance very rapidly, and destroys the cotton. It being a fungus, it follows, that it bears seed like all other fungi, and it must, consequently, be contagious, and, if only first produced in a few plants, infect the whole field, or at least a large part of it, and destroy the crop to a great extent.

The first diseased state of the cotton plant, which gives origin to the rust, is most probably produced by a stagnation and chemical change of the sap in the cotton plant, which can be caused in different ways:

1. By unfavorable weather. This is, of course, beyond the control of the agriculturist.

2. By a shallowness or bad preparation of the land; if, for instance, a field has a very hard subsoil only a few inches below the surface, and is

planted in cotton without breaking the subsoil up, and loosening it for the penetration of the tap-root of the cotton plant into the subsoil, the cotton plant will take the rust as soon as the tap-root reaches the subsoil.

An instance of this was afforded to me in the most fertile part of our State, the valley or bottom of the Yazoo river. The owner of a plantation showed me a large field, of an excellent soil, capable of bearing a very heavy crop, complaining that the field would not be planted in cotton because the plant took invariably the rust at a certain season, and when it had attained a certain heighth, but that this was not the case with corn.

The periodicity of the disease led me immediately to the idea that an impediment in the soil must be the cause. I examined the soil, and found that nine inches below the arable surface-soil, there was a clay sub-soil, very nearly as hard as a stone. Of course this sub-soil could not be penetrated by the tap-root of the cotton; its growth must, therefore, be arrested as soon as that tap-root reaches the sub-soil. This, then, causes a stagnation in the growth of the plant, and a chemical process takes place which we may call fermentation, giving rise to the growth of the parasitic fungus—the rust.

This disease must likewise take place, or can take place, when the land is not sufficiently prepared. It attacks, especially, and in these cases, nearly exclusively the cotton, and not the corn, because the cotton has a tap-root which has to penetrate deep into the ground, for the success of the plant; the corn has only hair-roots, and its roots remain on the surface.

3. The disease of the rust is especially produced by an imprudent and unnatural agriculture, and this is the reason why it is so frequently met with in the prairies, which require much more prudence and care in their cultivation than other lands, and which are neither sufficiently drained, nor correctly cultivated. Insufficient drainage, as well as the other enumerated causes, can produce a stagnation of the growth of the plant, and a chemical change of its sap; but besides, since the prairies came early into cultivation, and were noted for their great fertility, they have continually been forced to bear the same crop of cotton, and are now exhausted, or very nearly so, and the crops on them consequently subject to all kinds of diseases, especially if the weather be unfavorable.

It is very easy to recover these exhausted prairie lands, but it requires, nevertheless, more labor and care than our agriculturists are willing to bestow upon them.

The prairies have especially been exhausted by an utter neglect of an alternation of crops, and consequently those ingredients which are necessary for the growth of the cotton plant, which have continually been put into requisition, are nearly entirely wanting in the soil, as an analysis of it will show. Those ingredients must be replaced, before cotton can again be successfully cultivated on them. This is very easily done by application of the fine marl which has been discovered north and south of the State of Mississippi, and by the introduction of a different system of agriculture, consisting in properly ditching the lands, plowing and harrowing them sufficiently; by alternation of the crops, fallowing the lands when they have been in use for three or four years, according to the quality of the soil, and replacing the ingredients absorbed by the plants, by judicious application of manure.

Indeed, our prairie lands have been nearly all exhausted before they were even properly developed; their fertility has not even appeared in its highest state. Such a development can only be produced in the hands of a prudent agriculturist, who manages his land according to the rules of a sound and natural agriculture; who drains his prairies before cultivation, exerts himself to make the stiff clay looser, by successive application of sand, and even vegetable matter; who observes a rotation of his crops, and fallows those lands which have in succession been planted with all the cultivated vegetables. When thus managed, the fertility of our prairies, the surety of the crops, will soon be increased, and will be fully equal to that of the Colorado prairies, where nature has supplied the necessary loosening material. Thus managed, the prairies will never be exhausted; on the contrary, their fertility will rapidly increase, and all the legion of diseases of the crops, even a part of the insects inimical to the cultivation of cotton, will disappear. That such an agriculture is too troublesome, is only a prejudice; *it is a saving of labor and time.* One acre cultivated in that way will produce as much as two do now, and perhaps more, and will pay liberally for the excess of labor bestowed upon it.

60. The opulent State of Mississippi will, therefore, certainly not refuse to follow the example given, not only by the Government of the United States, but also by many of the States, to bring an insignificant sacrifice to a science, which, modern as it is, has done, in the short time of its existence, so much to reveal to us the wonderful history of the creation of our maternal earth, and to convince us that its fate, as well as ours, rests in the hands of an almighty, allwise, and all-bounteous God, who planned the appearance of man, His favorite creature, when this globe was still an embryo, and who prepared it for him, with untiring kindness and ardor, through many millions of years, until the inhospitable embryo, having emerged from fiery and watery ordeals, stood there changed into a paradise, where man was able to revel in the luxuries which nature affords spontaneously—gratuitously; to a science which has done so much to expel and banish for ever old prejudices, which, for thousands of years, have troubled and frightened the human race, and which, more than any other science, shows us that that religion which our Holy Book reveals is the will

of the almighty Creator of the universe, and has come down upon us by His inspiration.

Indeed, geology shows us that, however grand and sublime, how wonderful and magnificent, our maternal earth may be, its internal constitution and arrangements are not for an eternity—even if its elements should be. Its productiveness and fecundity for the same kind of creatures are exhaustible—the time of their passport here below is limited, and expires—they diminish and disappear in the course of innumerable centuries, never to return.

Revolutions and transformations take place on the surface of this globe—other genera and species of creatures appear, and urge their claims for life and its enjoyments. So it has been for innumerable centuries of time—God's own record, Nature, as revealed by geology, shows it too clearly to be disbelieved or denied—and so it will be for many, many centuries to come; the past is a guaranty for the future.

Geology convinces us, then, that no change is imminent now, and that our latest descendants may enjoy their sojourn here below, as we have done and are doing. Our earth is youthful still in its present condition—the spark of a Divine Spirit has just come down upon it, in man, comparatively a few years ago only—his development has scarcely begun; and the Creator of the universe is an eternal, an allwise, all-righteous, and all-bounteous Being; whatever He calls into existence bears the stamp of His Divine qualities—is unimprovable, and not created for the sport of a short moment, whatever human folly may devise.

61. The following article appeared in the *Mississippian*, of December, 1855:

"GREENE COUNTY, MISS., *November 5th*, 1855.

"Yesterday morning we examined the banks and bluffs of the Chickasawhay river, near Mr. Samuel Powe's plantation, in Wayne county, and there, to our utmost astonishment, we made quite an unexpected discovery. The high bluff of the river had partly slipped down, and the water of the river washed away a part of the earth fallen down from the upper part of the bluff, denuding a *primeval* TROPICAL *forest*, which, many thousands of years ago, had flourished there, in magnificent beauty, when man did not yet roam about over this wonderful terrestrial globe, and could not yet admire the gigantic growth of those trees, shrubs, and herbs, which a warmer climate than ours now is could only produce and mature.

"There, on the banks of the small Chickasawhay river, meandering now only through a country overgrown with the long-leaf pine (pinus palustris), the oak, the beech, the hickory, the magnolia, the tulip tree (lyriodendron tulipifera, our common poplar tree), and other trees indigenous in the temperate zone, we found the wonderful and gigantic palm trees, the beautiful and shady tree-ferns, the curious cycades, mixed with coniferous pines, and other exogenous trees; the slender arundinaceae, the humble lycopodites, nowadays all the children of a warmer climate. They were covered with a crust formed of the leaves of those and perhaps other trees, mixed with sand and clay, and concealed from thirty to forty feet deep below the surface. A whole primeval vegetable creation is there buried in the lap of our maternal earth, reminding us that time and space extend far beyond the origin of our proud race, and that, long before man appeared upon the surface of this terrestrial globe, it was carefully prepared for the reception of the favorite creatures of the Omnipotent Creator and Preserver of the universe, and overgrown with a gigantic and luxurious vegetation, a part of which forms the immense beds of coal and lignite, now so beneficial for mankind, and a more recent specimen of which appears here buried on the banks of the Chickasawhay river, in a less changed state and more fit for our inspection and examination. It is a fact, the tooth of time had been very busy—an entire change has taken place. The whole tropical forest is nearly reduced to carbon, and the leaves of the trees, mixed with clay and sand, are, unfortunately, no more to be recognized. All the trees were prostrated and lying in a motley mixture, one over the other; but a part of their bark, their cellular and vascular structures, are not yet entirely obliterated, and are easily recognized by the sharp and scrutinizing eye of the geologist; and, as their stumps were still standing near the prostrated trees, and their roots still extended in the soil, in all directions, it was easy to determine that they all grew during the tertiary period of our globe, where they now are lying and decaying—a period when the first exogenous trees, such as we now find in our forests in the temperate zone, had just first appeared on the surface of our globe, but when its internal heat still increased that produced by the rays of our sun to such an extent that even our now temperate zones were hot enough to produce tropical vegetation.

"Singular, indeed, we found all those trees prostrated, and in a horizontal position. It appears as if they had been cut not even by the axe, but by the saw of a woodman, so smooth were their still standing stumps on their surface; nevertheless, there were not yet woodmen at that early period; mammal quadrupeds only reigned supremely, and enjoyed the fruit and shade of those trees, and *many, many* thousands of years had still to elapse before the destructive steel of the woodman resounded in the terrestrial forests.

"In the sweat of our brows—the day was hot and sultry—did we collect a great many specimens of all the different trees and shrubs, which we found in such a state of preservation that they could be taken from their old resting-place and transported. We entrusted them to the kind care of the owner of the ground, Col. Samuel Powe, of Wayne County, who offered his services to dry, pack, and send them to our State University, whence they will be distributed among the museums of the University, and of our State, at Jackson, and will be really a great curiosity.

"*P. S.*—Those valuable specimens, so carefully dug up, were placed high above the water of the river, and sheltered from the immediate rays of the sun, which would have caused them to dry too rapidly and crack too much, by a covering with branches of trees, it being impossible to transport them in the wet and brittle state in which they were taken from their long concealment; but, most unfortunately, very heavy rains set in next day, and the specimens were not only ruined by the beating rain, but carried away by the water of the river, which rose rapidly from its low state, and overflowed its banks; it has, therefore, been impossible to examine those interesting remains of a by-gone age of our globe, and determine them!"

62. Cours Elémentaire de Paléontologie et de Géologie Stratigraphique: Paris, 1852, tome second, fascic. second, page 743.

D'Orbigny says: "D'aprés l'ensemble des faunes, nous avons aussi reconnu qu'il existe sur une vaste partie de l'Amerique septentrionale, depuis le 31er degré de latitude jusqu'au 39e. On le trouve surtout dans l'état d'Alabama, à Claiborne, à Ballast Point, à Tampa Bay, à Wilmington, sur lesquels Mr. C. H. Hale a fait un beau travail de recherches; dans la Floride; dans la Géorgie, sur les rives des rivières de Savannah et de Ogeechée, à Bluff, à Mill Haven; dans la Caroline du Sud, à Orangeburg, à Wantood; dans la Caroline du Nord, à Great Dismal Swamp; dans la Virginie, à Petersburg, et près de Fredericksburg.

"En résumé, l'étage, tel que nous le circonscrivons, en le séparant de l'étage Suessonien, n'est pas borné seulement au bassin anglo-parisien, ainsi qu'on l'a cru pendant long-temps; mais il occupe encore en France, les bassins pyrénéen et mediterranéen, la Belgique, et une grande surface de l'Amerique septentrionale."

D'Orbigny states in the foregoing that the same formation as that in the Paris basin extends over a large part of the known world, and especially over a large part of our Southern States; and he asserts that the rocks of Claiborne, in Alabama, belong to it. The occurrence of the orbitoides, in Alabama, near Claiborne, and over Mississippi, from the line of Alabama to the Mississippi river, and that of the fossil bones of the zeuglodon cetoides, in both localities, is a certain proof of their identity with respect to time, and both can, therefore, neither be older nor newer than that formation, and belong immediately above the nummulitic formation, which some geologists admit to be the lowest eocene; others, as belonging to the cretaceous rocks, and to take the uppermost place of the formations of the secondary age.

The fossils which I have called orbitoides is, as I have already indicated, the same which has been called by Mr. Conrad, and others, orbitulites mantelli. Dr. D'Orbigny (in his above-cited work, tome 2d, fascicle 1, page 192, §1418), divides the cephalopodous fossil, determined by Lamarck as orbitulites, in two genera, orbitulites and orbitoides. His orbitulites are characterized by concentric lines, which are wanting in orbitoides, and instead of which the latter has either lines radiating from the centre, or a kind of granulation. The orbitulites mantelli belongs to the latter description, and I believe must be justly separated from orbitulites; wherefore I have called it orbitoides, according to D'Orbigny.

Remarks.—Several months after having completed my report, I found that such a separation is deemed necessary by the famous German microgeologist, C. G. Ehrenberg, of Berlin, who says in his work, "Uber den Grünsand und seine Erläuterung des Organischen Lebens;" Berlin, 1856, page 143:—

"Abweichend von den Nummuliten sind die Orbituliten und Orbitoiden, die in zwei ganz getrennten Gruppen, vermuthlich der polythalamien gehören; estere zu den soritinen, letztere zu den helicosorinen."

Ehrenberg does, therefore, not only recognize the separation of the orbitulites of Lamarck, in orbitulites and orbitoides according to D'Orbigny, but he states that they belong to two entirely distinct groups; the orbitulites to the soritines, the orbitoides to the helicosorines. The orbitoides found in Claiborne, Alabama, were first determined as nummulites mantelli, then as orbitulites mantelli, and lastly recognized by Carpenter as orbitoides. I am, therefore, not the first to recognize and determine them as such.

Ehrenberg says, in a note to his above-quoted work: "That these orbitoides mantelli do not agree perfectly with the orbitoides, but, although differing by a greater simplicity of the shells, and the roundish, not square, form of the chambers, and approaching, in this respect, the genus soritis, they differ also from these, having a sipho which connects the concentric chambers, not found in the sorites. In the casts of the American form is, besides, between every two rows of chambers, a branching and strong canal in the thin shell itself. The different rows of the chambers have also connecting tubes which are only less regular than with the orbitoides."

Ehrenberg describes those orbitoides accordingly as follows:—

"Chambers roundish, without lateral tubes, concentric in a simple row, with a thin, simple, and indistinct cellular cover; a sipho, and a branching and closed system of canals in the thin shells." He calls them cyclosyphon, and puts them, together with orbitoides, among the helicosorines, whose characteristic is: a distinct sipho, square or roundish chambers, and closed canals of the shell. It appears, therefore, certain that those bryozoa, which were formerly called orbitulites mantelli, are no orbitulites; their name must be changed, and it seems to be most suitable to call them according to Ehrenberg, *cyclosiphon mantelli*.

63. This fine fossil came into my possession by the kindness of Mrs. Okeley of Jackson, a lady who possesses a fine palaeontological, mineralogical, and conchological collection, from which I have derived much advantage.

64. The circumstance that the eocene rocks were re-submerged at the time of the deposition of the miocene strata, or at the miocene period, and re-elevated before our present geological age, as the postpleiocene rocks deposited upon the miocene strata prove, shows us of what an immense duration each geological period must have been. It has already been stated that such elevations and depressions of parts of our globe are continually in process; and examples have been quoted, to which another very interesting one may be added here: In the year 1752, a little more than a century ago, an English vessel run ashore on an oyster bank, near Bourgneuf, not far from La Rochelle, in France. The remains of that vessel lie now in the middle of a cultivated field, 15 feet above the level of the Atlantic ocean, and since about 25 years inhabitants of the village have taken in more than 500 hectores of land at 100 acres each.

Fort Bahaud, where the Dutch vessels used to take in their cargo of salt, is now 900 feet distant from the sea. The former island of Olonne is now far from the sea, and only surrounded by swamps and meadows.

All these places are on the Atlantic coast of France. The elevation there must have amounted to more than 15 feet in a century, which is much more rapid than such elevations or subsidences generally are; but even at that rate, many thousands of years must have elapsed during the re-depression and re-elevation of the country; and this convinces us again that it is utter insanity to expect now a sudden change of the surface of our globe, and the destruction of the human race after the lapse of a short period only since its appearance on the surface of this globe.

65. Since a few years, the lignite has gained an importance; it has been found out that it is not only a very good fuel, but that its ashes, as well as the lignite in its natural state, if either pulverized or allowed to crumble to small fragments by exposure to the air and the operation of the rays of the sun, make an excellent manure. In Europe the lignite is used extensively for fuel in stores as well as furnaces, for blacksmiths' shops and steam engines; and if free, or nearly so, from sulphuret of iron, it is a good substitute for wood and coal. The inhabitants of some countries, for instance, of parts of the kingdom of Prussia, are entirely reduced to the use of lignite for fuel. In these countries it is even used for making gas, not only for illumination, but also for fusion of iron in iron works, and serves well for that purpose.

Our State has as good lignite as is found anywhere, and perhaps in greater abundance; but wood being here still in great superfluity, and its removal even necessary or desirable, a long time will still elapse before the lignite will be resorted to for either of these purposes; another use may therefore be made of it. A part of our lands, especially those in the middle of the State, begin to fail and to require manure; there is fortunately fine marl enough for the whole continent of America, in this State, which is, indeed, the very best of manures, much better than even guano; but this is not yet accessible in every part of the State, especially in those counties where the lignite is found in greatest abundance. I would, therefore, most earnestly recommend the use of the lignite for manure. In most places where it is found, it is easily quarried; and as its burning to ashes would be rather troublesome here, it not being needed for fuel, and our houses not being provided with stoves or grates to burn it, nothing is to be done to prepare it for manure but to quarry it several months before it is to be used, and to expose it to the sun; it crumbles then in small cubic pieces scarcely an inch square, or can easily be broken into such. If it is then carried to and spread over the land, in the fall, left again either exposed during the winter or ploughed slightly under the surface, it will prove a very fine manure. If the lignite be disintegrated in that manner, it loses much in weight, and bears transportation very well.

From eight to ten wagon-loads of lignite to the acre, is an abundant dressing, which will prove effective for six or eight years. For such manure that lignite will answer perfectly well which is not good for fuel, being too much mixed with sulphuret of iron. By exposure to the atmosphere the sulphur combined with the iron (at the rate of 53.3 per cent. of sulphur, to 46.7 of oxide of iron) will change to sulphuric acid, and the whole sulphuret of iron to sulphate of iron, which contains 63.7 per cent. of oxide of iron, and 36.3 per cent. of sulphuric acid; and this sulphuric acid is well known as a fine manure, in addition to the other fertilizing ingredients of the lignite.

The effect of sulphuric acid upon the land is sufficiently proven by manuring the soil with plaster of Paris or sulphate of lime, which contains 58.746 per cent of sulphuric acid, and 41.254 per cent. of lime. The sulphuric acid acts as a solvent for many ingredients of the soil, especially for silica, and renders them fit for nourishment for the plants; wherefore it is especially a good manure for all kinds of cereal grains—corn, wheat, oats, rye, barley, and others. Lignite is besides useful for another purpose: the brown color called "umber," or earth of cologne, is prepared of it.

Fabrication of Bricks.—(Page 168, No. 4.)

Bricks can be made of a natural mixture of clay and sand, generally called loam, a material usually taken for their fabrication. The loam or clay is best if it contains only from 15 to 25 per cent. of sand, and not too much oxide of iron, which renders it too brittle. How much sand, clay or loam selected for bricks contains, can easily be ascertained by drying a specimen of it thoroughly in the sun, or on a fire. A weighed portion of the dry clay must then be taken, stirred in water, and boiled in it for some time. The water containing the clay is then allowed to cool a little, again stirred and allowed to settle for a moment, and the water, with the particles of clay in suspension, poured off. This process is repeated until nothing but the sand remains, and the water, even after stirring, appears perfectly clear; but care must be taken not to let the sand escape with the water. The sand is then again thoroughly dryed, and accurately weighed: the weight indicates the proportion of sand; the loss from the former weight, the proportion of clay.

Another kind of bricks is made of marl, or a mixture of clay or lime, with little or no sand. The less lime there is among the clay, the better the material for bricks, about four or five per cent. is all sufficient.

A third kind of bricks, called fire-proof bricks, is made of a compound of silica and clay, very nearly or entirely pure, and especially free from lime and magnesia, and infusible before the blow-pipe. Such bricks are very refractory in the fire, and the very best material for constructing chimneys and forges.

The bricks made here in our State are generally very bad, which is not the fault of our clay, for there is good material for bricks nearly everywhere; it is the fault of the fabrication.

In order to make good bricks, the loam or clay must be dug up in the fall, and exposed, during the winter, to the influence of the atmosphere. For that purpose it must be turned repeatedly, that every part of it may be submitted equally to the atmosphere, and especially the frost.

When use shall be made of the clay in the spring, all the lumps must be broken, and it must be thrown into shallow pits, to soak there for several days—even for a week is not too long. When taken from the pits, it must be well and thoroughly tempered, that is to say, trod by men or animals. This tempering must be carefully done, for it is the most important operation, and the quality of the bricks depends mainly upon it. It is absolutely necessary that all the stones should be removed, particularly those containing oxide of iron and lime. The whole mass must be kneaded to a uniform and homogeneous paste, with as little water as possible.

Only in this manner good solid bricks can be made, which resist the influence of the atmosphere, and do not break when handled and laid.

The fabrication of fire-proof bricks, from the above designated strata of clay in Wayne county, cannot be too earnestly recommended. They are made exactly in the above described manner; it is only necessary that the clay selected should be infusible before the blow-pipe. Their fabrication is even less troublesome, because the material is finer and more plastic. Such bricks are desirable everywhere, for the building of fire-places, forges, chimneys, and even whole houses, and will be well paid for in our large towns; and, if sent to Mobile and New-Orleans, on the railroad or on the Chickasawhay river, they must command a handsome price, and yield a large profit as soon as their quality is known.

66. An analysis of the Lauderdale Springs, by the author, gave the following result:

A.—*The Sulphur Springs.*

Specific Gravity = 0.995. Temperature = 68° Fahr.

I.—VOLATILE INGREDIENTS:	In 100 grammes, or 1 hectogramme.
Sulphuretted hydrogen	0.233974
Carbonic acid (uncombined)	0.257654
Oxygen and nitrogen, together	0.257280
Carburetted hydrogen, a trace.	
II.—ACIDS:	
Sulphuric acid	0.000085
Carbonic acid	0.000066
Silicic acid	0.001000
Chlorine	0.000617
Iodine	0.000065
Apocrenic acid	0.000075
Crenic acid	0.000017
Hydrogen, in combination with sulphur	0.000025
Bromine (inappreciable).	
III.—BASES:	
Peroxide of iron	0.000471
Lime	0.000140
Magnesia (inappreciable).	
Sulphur, combined with hydrogen	0.000337
Alumina	0.000056
Potash	0.000117
Soda	0.002263
Ammonia	0.000004
Total of ingredients	0.752287
Pure water	99.247713
	100

B.—*The Chalybeate Springs.*

Specific Gravity = 1.00440. Temperature = 64. 4° Fahr.

	In 100 grammes, or 1 hectogramme.
I.—VOLATILE INGREDIENTS:	
Carbonic acid gas	0.094556
Oxygen and nitrogen together	0.196458
II.—ACIDS:	
Sulphuric acid	0.000935
Carbonic acid combined	0.002448
Silicic acid	0.001040
Chlorine	0.000296
Apocrenic acid, a trace.	
III.—BASES:	
Lime	0.000393
Oxide of iron	0.000420
Magnesia	C·000181
Alumina	0.000020
Potash	0.000180
Soda	0.001353
Total of ingredients	0.298280
Pure water	99.701720
	100

67. *Qualitative Analysis of the Quitman Red Sulphur Springs.*

Specific gravity = 0.9940. Distilled water being one. Reaction, alkaline, coloring red litmus paper slightly blue; when concentrated the alkaline reaction is strong.

CONTENTS.

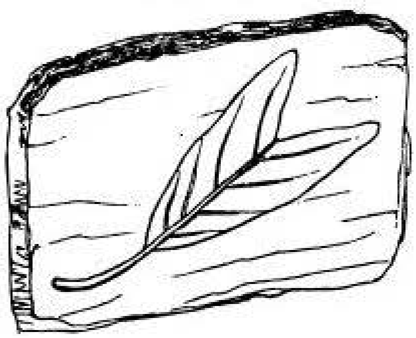
Sulphuretted hydrogen.
Carbonic acid.
Sulphuric acid.
Lime.
Magnesia in small quantity.
Apocrenic acid, a large quantity; it is the matter which imparts the brown and red color to the water.
Organic extractive matter.
A large quantity of potash in form of a carbonate.
Soda, a trace only.
Chlorine, a trace only.

69. A good many of those leaves were found by the author, but much

more of them, found in the same locality, were shown to the author by Mr. H. A. Gwyn, Principal of the Woodland Academy, in Salisbury, Tennessee, to whom his sincere thanks are due.

70. The Assistant Geologist found on S. 9, T. 5, R. 2, E., similar impressions; for instance, a leaf of a willow, one probably of a morus (mulberry), and a very conspicuous exogenous leaf, of an obovate, cuneate, and truncate form, sinuate at the top, and very pubescent, which the following diagram exhibits,

[No. 52.]



and which has not yet been determined. Among those leaves were, as he thinks, numerous impressions of endogenous leaves of trees belonging mostly to tropical genera. If so, which, remote from the specimens illustrating his report, I can neither deny nor confirm, the impressions must originate from different periods, and accidentally have been mixed together; the salices and querci appear first in the miocene and pliocene age, when the tropical vegetation had already receded from the 35th degree of north latitude, and left only a small proportion of subtropical plants; and the morus is still of later origin. The trees from which those leaves originate can, therefore, not have grown together with real tropical plants.

Through the kindness of the State Geologist of Tennessee, Prof. James M. Safford, of Lebanon, Tennessee, I received also some very singularly marked pieces of brown iron ore, found in the orange sand group of this State and also of Tennessee, which have very much the appearance of pieces of petrified coral, but which, after a careful examination, were found to have been formed by electro-magnetic currents.

71. Here, where the loess appears only in isolated places, these places are called deer-licks, because not only the deer, but horses, cattle, and hogs come to lick it, and indeed lick deep holes in it. Even the parroquets (psittacus carolinensis), and other birds come to lick it, and eat near the tops of the bluffs considerable holes. It could not be ascertained whether the large quantity of carbonate of lime, contained in the loess, or perhaps an admixture of chloride of sodium, attracts the animals.

72. This well was dug on the plantation of Mr. Shelby Bevins, who relates the following very remarkable incident:—

"When, at the depth of about 70 feet, the stratum of pebbles was penetrated, a great deal of *charcoal* was found underlying it, and among them sticks, evidently cut by a sharp instrument, and burnt off on one side. Underlying the charcoal were discovered human teeth, together with rags of decayed cloth. Pieces of the latter, as large as the hand of a man, were taken out." Mr. Bevins declares that there could not have been any mistake about it, for the impression of the cloth was distinctly perceptible upon white clay, the substratum of the coal and rags.

For the greater reliance upon these most extraordinary facts, Mr. Bevins referred to the testimony of Dr. Vaughan.

Soon afterwards Dr. Vaughan was asked about the facts related by Mr. Bevins, and testified: "that he saw the rags, not the human teeth, and that they were really rags of cloth, the threads or lint of which could easily be recognized. The sticks he saw also; they appeared, indeed, on one side cut with a sharp instrument, and burnt on the other; they were from about 1 inch to 1½ inches in diameter."

Nothing of the objects above mentioned, neither the teeth nor the charcoal, nor the sticks or rags, were now extant, nearly four years having elapsed since they have been found; unfortunately neither of them could consequently be examined by the author.

The above facts are most remarkable indeed; and, if beyond any mistake, would extend the human era of our maternal globe much farther beyond the historical time than we have now any idea of it; will therefore be of some interest to dwell a few moments upon their impartial consideration.

I should perhaps unhesitatingly have proclaimed that the remarkable objects, above mentioned, had been entombed by some accident in the ground where they were found, if not several incontrovertible objections opposed this opinion.

1. The objects were found 70 feet deep under ground, a depth to which excavations in a tertiary non-metalliferous formation are seldom carried, even by civilized nations, provided with all the facilities of sinking shafts.

2. This objection does apply with much more force to a tertiary formation, until very recently inhabited by uncivilized Indians, entirely destitute of all instruments fit for excavation, and the annals of whom do not mention that they ever excavated the ground, even at a period when their civilization was upon a much higher degree than it ever has been since our acquaintance with them, either here or in Mexico and South America.

3. The objects above mentioned have been found below the stratum of

pebbles. This stratum can consequently not have been removed, which circumstance contradicts then also the exception that perhaps a well had been dug there within the historical time of the United States, only a few years ago (whose scar would even not have been entirely obliterated). Had the stratum of pebbles been removed, it would and could not have been replaced in its natural position.

Such objections must exclude the above opinion. What explanation remains then for us? Shall we consider the above circumstances as establishing the fact that the human race existed upon our earth before the deposition of the pebble stratum? The first question would then be, at what geological period of our globe was that pebble stratum carried to the place where we find it now?

Without entering here into an unnecessary discussion, we will refer to our treatise concerning this stratum of pebbles (page 223) in which we believe to have established, in a most incontrovertible manner, that it is not a *diluvial relic*, as it has been erroneously believed to be, but that the act of its deposition in this State belongs to the middle tertiary or miocene period, and cannot be placed in a later age of our globe.

The existence of man upon this globe at that time cannot be denied, on account of its *impossibility*, a plea which might be applicable to all earlier periods of our earth. At the miocene period, large continents existed already, which were overgrown by a luxuriant vegetation; climatical influence was already perceptible, and the tropical temperature which extended before nearly over the whole globe, had receded to a latitude lower than ours is here. All classes of animals were already represented: monstrous quadrupeds populated the continents, as for instance the dinotherium, sivatherium, taxodon, and many others; turtles and tortoises existed in water and on land, birds crossed the air, even insects swarmed about—why could not man find then room upon a domain assigned to him by his kind Creator? But why could he not, is not a proper question; it might imply a reproach to Him who sees farther than man in his presumption. Did he not then exist? Most probably not. None of the vestiges of man go down as far as the miocene period.

It is true, it is scarcely any longer deniable that man has existed much longer here below than an unwarranted calculation admits.

Bones of man have been found in caverns, together with, and in the same state of preservation, as bones of species of animals which have long ago disappeared from our globe; this, for instance, was the case in the caverns of Bize, Narbonne, Pondres, and Souvignargues, in France; of Gailenreuth, in Germany; in caverns in England and Brazil, etc. Rude toys and implements have been found among those bones, which belong to no period of human records, and testify that the feet of man once trod those caverns, many of which were even stopped up by a catastrophe unknown in history and inexplainable by anything which happened in historical times.

The existence of man upon our maternal earth long before the time pointed out by our short-sighted and even unwarranted and disagreeing calculations, seems, then, to be established by indisputable traces; but none of these traces go beyond a period preparatory to our present human period—beyond the diluvial or glacial period; whereas our traces would lead us beyond another long and important tertiary period—that of the pleiocene age, and at least in the middle of the miocene period—perhaps, nay, most probably, millions of years farther down.

It is, indeed, unwarranted to permit an isolated fact to lead us to such a conclusion; but even would we do this, how, then, could we account for the appearance of the charcoals, the sticks, the rags, and human teeth, on the place where they were found?

The white clay, upon which those objects were found, belongs to the miocene formation, and formed the bottom of the sea when the orange sand stratum, with the pebbles, was carried over it. How could those objects come upon the bottom of the sea? The sticks and charcoal, even the rags, are of a lower specific gravity than the water, and swim; the waves and tide might, consequently, have carried them to some shore; but even there they could not have been covered with a stratum of *the same formation*, seventy feet in thickness. The human teeth might have come and sunk there, by some accident; but how could they come among the charcoal?

Without calling in question the veracity of those most honorable gentlemen, who believe firmly what they depose, we must then admit the intrusion of a mistake, to which all of us are most liable.

It is easy to mistake carbonized wood for charcoal; many times geologists are under the necessity of resorting to the most minute examination before they are able to distinguish the one from the other.

The mistake of the smooth surface of the sticks for a surface produced by an edged tool, is also very easily committed. An example will prove this. On the 7th of September, 1855, the author was in Louisville, in Winston county, where a gentleman exhibited a piece of carbonized wood, taken from a well, which he believed to be cut with a sharp instrument. The piece of wood appeared so much like it that nobody doubted it; and the tale of a piece of wood, cut with a sharp instrument, having been found about thirty feet under the surface, would have gone forth, had the wood itself not come to the hands of the writer. The similarity of the smooth surface to a cut surface was, indeed, most striking and illusive, and it was only at the well, where the not yet entirely carbonized wood was dug up, and after an examination of the stratum, that a certainty could be arrived at, that the smooth surface originated from cleavage—from a splitting of the wood after having been exposed for some time to the atmosphere.

Can the same mistake not have taken place here? Most probably it has.

Respecting the teeth, it seems certain that teeth of some animal have been mistaken for human teeth—a mistake which is, indeed, very pardonable.

There remains then to explain what could have been mistaken for rags. Perhaps the internal bark of a coniferous or pine tree; a piece of driftwood may have sunk there, and, buried in mud and sand, been protected from entire decay by the exclusion of the atmospheric air; such half decayed bark assumes often the appearance of rags.

73. About a mile S. S. E. of Satartia a hill projects into the Yazoo bottom, and commands a full view over the Yazoo and Mississippi valley, the woods of which form the background, and the plantations along the bluff the foreground. To the right is the town of Satartia; to the left the plantations can be seen for a distance of from 12 to 15 miles. This is now certainly one of the finest views in the State of Mississippi, and will, when once the whole Mississippi valley is under cultivation, be of surpassing magnificence; not a wild scenery over mountain peaks and abysses, but over the garden of nature, over the towns, villages, and hamlets, and the busy life of the husbandman, toiling for the support of his fellow-man.

74. This fine clay, approaching kaolin in its lithological character, appears here again nearly in the same longitude as the kaolin above it in Tishamingo county, and that found in small nodules below it in Wayne county. It is found in no other part of the State as far as it has now been ascertained, and has most probably been carried there by the same current which deposited the other kaolin. The current must, therefore, have had a direction from north to south, entirely different from that which carried the pebble stratum, whose direction must have been from N. W. to S. E.

75. This chalybeate spring yields a large quantity of water, at least from 50 to 60 gallons in a minute. It boils up from under a ledge of compact iron sand stone, in a valley between two hills, and forms a considerable creek, which runs around a hill, and the bed of which appears perfectly coated with red hydrated peroxide of iron. The water does not always boil up with the same force—showing a kind of pulsation. Sometimes it throws up the white sand through which it seems to come with considerable power, at other times the boiling disappears entirely under a sediment of vegetable matter, which shows then only a kind of undulation; this changes about every 30 seconds, but then the violence is not always the same; every four or five minutes the boiling appears most violent.

76. The appearance of brackish water from the greenish clay, reminds us of the brackish Tegel of the Vienna miocene basin, with which the clay of Hartford agrees in its lithological character. The fossils of that Tegel are not found here. It has not yet been possible to submit the Hartford formation to a closer examination, which might lead to important results, perhaps to the discovery of a real briny spring.

77. This water is said to have been an infallible remedy for dropsical diseases, but the spring has, unfortunately, disappeared. A boring down in or near the spot where it formerly was, would most probably soon resuscitate it, as it originated evidently from the stratum of lignite.

78. The rocks of this formation, as far as they are now known, belong all to two classes: they are either *klastic* or *amorphous;* no *crystalline* rocks have been discovered among them. The klastic rocks are those which consist of fragments or detritus of other rocks of older formations, as all the sands, mica, pebbles, &c., are of foreign origin. The amorphous rocks, which are all without any regular form and structure, to which certain laws or rules could be applied—formless, as we might call them—are only *porodine*, of aquatic origin, or originating from a pulpous mass; or *pelitic*, the remnants of a decomposition or entire disintegration, as all the clays; no rocks which could be called *hyaline*, or of an igneous origin, are found among them.

79. For the proof of which we refer to the works of Dr. H. G. Bronn, Micheoletti, Hornes, Reuss, Sandberger, on the subject, and especially to Dr. C. G. Naumann's Geognosie, Vol. II., page 1058, and the following:

80. If the stratum of pebbles did belong to the diluvial formation, it could only take the place of the plusiatic diluvial formation (in Germany, Seifengebirge), which consists mostly of a mineral detritus, in which are found precious stones and metals, especially gold and platina and other valuable ores. This plusiatic formation consists mostly of klastic masses, sand, finely divided detritus and shingle; frequently it contains ferruginous sand mixed with magnetic iron ore. Among those masses of detritus, occur in small particles, gold, platina, iridium, osmiridium, palladium; sometimes, also, lead, copper, meteoric iron; in the state of ores, tin, chrom iron, titaniferous iron ore, rutil, anatas, &c., and the following precious stones: diamond, topaz, beryll, korund, chrysoberyll, spinell, zirkon, garnet, amethyst, quartz-crystals, &c. These plusiatic deposits are mostly found in valleys, gullies, and depressions of the surface; sometimes, also, on the bases and declivities of mountains (comp. Zerrenner Instructions for Washing Gold and Platina).

That our pebble stratum cannot be considered as such a plusiatic deposit, or even as taking its place, is clear enough, without any further contradiction. The auriferous deposits in California, in the province of

Minas Geraes, in Brazil (where the diamonds are found), and in South Carolina and Georgia, are probably deposits of an earlier time, at least the last; their difference from our shingle is also striking enough.

81. (See first and second annual reports of the Geological Survey of Missouri, by G. C. Swallow, State Geologist, published in 1855).

Professor Swallow says that in the drift formation there appear to be three distinct deposits:

1. What might be called an "altered drift." These strata of sand and pebbles appear to be the finer materials of the drift, removed and re-arranged by aqueous agencies subsequent to the drift period, and prior to the formation of the bluff or locss. This is not the case in our State, as we shall see later; the loess is here anterior to the yellow loam, and underlies it. The pebbles are from all varieties of rocks found in the true drift.

2. The boulder formation. It is a heterogenous stratum of sand, gravel and boulders, all water-worn fragments of the older rocks. The larger part are from igneous and metamorphic rocks, in place at the North, and the remainder from palaeozoic strata upon which they rest. The metamorphic and igneous rocks must have come from the northern localities of those strata, the nearest of which, according to Dr. Owen's report, is on the St. Peter's river, about 300 miles north of St. Joseph. But the palaeozoic fragments are usually from localities near where they rest, as shown by the fossils they contain, and are completely rounded as those from the more distant points. The largest boulders observed in Missouri, are 5 or 6 feet in diameter; they are granite and metamorphic sandstone. These, though large for this latitude, sink into insignificance when compared with those huge rounded masses, so abundant in the N. E. States, and particularly along the coast of Maine; and even in the interior part of Maine, New Hampshire, Vermont, and Canada. Near Stanstead Plain, in St. Francis' District, Canada East, I found a serpentine boulder lying on a little river, the largest I have ever seen, as far as I remember; it measured 15 feet in length, 12 feet in width, and 12 feet in height; contains consequently 2160 cubic feet, and must weigh more than 600 tons.

3. The pipe-clay lies directly below the boulder deposit, wherever it has been observed, and boulders are more or less dispersed through the upper part of it. Its thickness varies from 1 to 6 feet. This clay may possibly belong to an older formation. It is not fossiliferous.

Concerning range and thickness of the drift, Professor Swallow remarks: "Drift abounds in all parts of the State, north of the Missouri, and exists in small quantities as far south as the Osage and Meramec. Its thickness is variable, from one to forty-five feet."

It is then very evident that the drift deposit of Missouri is quite different from our orange sand stratum, containing the pebbles, and is only found in the northern part of Missouri, not at all in the southern; how could it come here so much further south?

An appropriation for a geological survey of Arkansas has been made, we know, upon the recommendation of its patriotic Governor, and its result will throw more light soon upon our orange sand and pebble strata, which have come to Mississippi from that direction.

82. My friend, A. Winchell, Professor of Geology and Natural Science, of the University of Michigan, at Ann Arbor, has, at my request, kindly given me a description of the geological character of the superficial formation of the State of Michigan, which I insert here for a comparison:

"The surface soil of this portion of Michigan (of which alone I can speak from personal observation) is undulating, being shaped into rounded hills and ridges, rising sometimes to the height of one, two, or three hundred feet above the intervening valleys. The underlying Helderberg, Hamilton, and Chemung groups of rocks are scarcely anywhere exposed, and the carboniferous strata are only occasionally seen. I should judge that the mean thickness of the drift deposits might amount, in the south-eastern portion of the State, to two hundred feet at least. Many of the depressions in the original surface of these superficial accumulations became occupied by little lakes. Very many of these lakes have, in the course of time, become filled, first, with calcareous material, derived from a state of solution in the water, and from the exuviae of lacustrine molluscs; and, secondly, accumulations of vegetable matter, produced after the water of the lake became shallower.

"Thus we have innumerable deposits of peat. Some of the peat swamps thus formed have become converted into beautiful and inexhaustibly fertile farming lands, while many others are still too wet for cultivation, and constitute the swamp lands of the State.

"The drift materials, in the inequalities of which these deposits of marl and peat have accumulated, consist of coarser and finer fragments of the rocks now found in place over the area extending as far northwards as Mackinaw and Lake Superior. This fact is shown by the occurrence of granitic, quartzose, and trappose fragments, and by the appearance of lower silurian fossils, such as spyrifer lynx and stromatocerium rugosum.

"Most of the materials, however, seem to have been derived from rocks nearer by, containing abundant fossils of the Chemung and upper Helderberg series. In Jackson, Gennessee, and other counties, situated on or near the carboniferous series, the carboniferous limestones and sandstones have contributed most largely to the drift accumulations.

"Comparatively few large boulders make their appearance at the surface in this part of the State, but occasionally one is seen containing from 25 to 30 cubic feet. In other parts of the State I understand they occur of a larger size. The larger fragments are generally granitic, quartzose and conglomeratic, and seem, therefore, to have been transported the greatest distance. These, and all smaller fragments, have been rounded by long and powerful attrition. A large proportion of these deposits is made up of coarser and finer sand and clay.

"The arrangement of the drift is that of materials assorted and semi-stratified by water. It consists of local accumulations of coarse pebbles, or finer pebbles, or of sand, or of clay; the finer the materials, the more distinct the traces of stratification. The clay is sometimes plastic, at others, compact and shaly, and the strata may be traced for many rods.

"The more water-worn and assorted materials are said, by the writers on the northern drift, to belong to the higher portion of the series; the coarser and less worn and assorted lying at the base. My own observations do not enable me to express any opinion on this point. The evidences are conclusive, however, that the whole series of deposits have had a kindred origin, and belong to one geological period.

"The same thing cannot be said of the superficial accumulations of Alabama and Mississippi."

Indeed, the superficial accumulations of Mississippi are quite different, and if we separate the superficial loam from the underlying orange sand group, and especially from the pebble stratum contained in it, which cannot belong to the drift, there is not the least similarity between the red and yellow loam of Mississippi and the diluvial accumulations of the Northern States.

83. When my Report was written and ready for the press, I met accidentally with the author of the above note, Professor A. Winchell, an old friend and companion of geological excursions and examinations in Alabama. After a discussion about the stratum overlying the miocene sands, so often mistaken for till, and the assertion, "that that stratum of loam is nothing else but a formation *in situ*," he not only concurred entirely with me, but convinced me by earlier drawings that he had simultaneously, but without any communication between us, come to the same conclusion. Professor Winchell says of it, in a posterior letter of the 17th of June, 1857:

"This remarkable formation has very much puzzled me, but I have finally made observations which enable me to distinguish it from the diluvium, and to assert that it has been formed in place; in some cases having been transported to a moderate distance, and generally having been somewhat mixed with the diluvium."

The writer considers the orange sand, with the pebbles, as diluvial, in which opinion I cannot concur.

"I have sections in my possession, taken on the spot, showing the rotten limestone passing into the red loam, both by gradual change in an upward direction and in a horizontal one," &c.

This simultaneous conclusion is a singular accident, which adds the strength to the above theory which a gentleman of intelligence, close observation, and great application is able to afford.

The State Geologist of Tennessee, Prof. Jas. M. Safford, has not yet had time enough to examine the newer tertiary formation in Tennessee, in Wayne, Hardin, and adjacent counties. In his excellent Geological Recognisance of Tennessee, published in Nashville in 1856, he says: "The pebbles are often quartzose, and occasionally contain scolithus linearis;" a fossil which we have never found among our pebbles. In his section of the Mississippi bluff, at Old river, which is about 160 feet thick (see page 102 of his report), he mentions exactly the strata which we have described, under the head of our orange-sand and lignite groups.

That the same deposit must extend all along the Mississippi river in Tennessee, and even over some of the western counties of Kentucky, appears doubtless; we saw traces of it at Hickman, Kentucky, on the banks of the Mississippi river, and found among the pebbles an agatized fragment of a columnaria, exactly such as characterize the stratum here in Mississippi.

REMARKS.

When our article on the miocene formation and the stratum of pebbles was written and ready for the press, we received a letter from our friend Prof. J. M. Safford, for which we are under much obligation to him, and from which we take the permission to extract the following interesting passage:

"I will, as you suggest, pay close attention to the *gravel bed*. It is something of a coincidence that, for a few days past, my mind has been dwelling upon this same gravel bed. It is found all along the Mississippi bluff from Kentucky to Memphis. At Memphis the bluff is not as high as at several points further north, and the gravel is only seen when the river is very low. In a branch back of this city, however, it rises from the the river, and is generally well exposed. At Raleigh, nine miles from Memphis, and at other points, near the eastern boundary of Shelby county, it appears.

"The position of the gravel, or pebble bed, at all points in the Mississippi river counties, is about what it is in the Mississippi bluff at Old river (page 102 of my report). In Shelby county there appears to be more sand (orange and yellow) above it. The pebbles are carboniferous cherty masses, often containing fossils.

"I know of nothing in Tennessee contradictory to the view you take of this gravel-bed. For my own part, I have not regarded it as belonging to the true drift of the glacial period."

Having risked to combat a common opinion, nothing can, indeed, be more flattering than an encouragement from an intelligent geologist, as the State Geologist of Tennessee is.

84. Fuller's earth is a white, greenish-white, or grayish earth, of a greasy feel, which falls to pieces when put in water, without becoming plastic, and admits air bubbles. It is dull, but assumes a fatty lustre upon pressure. It does not adhere to the tongue, and has a specific gravity, varying from 1.82 to 2.19. It melts at a high degree of heat into a brown slag. It consists of 53.0 silica, 10.0 alumina, 9.75 oxide of iron, 1.25 magnesia, 0.5 lime, 24.0 water, and a trace of potash. It is used for cleansing woolen stuff from grease, which quality it derives from its power of absorbing fatty or oily matter. It can also be used for extricating any grease from wood, as for instance, floors, &c. In order to use it for fine cloth, it should be prepared by stirring it in water and decanting the finely divided matter frequently, and preparing the latter for use by filtering the water off and drying the sediment.

It is called "Fuller's earth" because it was formerly constantly used by the fullers, for cleaning the wool from grease.

85. We have to acknowledge the kindness of the former Chief-Engineer, Mr. Martin Greene, for a statement of the different elevations of the surface of the country along the Central Railroad of Mississippi, and hope the chief-engineers of the other railroads will have the kindness to furnish us similar statements, in order to record as many elevations in the State as possible in the final report on the gelology of Mississippi.

86. The fertility of the territory of the loess formation appears from stumps of cypress trees (cupressus disticha), which were found near the place where the now drained Clark's Lake formerly was. One of them measured, 3 feet from the ground, 9 feet in diameter, consequently its circumference would be from 27 to 28 feet. The annual or year-rings were counted in many different places, and it was found that at an average 20 came in the space of an inch; the tree must, therefore, have been 1080 years old.

Another stump of the same kind of trees was found which measured, 3 feet from the ground, 11 feet in diameter, and in circumference from 34 to 35 feet; 23 rings came within the space of an inch, and at the time when it was cut down, it must have had, at least, an age of 1518 years, and originated from the fourth century of our present era

87. Originally this alluvial plane commences at Memphis, where Chocktaw bluff extends to the Mississippi river.

There are five points where the tertiary hills extend to the river:

1. At Memphis, Chocktaw bluff reaches the river.
2. At Vicksburg, Great Chocktaw bluff.
3. The Rodney bluff.
4. The Natchez bluff.
5. The Baton-Rouge bluff.

88. The large bottom of the Mississippi river in this State, which only very lately has attracted the attention of agriculturists of our Southern States, appears to have been the principal home of a tribe of Indians who, at an early period, inhabited this country; it is especially there that their remarkable mounds, surrounded with brick walls, are found, which contain the mortal remains of those early inhabitants. The plough will soon level the mounds and efface every trace of that remarkable nation, and I would most earnestly entreat our enlightened legislature to make some appropriation for the photography of some of those mounds, the collection of the many utensils of war and domestic economy found in and around them, and even of some of the remains of their bodies, for the perpetuation of the memory of that remarkable nation, and a future history of the State of Mississippi.

It does not appear that these aborigines have selected that alluvial plane on account of its fertility; it is more probable that the abundance of game in the thick forests, and of fishes in the rivers and lakes, attracted their attention. The mounds are generally found on the banks of rivers. The bricks of the walls that surround the mounds are of a singular and fine vermilion color, finely grained, and have the appearance as if they had been burned upon cane, being fluted in that manner. They seem to contain a great deal of lime. An analysis has not yet been made of them.

APPENDIX.

ON THE MARLS AND GREEN SANDS OF THE STATE OF MISSISSIPPI, AND THEIR USE AS A MANURE.

UNDER the expression of *marl* we understand a mixture of mineral matter, containing a certain quantity of *carbonate of lime*. Most generally this term is misapplied, and used for all mixtures of mineral matter which contain carbonate of lime, regardless of the quantity of the latter.

Thus we find many soils containing an admixture of lime—as, for instance, the loess or bluff formation—and others, called marl, which do not come under that appellation, if it be correctly applied.

Only such a mixture of mineral matter which contains carbonate of lime can be called marl; if the latter, the carbonate of lime constitutes at least one-fifth, or twenty per cent. of the mixture. If the quantity of carbonate of lime, or of other salts of lime, be less than that, the mixture is nothing but *a soil; a clay soil*, if the largest proportion of it be clay, and *a sand soil*, if the largest proportion of it be silicious sand.

Thus the loess or bluff formation, found along the banks of the Mississippi, and, in smaller quantities, along other rivers of our State, cannot be called marl, because it contains only 15.045 per cent. of carbonate of lime; but as it contains, besides, 64.155 per cent. of fine insoluble matter, and only 6.522 per cent. of coarse sand, it is a real *limy clay soil*.

The green sand of the cretaceous formation of our State, and, in fact, of any country, can also generally not be comprehended under the expression of marl. It contains, in our State, even not as much carbonate of lime as the loess; and even in Virginia and New-Jersey, where probably the best cretaceous green sand is found, it contains a very inconsiderable proportion of salts of lime—in some places not more than about 5 per cent., which does not entitle it to the name of marl.

An admixture of so much lime decreases generally the cohesive power of the mineral substance; and, therefore, marl can generally be distinguished from any other similar substance, by its immersion in water. If left a short time in water, genuine marl crumbles to small fragments or powder; whereas clay will not be disintegrated in that manner.

The marl is divided into different kinds, according to its principal constituents and quality. If a sufficient quantity of salts of lime is contained in sandy material, or in a mixture of sand and clay in which the former pre dominates, it is called *sand marl.*

If a sufficient quantity of salts of lime is contained in a mineral mixture of clay with sand, in which the former predominates, the mixture is called *clay marl.*

If a mineral mass, consisting of clay, sand, and a sufficient quantity of lime, is cemented, either by calcareous, silicious, aluminous matter, or by oxide of iron, and exists in the form of a stone, it is called *stone marl.*

Such stone marl can either be sand or clay marl, according to the prevalence of sand or clay.

If a mineral mass consists of a large quantity of disintegrated shells, either marine, lacustrine, or fluviatile, which add to it a sufficient quantity of salts of lime, the mixture is called *shell marl.* Such shell marl can either be clay, sand, or even stone marl, according to the admixture of a larger quantity of clay or sand, and to its coherence and hardness, like that of a stone.

According to the above determination, there are, therefore, four different kinds of marl—sand, clay, stone, and shell marls. We will now add another one to it: *green-sand marl.* Green sand is, originally and correctly, no marl, as it does not contain the requisite quantity of salts of lime; but it is now extensively applied for the fertilization of lands, not on account of its admixture of lime, but principally of its alkaline constituents, and is generally called green-sand marl.

The marls, in general, are of different colors; most of the marls, properly speaking, are white, or whitish, from the salts of lime mixed with them, which are generally of a white color; but this white color is, by no means, a necessary quality of a marl; a great many marls are of different colors, as, for instance, gray, greenish, blue, bluish green, yellow, and even red. The color is generally produced by the admixture of iron, and depends upon the condition in which the iron is found As an oxide, it produces generally a dark color, either dark gray, or even bluish; as a peroxide, it produces a yellow or red color; and as a silicate, it produces a greenish color.

If the marl be white or gray, this is generally a sign that there is not much iron in it. The green sands contain a considerable quantity of grains of chloride, or silicate of iron, which impart a greenish color to it.

We will bestow upon the different marls a closer and more specific examination.

1.—*Sand Marls.*

These occur most generally in the form of a more or less fine, loose, and incoherent sandy powder, which is the finer and more dusty the more lime they contain in admixture. Their color is generally gray, but frequently also white. They are found in the State of Mississippi, in the upper stratum of the cretaceous, as well as the eocene, lime group, and are formed from disintegrated particles of the white carbonate of lime, and an admixture of the orange sand, nearly everywhere overlying that carbonate of lime. Their fertilizing property is confined to the carbonate of lime, and the quality of loosening the soil to which they are added. The latter quality is only an advantage in close and sticky clay soils, and a disadvantage to loose sandy soils; wherefore their application ought to be limited to the former, or the clay soils, exclusively.

2.—*Clay Marls.*

The clay marls are generally much more coherent than the sandy marls, and have, therefore, more the appearance of real clay; nevertheless, when exposed for some time to the influence of the atmosphere, or immersed in water, they crumble to powder, on account of the admixture of the carbonate of lime, and are thus distinguishable from pure clay, which does not crumble and fall to pieces. The color of the clay marl is generally white, yellow, or bluish, sometimes, also, greenish.

This marl exists in the State of Mississippi in large quantity, as the white and blue carbonate of lime of the cretaceous and eocene formations. Its fertilizing quality is limited to the effect of the carbonate of lime, and to the quality of the aluminous matter or clay combined with it, of rendering the soil with which it is mixed more close and heavy; its application ought, therefore, to be confined to such soils which require to be made closer and heavier—to sandy soils; to such especially this clay marl will prove a real benefit.

Clay marls contain generally from 20 to 40 per cent. of salts of lime, mostly carbonate of lime, and from 60 to 80 per cent. of insoluble aluminous and silicious matter.

The clay marls of the above-named formations in Mississippi contain more salts of lime; and the soluble calcareous matter, and the insoluble aluminous and silicious matter, exist in them at least in equal proportions.

The sand and clay marls contain the same kinds of salts of lime, and, as their efficacy is principally limited to that fertilizing matter, they operate in that respect in a similar manner. The carbonic acid they contain serves as an immediate food for the plants; and, by means of the great affinity which lime has for the carbonic acid, that portion absorbed by the plants is immediately re-supplied, by absorption by the lime of another portion of carbonic acid from the atmosphere.

3.—*Stone Marl.*

The stone marls are frequently very rich in lime, much more so than either the sand or clay marl. They have generally the same ingredients as the sand and clay marls, and operate, consequently, in the same manner. The principal difference of the stone marl is, that this disintegrates slowly, its mixture with the soil proceeds gradually, it is, therefore, in the same time much less effective, but lasts a very long time. It is, consequently, necessary to apply the stone marl in much larger quantity to the land.

Stone marl is either clayey or sandy, and its application to clay or sand soil must accordingly be modified as that of sand and clay marl, and sandstone marl applied to clay soils, and clay stone marl to sandy soils; but stone marl is generally less clayey than clay marl, and less sandy than sand marl, an indifferent application therefore not so disadvantageous as with the other marls.

Stone marl exists in the State of Mississippi only in the form of green sandstone, which, on account of the larger quantity of carbonate of lime than the other green sand contains, is better than the common cretaceous green sand.

4.—*Shell Marls.*

This marl is quite different in its nature from all the other marls, and of a much superior quality. The other marls derive their fertilizing quality nearly exclusively from the carbonate of lime which they have in admixture; they contain very little of any other fertilizing matter. The shell marl derives all the lime which it contains from disintegrated marine or lacustrine shells, and must, therefore, be divided into *marine* or *lacustrine marl.* The shell marl in the State of Mississippi is all marine. Lacustrine shell marls are scarce; on the continent of America I have only found them in St. Francis' district of Canada East, where small lakes or ponds have been partly or entirely filled up in modern times by fresh water molluscs (of the genera planorbis, limnea, physa, and others), and where the silt, mixed with innumerable shells, forms now a very fine lacustrine marl. These lacustrine marls exist also in the State of Michigan.

Such shell marl derives its fertilizing properties, not only from the shells of the decayed molluscs, but also partly from their decayed bodies; and contains, therefore, besides carbonate of lime, other salts of lime, as, for instance, phosphate and sulphate of lime, and alkaline matter, which increase its fertilizing power considerably.

The shell marl disintegrates soon when exposed to the influence of the atmosphere; its effect is, therefore, generally quicker than that of other marls, and as it is not only of a less specific gravity on account of the large amount of decayed shells, but also of greater fertility, less is required than of other marl, and its application offers less difficulty.

Marls, in the common acceptation of the expression, according to which every soil is called so which contains a little more lime than soils usually do, are of frequent occurrence; but such soils cannot generally be used as fertilizers, although they may be very fertile soils, as, for instance, the loess and the prairie soil,

Really good marls are scarce. The survey of the State of New-York has disclosed several fine marls, the analyses of which we give below.

Localities where the marls are found.	Carbonate of Lime.	Oxide of iron and alumina.	Organic Matter.	Insoluble Matter.	Magnesia.	Water.	Phosphoric Acid.
Saratoga County....	85.62	1.24	3.92	3.40	3.80	2.32	—
Fairmount.........	21.24	—	—	—	—	—	—
Salem............	83.22	1.24	0.51	2.42	trace	7.25	—
Christian Hollow...	75.45	0.62	0.52	0.56	0.62	22.24	—
Cayuga Bridge.....	22.20	8.88	3.00	41.75	19.30	4.88	—
Peterborough......	80.02	2.69	7.06	9.57	0.66	—	trace

Most of these marls contain a large quantity of lime, and are, therefore, very good. The best are the marls of Saratoga and Peterborough, which contain, besides a large quantity of lime, a considerable quantity of organic matter, constituting, consequently, a valuable fertilizing substance.

The white and blue carbonate of lime of the lime group of the cretaceous formation in Mississippi, which crops out in Noxubee, Lowndes, Ocktibbehah, Chickasaw, Monroe, Pontotoc, and in some places in Tippah, Itawamba, and Tishamingo counties, is of the same kind of marl. It has not yet been analyzed for want of an analytical laboratory, of which the survey was deprived; but the same carbonate of lime or marl crops out in Alabama; it was there examined bv the author, and found to contain from 40 to 60 per cent. of carbonate of lime, the remaining part consists principally in alumina, oxide of iron, a small quantity of magnesia, organic matter, and water in combination.

This marl constitutes, therefore, a good manure, especially for light sandy soils destitute of lime, but it is inferior to the other marls of the State of Mississippi, which will be later treated of.

5.—*Green Sand.*

The green sand generally does, as we have already stated, properly not deserve the name of marl—not containing a sufficient quantity of lime; its property as a manure depends principally upon other ingredients, especially upon a, comparatively, large proportion of potash.

The green sand is a very interesting geological formation, which is, with us, most generally found in the cretaceous, but also in the lower tertiary or eocene formation. In the cretaceous formation it is found in several States, as, for instance, in New-Jersey, in Maryland, Virginia, Alabama, Mississippi, Tennessee, and Texas; in the eocene formation it exists, according to my knowledge, in Alabama, Mississippi, and Virginia. It is by no means confined to those two formations; the great naturalist, Alexander von Humboldt, says in his Geognostic Essay (Geognostischer Versuch), published in 1823: "The green or chloritic earth, which characterizes the sand stratum next to the chalk formation (Kreide), is found in formations of very different ages: in the carboniferous sandstone of Hungary (near the boundary line of Gallice), in the variegated sandstone (im bunten Sandsteine), and in the gypsum belonging to it; in the freestone (im Quader-sandstein), and in the lower part of the coarse sandstone (calcaire grossier, Grobkalk) of the Paris basin."

According to more recent geological researches of Sir R. Murchison, the green sand is found so low downwards in the geological series of the crust of our globe, that it overlies immediately the metamorphic rocks, and belongs to the transition formation, which has apparently been deposited before the appearance of any organic life on the surface of our globe. From there it is found upwards to the tertiary formation. It is, consequently, a most important geological formation, which, as the annexed Table I. will explain, was continued or repeated during three whole ages of our globe; the primary fossiliferous or palaeozoic, the secondary or mesozoic, and the tertiary or kainozoic. It has, according to my knowledge, never been found higher upwards than in the nummulitic and lower eocene deposits; but Professor J. W. Bailey, the late great microgeologist and microscopist, shows in his treatise "On the Origin of the Green Sand in our Oceans and Seas," (Proceedings of the Boston Soc. of Nat. Hist., v. 364; Silliman's Journal: 1856, xxii, 280–284), "That the present bottom of the ocean exhibits, in many places, entirely the same compositions as the green sand; which knowledge he derived from a close examination of the samples of black sand (real green sand with globigerina), taken from the bottom of the Gulf Stream (lat. 31° 35′, long. 19° 36′), at a depth of 150 fathoms, or 900 feet, and from the Gulf of Mexico, in which the grains of sand are nothing else but casts of the chambers of polythalamia (small microscopic animals) of various colors. It consists, accordingly, entirely of the same matter as the green sand of the older formations, which are also mixed with casts of polythalamia, small branchy tubes, &c.

The true character of the green sand was for a long time unknown; the analysis of the green sand of the eocene formation of Paris, by Berthier (published in the Annales des Mines, sec. I., vol. VI., 1821), shed first light upon it, and showed that the grains of green sand communicating the color to the whole stratum, are a peculiar protoxide and silicate of iron.

Still more honor is due to Dr. C. G. Ehrenberg, of Berlin, who has bestowed a careful misroscopic examination upon the green sand in general, and discovered that all green sand belongs to those miraculous formations which contain the fossil remains of a whole creation of microscopic animalculi (polythalamia) too small and insignificant to be perceived with the naked eye.

(See C. G. Ehrenberg, "Ueber den Gruensand, und seine Erlaueterungen des Organischen Lebens." Berlin, 1856.)

Ehrenberg says: "After a solution of the lime (by means of diluted hydrochloric acid) it was found that many green grains had the very distinct form of polythalamia, and that the great number of the rest were entirely of the form of casts of single cells. The great mass of the grains of the green sand appeared at first sight, indeed, devoid of organic form; but on close comparison and examination so many of them could be reduced to a peculiar formation of casts, that the remainder could be considered as fragments, the existence of which must be deemed a necessary consequence of fracture and imperfect silicification. Casts of triloculina oblonga were recognized immediately in whole forms as a vitreous and green silicate of iron. Quinqueloculina saxorum, alveolina boscii, sorites (orbitulites) complanatus, were other forms unchanged by the acid, which could soon be recognized."

Besides the fossil remains of these polythalamia, the green sand contains, everywhere, where it is found in the fossiliferous region of the crust of our globe, a great many fossils as large and even of larger size. We have, for instance, seen that the cretaceous green sand of Mississippi contains the fossil remains of several ammonites, of many nautili, innocerami, terebratulae, exogyrae, ostreae, hamites, scaphites, baculites, naticae, serpulae, hamuli, vertebrae, and teeth of fishes, and many other fossils.

The green sand of the tertiary formation contains, also, besides the polythalamia, a great abundance of fossils, as ostreae, carditae, cardiae, turritéllae, cerithiae, naticae, volutae, mitrae, pinnae, murices, ancillariae, actaeones, dentalia, solaria, bones of saurians, vertebrae of fishes, and others.

It can, therefore, very easily be explained how the green sand has received its property as a manure. It must be attributed to the decay of so many animal bodies, together with their bones and shells in it. Not only animal remains, but also those of trees and other vegetables of marine and terrestrial origin, are found in it, which contribute much to fill it with fertilizing matter, especially potash; the latter is probably mostly derived from vegetable matter.

The ingredients of the green sand consist principally in silica, alumina, protoxide of iron, lime, magnesia, alkaline matter, especially potash and water, in chemical combination; but these ingredients are by no means constant. The percentage of silica varies from 40 to 80; that of the alumina from 5 to about 10; that of the protoxide of iron from 15 to very nearly 30; that of the potash from 2 or 3 to 15; that of the water from 3 to 8, and besides some green sands contain a small quantity of chlorine and sulphuric acid.

The best *cretaceous* green sand in the United States, is found farther northwards in New Jersey; it extends from there, from Monmouth county, opposite Sandy Hook, all along the coast, into Delaware, Virginia, and Maryland, and is now extensively used as a manure.

I have examined the green sand of New Jersey, in several of its outcrops. In all those outcrops I found no trace of the lime group of the cretaceous formation which overlies it in the southern States. It crops out under a stratum of dark clay, which is overlaid by diluvial or drift deposits; it extends from 30 to 40 feet downwards, and disappears under the surface soil; it is probably much thicker than that, but cannot be examined lower down. It is of easy access; being immediately on the sea-coast, it can, without any difficulty, be laden into vessels or boats, and transported in all directions.

The green sand in those outcrops is characterized by the same fossils as ours; by exogyra costata, many ostreae, naticae, terebratulae, innocerami, etc., and even by belemnites, which are never found in the green-sand of the southern states. But on the other hand, it appears to me remarkably destitute of other cephalopodous mollusks, especially of the baculites so characteristic of it in Alabama, Tennessee, Mississippi, and Texas. I have, nevertheless, no doubt but that it occupies the same stratigraphic position as a glauconitic group below the cretaceous or lime group, constituting the "étage turonien" of D'Orbigny, as the green sand of the Southern States does, which is most probably only a continuation of the northern glauconitic group.

The northern green sand of the cretaceous formation is superior with respect to its fertilizing quality, to the true southern cretaceous green sand, but inferior to the Mississippi cretaceous and eocene real green sand marls, which will be later examined.

Professor Rogers, in his report on the geology of New Jersey, describes especially the green sand of three different locations, and gives an analysis of it.

1. The green sand or green sand marl from near *Poke Hill, Plattsburg, Burlington county*, is very granular; the granules are of a rich dark, olive-green color, rather coarse; an analysis of it gave the following result:

Silica	50.75	per cent.
Alumina	6.50	"
Protoxide of iron	22.14	"

Potash	12.96	per cent.
Water	7.50	"
	99.85	

2. The green sand of Squankum is also of a dark olive-green color, a little finer grained; an analysis of it gave the following result:

Silica	51.00	per cent.
Alumina	6.50	"
Protoxide of iron	21.55	"
Potash	10.50	"
Lime, a trace.		"
Magnesia	1.08	"
Water	9.00	"
	99.63	

3. The green sand of Freehold, Monmouth county, is of a rich, green color, and small grained; its analysis gave the following result:

Silica	50.00	per cent.
Alumina	7.00	"
Protoxide of iron	22.00	"
Potash	11.00	"
Lime	1.00	"
Magnesia, a trace.		"
Water	9.00	"
	100	

Besides, Professor Cook has made an analysis of a specimen of the green-sand of the pits of the New Jersey Fertilizer Company, in Monmouth county, New Jersey, which appears very minute, and gives the following results:

Soluble silica	36.89	per cent.
Alumina	5.75	"
Protoxide of iron	17.18	"
Lime	0.11	"
Sulphate of lime	4.08	"
Magnesia	0.79	"
Phosphoric acid	1.61	"
Quartz	18.80	"
Potash and soda	5.27	"
Water	9.65	"
	100	

(REMARK.—The 36.89 per cent. of silica is probably not soluble in dilute hydrochloric acid alone, but has been dissolved after having been fluxed with alkalies; a green sand, containing altogether only 55.69 of silica, could not well contain nearly 37 per cent. of silica, soluble in acid alone. The phosphoric acid must be in combination partly with lime, and partly with a portion of the iron.

There is a discrepancy in the latter two analyses, which are both of the green sand of Monmouth county, New Jersey. Professor Rogers found in the specimen analyzed by him the large quantity of 11 per cent. of potash, and no soda; Professor Cook only 5.27 per cent of potash and soda. Professor R. found 22 per cent. of iron; Prof. C. only 17.18 per cent. Prof. R. found neither sulphuric nor phosphoric acid, and only 1 per cent. of lime; Prof. C. found both acids, and very nearly three per cent of lime; this discrepancy originates probably from the circumstance that the specimens analyzed have been taken from different localities.)

According to the analysis of Prof. Rogers the potash is the only valuable ingredient of the New Jersey green sand; that which contains most of this ingredient is therefore the best; the green sand of Plattsburg contains most potash, very nearly 13 per cent., it is therefore the best for a fertilizer; a ton of it would contain nearly 300 lbs. of *carbonate* of potash, and be worth, at 7 cents a pound, about $21. According to the analysis of Professor Cook, the value of that green sand would not be so high.

Professor Cook found in the green sand only 5.27 per cent. of potash and soda; suppose that this 5.27 per cent. were all potash, a ton of the green sand would contain about 150 lbs. of carbonate of potash, which, valued at the rate of 7 cents a pound, would amount to about $10 50

The sulphate and phosphate of lime found by Prof. Cook in the green-sand, would be worth, in a ton of it about - - -	2 00
The value of a ton of it would therefore be - - - - -	$12 50

The cretaceous green sand of our State is not as valuable as that of New Jersey. According to the analysis of a sample of it from Lowndes county, its contents are:

Carbonate of lime....................	22.381	per cent.
Oxide of iron and alumina............	3.680	"
Carbonate of magnesia................	1.368	"
Potash...............................	0.311	"
Water and loss.......................	3.740	"
Insoluble silicious sand.............	56.730	"
Insoluble aluminous matter...........	11.790	"
	100	

This cretaceous green sand contains an unusual proportion of lime, seldom found in it. A ton of it would contain:

1. Carbonate of lime, 447.620 lbs., which is worth, at 25 cents per 100 lbs.	$1 12
2. Carbonate of Magnesia, 27.360 lbs., which is worth, at 12 cents a lb.	3 28
3. Potash, 6.220 lbs., or carbonate of potash, 9.105 lbs., which would be worth, at 7 cents a lb.	0 64
The real value of a ton of the green sand is therefore	$5 04

I must remark that the carbonate of lime, as well as the magnesia, has been estimated very low. A barrel of lime containing about three bushels, or 250 pounds, can never be bought cheaper than about $1.25. In the interior of our State, 100 pounds would, accordingly, be worth 50 cents, and the magnesia cannot be bought for less than from 25 to 30 cents a pound.

Besides, if applied to the suitable land—to clay land—the insoluble silicious sand would also be of a considerable value, as it loosens the land and improves it very much.

The cretaceous green sand of Tippah county, although it contains less lime, is better than that of Lowndes county. We have seen (page 120) it contains, according to an analysis:

Silicic acid	0.400	per cent.
Sulphuric acid	2.370	"
Carbonic acid	4.577	"
Phosphoric acid	0.652	"
Lime	9.474	"
Magnesia	1.677	"
Oxide of iron and maganese	3.707	"
Alumina	3.121	"
Potash	1.533	"
Organic matter and water	4.550	"
Insoluble remnant of silica and alumina	67.939	"
	100	"

The fertilizing substances in this green sand are: 1, the sulphuric acid; 2, the phosphoric acid; 3, the carbonic acid; 4, the lime; 5, the magnesia; 6, potash; and 7, the organic matter.

A ton of the cretaceous green sand contains:

1. Sulphuric acid.......47 lbs.,	worth at	3 cents a lb...		$1 41
2. Carbonic acid.				
3. Phosphoric acid.....13	"	"	10	"	1 13
4. Lime 189	"	"	25 per 100 lbs.,		47
5. Magnesia.......... 27	"	"	12 cents a lb...		3 34
6. Potash............ 31	"	"	7	"	2 17
The ton of this green sand would be worth...........					$7 52

although the carbonic acid cannot well be, and the organic matter has not been, estimated, because the quantity has not been separately and accurately ascertained.

This green sand is only the most inferior of the mineral fertilizers found in the State of Mississippi; it would not pay for a transportation to a considerable distance, and can only be recommended as a manure for the heavy clay lands—for post-oak, as well as for prairie soil—in its immediate neighborhood. For these lands it will be found of very great value, not only on account of its manuring, but also of its loosening, properties.

6.—*The Eocene Green-Sand Marl of the State of Mississippi.*

Very different from the cretaceous green sand is the eocene green-sand marl. The green sand is a fertilizing substance, because it contains such matter which not only serves for the immediate nourishment of vegetables, but also for solvents of such nourishments which are contained in the ground, but not in such a state that they can be imbibed by the roots of the plants. Although a fertilizer, the cretaceous green sand deserves, generally, not the name of marl, because it contains, in most instances, not the quantity of lime which makes it a marl—it does not contain one-fifth, or 20 per cent., of carbonate of lime, which, we have seen, is necessary to constitute a real marl.

The green sand of New-Jersey, probably the best in the United States, contains, according to the analysis of Professor Cook, only about 4.2 per cent. of lime, of which 4.08 per cent. is in the state of a sulphate.

The green-sand marl of our State is a mixture of green sand with a large quantity of the detritus of marine shells, from which all the lime it contains is derived. This green-sand marl is principally found among the deposits of the eocene formation, below the different limestones, especially below that containing the fossil remains of the zeuglodon. A specimen of it, from Alabama, has been submitted, by Professor C. G. Ehrenberg, of Berlin, to a minute microscopic examination, and proclaimed to be the richest source of finely preserved fossil remains of polythalamia, in the form of silicious sand of a green color; which opinion has been confirmed by the late Professor T. W. Baily, of West Point. It is, therefore, easily explained why this green-sand marl is such a fine manure; not only the lime contained in it is derived from the disintegration of innumerable shells, but even the silicious sand consists of fossil remains of microscopic animals; and, consequently, the decayed bodies of all those molluscs and polythalamia must have contributed to render that marl a fine fertilizer.

Only one specimen of this real green-sand marl, taken from Sec. 3, T. 10, R. 7, W., has hitherto been analyzed, which gave the following satisfactory result (comp. page 171):

Specific gravity = 2.300.

Oxide of iron and alumina............	8.000	per cent.
Carbonate of lime....................	32.954	"
Phosphate of lime....................	3.352	"
Sulphate of lime.....................	3.684	"
Chloride of magnesium................	0.900	"
Alkalies, mostly potash..............	7.840	"
Insoluble silica and alumina.........	41.530	"
Hygroscopic water, and loss..........	1.740	"
	100	

A ton of this green sand marl contains, accordingly, the following fertilizing matter:

Carbonate of lime..........................	lbs.	659
Phosphate of lime..........................	"	67
Sulphate of lime...........................	"	74
Chloride of magnesium......................	"	18
Alkalies, mostly potash....................	"	156

If we now estimate those ingredients at the following low prices:

1. The carbonate of lime, at 25 cents for 100 lbs..	$1 64
2. Phosphate of lime, at 2 cents a lb............	1 34
3. Sulphate of lime, at ½ cent a lb...............	37
4. Chloride of magnesium, at 12 cents a lb......	2 16
5. Alkalies, taken as potash, at 7 cents a lb......	10 92
A ton of this green sand marl would be worth, as a manure on our lands..................	$16 43

We see, therefore, what a high value this marl has as a fertilizer.

Neither the green sand nor the marl has been used in our State as a manure—no experience has been acquired; and it will, therefore, be useful to communicate the information which I have collected concerning the application and effect of the green sand as a fertilizer in other States, which have been much benefited by this manure, and from works written on the subject.

The green sand has been in New-Jersey in use as a manure ever since Professor Rogers discovered those large deposits of it, and made them known in his report on the geology of that State, published in 1836.

Professor H. D. Rogers says: "By the use of these marls the value of lands has risen from $2 50 to $37 per acre. The most sterile patches of sandy soil are made to sustain very admirable crops of corn, by the use of this powerful agent."

The green sand has been, furthermore, recommended as a manure by Professors Booth, Turner, and Cook.

In consequence of these recommendations, it has been used to a large extent in New-Jersey, Delaware, and Virginia. It is stated by the *New-Jersey Farmer*, that in that State more than 360,000 bushels have been carried over the road.

What an effect this manure has had upon the lands of Virginia is very well known. A large part of the lands of that State, which were perfectly exhausted, have been entirely recovered and re-fertilized; I can, therefore, not too highly recommend the use of the green sand and green-sand marl, with which our State abounds, for agriculture.

A common method of using the green sand as a manure, in New-Jersey, is to mix it with other fertilizing substances, or to compost it.

If it is composted with any other fertilizing matter, it is most commonly spread or broad cast upon the ground, and plowed under.

When used alone, it is frequently applied for potatoes, by putting from a quart to a pint into a hill when the potatoes are planted, and subsequently covered with earth.

For corn, the green sand is nearly invariably spread upon the ground, and plowed under; but sometimes, also, spread or strewed over the land, when plowed. If the necessary quantity is used, it is perfectly immaterial which of those methods is used.

Those who strew it over the land when it is plowed, believe that on account of the higher specific gravity of the green sand than the land, it has a tendency to sink, and would sink too deep, if not spread upon the land.

This is decidedly a mistake. The specific gravity of the cretaceous green sand of this State has not been ascertained; that of the specimen of green sand marl of the eocene formation is = 2.300, distilled water being the unit. The specific gravities of the soil range generally from 2.220 to

2.400; that of the lower prairie soil, for instance, which contains only a very small quantity of silicious sand, and is, consequently, of a low specific gravity, is =2230. Such a small difference in the specific gravity can hardly effect a sinking of the green sand in the soil; besides, most of the soils are of an equal specific gravity, and some surpass it even.

The spreading of the green sand upon the land, and leaving it there exposed to the atmosphere for a long time, is, nevertheless, no disadvantage to it, and does not decrease its fertilizing properties as it would with most of the other manures, for it can neither be decomposed nor in any other way injured by atmospheric influence.

It is certainly very good if the green sand, or green sand marl, is mixed with other fertilizing matter, especially with vegetable manure. This accelerates its efficacy, but it is by no means necessary.

The effect of the green sand and green sand marl is not confined to those vegetables which are cultivated in the states of New Jersey, Delaware, Virginia, &c.; it is just as good a manure for the cotton plant, and the green sand marl which contains a larger quantity of lime, is, indeed, a better manure for the cotton plant than for many other cultivated plants, because this plant requires a larger quantity of lime for its growth than nearly all the other cultivated plants, which the green sand, but especially the green sand marl of the State of Mississippi, conveys into the soil.

With respect to the use or the effect of the green sand as a manure, the following facts have been ascertained: adjacent acres of land have been manured, the one with 200 loads of good stable manure, the other with 20 loads of green sand, and the crops have proved to be much heavier upon the acre manured with green sand than upon that manured with stable manure. In another instance, a field, one part of which was manured with green sand, the other not, was planted in corn. The manured part of the land yielded two bushels for one. The same experiment was tried with potatoes, and the marled part of the field yielded three or four bushels for one.

The manure has been applied to grass, carrots, beets, and even fruit trees, and has been found an excellent fertilizer for those vegetables.

It is stated (American Muck Book, page 126) that 20 loads of marl to the acre must be regarded as an unnecessarily bountiful dressing. Practical farmers have assured me that one or two hundred bushels of the green sand to the acre, may be considered as a fair dressing.

With respect to the time for which the green sand retains its fertilizing property, the author of the "American Muck Book," says:

"Experience has already shown that the land once amply marled, retains its fertility with little diminution for at least 10 or 12 years, if care be had not to crop it too severely; while, with all practical precaution, the stable manure must be renewed at least three times in that interval to retain in the soil a corresponding degree of vigor.

This agrees perfectly with the opinion of practical farmers who have used marl and green sand as a manure.

These experiences will apply both to our green sand and the green sand marl; the ingredients in both of them are nearly the same, only the quantity is different; it is, therefore, only necessary to observe that the better the green sand or marl, the less can be taken in quantity.

I would most earnestly recommend to the agricultural population of the State of Mississippi, to resort as soon as possible to the use of the fine green sand and green sand marl which have been discovered in the State of Mississippi, and experience will soon show that their usefulness has not been exaggerated.

With respect to the use of that fertilizer, I would recommend, either to use it alone or mixed with disintegrated or nearly disintegrated vegetable matter, or stable manure.

In both cases it is certainly advisable to apply the marl broad-cast to the land. This is decidedly the best manner of its application; it is then equally distributed all over the land, and found by the roots of the plants wherever they may grow and extend their rootlets. It is the only correct application of a manure which is not only a stimulant, but maintains its effect for a long time, improves the land lastingly, and which must for that purpose be intimately and equally mixed with the soil.

If the green sand marl is used alone, it is perfectly immaterial whether, after having been broad-cast over the land, it is ploughed under or remains upon the surface exposed to the atmosphere. If it is used composted with vegetable matter or stable manure, it must be ploughed under and treated like stable manure.

With respect to the quantity of green sand marl, my opinion is, that from 100 to 200 bushels is an adequate quantity for from five to six years; after the lapse of that time the marling should be repeated.

The quantity of the marl can be modified according to the quality; if the quality be very good, one hundred bushels may suffice for the dressing of an acre, if not more must be taken.

I have finally to remark that I have only ventured to add to this report my views on the marls of our State, from an anxiety to see the agricultural public benefited by them. It has been impossible for me to bestow that attention on the subject which is necessary; but this will be done in the course of the continuation of the survey, and the above article completed as soon as it can be done.

REMARKS.—The printing of the present report was nearly finished when I received the information that a chemist, Dr. Chas. F. Spieker, of New-Jersey, had invented an easy method of impregnating the green sand marl with ammonia, as well as with phosphoric acid, and fix both in such a manner that they do neither decompose, or evaporate when exposed to the atmosphere, and secured letters patent for that invention.

On a visit to the laboratory of the Doctor, he had the kindness to show me a specimen of green sand impregnated with ammonia, which, having been mixed with caustic lime and moistened, proved to contain fully as much ammonia as the best of the guanos; it will, therefore, be, in some respects, a better manure than the guano, as it affords a lasting benefit for the land, which the guano does not.

The invention is certainly of the utmost importance, and will supersede the guano, as the prepared marl can be sold for about half the price of the former, and perhaps for less, if manufactured on a large scale.

CLOSING REMARKS.

I cannot send forth this volume without remarking again, that the materials have been collected, and that it especially has been written under the most unfavorable circumstances. A great deal of uncertainty exists still concerning the *exact* limits of the different formations. The charts, the large chart of the Geology of the State of Mississippi as well, as the particular maps of the four counties, have therefore been arranged in such a manner that the boundary lines of the different formations can be easily altered without any trouble and expense. A great doubt exists especially concerning the lines of the carboniferous and cretaceous formations in Tishamingo, and the cretaceous formation in Itawamba county. The reports from which I had *partially* to derive my information are contradictory.

In Tishamingo county there cannot be a newer formation between the cretaceous and the carboniferous than the cretaceous formation, unless it be an overlying one. This is against the nature of things; it would have required a miraculous insertion, after the deposition of both formations in a narrower strip of a few miles only in width.

An overlying formation can only be the miocene, which overlies both the carboniferous and the cretaceous formations; were it any other formation, it could not have been confined to that narrow strip, but must have a connection with other parts of the eocene, which does not exist, unless it be in Tennessee. Meanwhile, until this point has been decided, with the assistance of my learned friend, Professor Safford, the State Geologist of Tennessee, I have brought the carboniferous and cretaceous formations together, and represented them as heavily overlaid by miocene rocks.

In Itawamba county, I am entirely uncertain about a part of the eastern limits of the cretaceous formation, as I have stated in my preface, on pages 10 and 11. I suspect there even another formation older than the cretaceous, as I have also stated in another place. I have left a doubtful place on the map, which can easily be filled by coloring, when I have been able to examine the locality closely, and refer here to notes 10 and 11, p. 267, and 28, p, 273. Those uncertainties are of no practical, but only of theoretical or scientific importance, and are inevitable in preliminary reports.

GLOSSARY.

EXPLAINING THE TECHNICAL TERMS USED IN THE REPORT.

ACEPHALOUS—Animals without bones or molluscs without a head, such as the clam, oyster, and the muscles of our rivers.

ALLUVIUM—The soil swept together and deposited by rivers, lakes, and seas. It consists generally of sand, clay, and vegetable, or animal, or organic matter. Alluvial is the adjective, meaning swept together and deposited in the above manner.

AGGLOMERATION—Heaping up, joining, and cementing together of mineral matter.

AMORPHOUS—Without regular form and internal or external division; not in layers, or not stratified.

ANTHOZOA—Literally, flower animals. Radiate animals, with a gelatinous or coriaceous (like leather) body of different forms, mostly fixed on some object with the abdominal part.

ANTICLINAL—Leaned together above, like a half opened book put upon the edges. An anticlinal axis is an elevation from which the ground slopes down towards both sides. The anticlinal axis, properly speaking, is the imaginary line between two layers of soil leaning together and sloping in opposite directions. A line drawn along a ridge of a chain of mountains would represent such an axis.

AQUEOUS—Watery; full of water; consisting of water.

AREA—The surface of a country.

ARGILLACEOUS—Containing clay; composed of clay; clayey.

ARGILLO-CALCAREOUS—Clayey and limy together.

ARTESIAN—From the province of Artois, in France; or according to the fashion or example of Artois.

AZOIC—Destitute of life; where no life exists, or has existed. Compare note 1, page 263.

BASIN—A geological formation lying in the shape of a trough, as the carboniferous basin exhibited in diagram No. 1, page 41.

BED—Synonymous with stratum or layer; an extended formation of a common character, generally in horizontal position.

BOULDER—A large rounded block of stone not indigenous where it is found, either on the surface of the ground or in the ground, but transported from some distance by water or floating ice. Synonymous with *erratic block* or *erratic*.

BRANCHIFERS—Provided with gills to respire water.

BRECCIA—A (conglomerated) rock cemented together, and consisting of *angular* fragments of different rocks.

BRYOZOA—Literally moss animals; animals living in water, and mostly fixed on some object; having shells, receptacles, or houses; their mouth is surrounded with thread-like feelers or lashes, and a bent gut or rectum opens in the anus near the mouth. They are hermaphrodites; male and female in the same individual.

CALCAREOUS—Containing lime.

CALCINE—or Calcinate—burn to caustic lime; drive off the carbonic acid by heat.

CARBON—One of the elementary bodies; the substance contained in charcoal, and purest of all, in diamond.

CARBONATE—A salt, or a combination of a base with carbonic acid; an acid derived from carbon.

CARBONIZED—Converted into coal and charcoal.

CABONIFEROUS—Coal bearing; containing mineral coal.

CATASTROPHE—A great natural event or development.

CEPHALOPODA—A kind of molluscs, shells, or muscles having their organs of motion from one place to another arranged around their head. They are generally provided with a beak.

CETACEA—Vertebrated mammal animals belonging to the whale tribe, and inhabiting the water, mostly exclusively the sea.

CHALYBEATE—Holding oxide in form of sulphate, carbonate, or chloride of iron, generally speaking, iron in solution.

CHALCEDONY—A mineral belonging to the quartz, but amorphous or uncrystallized.

CHERT—A silicious mineral; impure quartz nearly allied to flint and chalcedony.

CHLORIDE—A salt containing hydrochloric acid.

CHLORITIC—Containing the mineral chlorite, and being dyed green by it.

CLEAVAGE—The property of cleaving or being cleaved into an indefinite number of thin laminae parallel to each other, but not to the stratification or division in layers by deposition by water.

COAL MEASURES—That part of the carboniferous formation containing the coal in different layers or strata is called the coal measures, to distinguish it from other parts of the same formation which contain no coal.

CONCHOIDAL—Like the surface of a shell.

CONCRETION—A mass balled or cemented together into a solid body.

CONFIGURATION—Manner in which a body is shaped; the form or shape.

CONFORMABLE—Parallel to or with. Is used for layers or strata of our earth. In diagram 42, page 201, and 44, page 208 the strata lie conformable to each other.

CONGLOBATE—To form in roundish balls.

CONGLOMERATE—A body cemented together from different mineral substances of a different nature, as clay and sand, iron and clay or sand, &c.

CORNICE WORK—The decoration of a column or the ceiling of a room with mortar, gypsum, or even stone.

CRETACEOUS—Originally containing chalk (Latin, creta), but used in the report as meaning belonging to the upper secondary or cretaceous formation.

CRINOID—A sea lily, hair star, a division of the radiata, particularly echinoidea, whose characteristic is, that it is provided with a stem, either only when young or during the whole lifetime. The crinoidea appear like flowers, are rooted in the ground of the sea, and their head resembles a lily.

CRUSTACEA—Animals living mostly in water, provided with a hard crust of carbonate of lime, as, for instance, the lobster, crab, crawfish, and others.

CRYPTO-CRYSTALLINE—Not perceptibly crystallized.

CRYSTAL—A mineral in a regular form, with facets like cut glass. The same mineral assumes under similar circumstances always the same regular form; minerals can, therefore, be distinguished according to their crystallization. Adjective, crystalline, in form of a crystal.

CYCADEA—Plants which are neither exogens nor endogens; neither belonging to those that grow from without nor from within, but gymnogens. Their leaves are similar to those of the cocoa-nut palm. In a fossil state they are easily recognized by their perforated woody fibres.

DELTA—Rivers, especially great rivers, before emptying into the sea (or even into lakes), appear often divided into two or more arms, forming a triangle, or a Greek d, called delta, which resembles a triangle Δ. This is especially the case with the Egyptian river Nile; the mouth of the Nile was, therefore, in early times, called its Delta, and after it that of all considerable rivers. In geology the term "delta of a river" is applied to the alluvium invariably found near the mouth of rivers, irrespectively of its figure.

DENUDATION—The laying bare of underlying rocks, by washing away the overlying material.

DETRITUS—Matter rubbed or worn off from geological formations or rocks. The adjective *detrital* means consisting of such worn off matter.

DILUVIUM—Accumulation or deposits of loose material consisting of sand, clay, gravel, and pebbles, produced by a current which is admitted to have swept over a part of the northern hemisphere of our globe, during the latter part of the tertiary age; or between the tertiary and quaternary ages, during a time which is called "the glacial period," because it must have been of a low temperature, favoring the existence of immense icebergs and glaciers.

DIAGRAM—A sketch in outlines only.

DIP—The inclination of a geological formation from a horizontal line, or the angle which it forms with the horizon.

DISCOID—In form of a disk.

DISINTEGRATION—Crumbling to pieces, and remaining no longer a whole. Disintegrated, crumbled, broken up.

DRIFT—Is synonymous with "diluvium," but includes those large stones, boulders or erratics, which overlie the northern hemisphere on this Continent from the 40th, in Europe from the 50th, and in Asia from the 60th degree of N. latitude, upwards, and which have been attributed te the Noachian deluge.

DYKES—Veins of trap-rock ; also often veins of larger dimensions.

ENCRINITES—From the Greek ἐν, in, and κρίνος, lily a kind of sea-lilies belonging to the radiatae (radiate animals).

ENDOGENS—A class of plants, with flowers, and a visible sexual system, that do not grow from without, by means of a new layer of wood formed annually below the bark, but from within, and the stems of which are soft inside, and exhibit no distinction of wood, pith, and bark. All the palm-trees belong to this class. The palmetto tree and leaves, are, in our country, the only representatives of this class, whose home is the tropics.

EOCENE—The fossils of the older formation exhibit a general character quite distinct from that of our age. Only those of the beginning of the tertiary age commence to have some similarity with the character of living animals. The formation where this similarity commences, was, therefore, called by Lyell, the "eocene," or dawn of a new era, or of modern times. The eocene period commences after the cretaceous period, or deposition of the cretaceous formation ; it embraces, consequently, the first period of the tertiary age, and extends to the miocene period.

EROSION—Eating out, corroding ; excavating by solution and washing away.

ESCARPMENT—The steep and abrupt front of a mountain, hill, or bluff.

EXOGENS, or Exogenous Plants. Flowering plants, characterized by distinctly separated pith, wood, and bark, which grow from without, by layers of new wood formed annually immediately under the bark, upon the old wood, producing every year an annual ring. All our forest trees belong to this class of plants.

FELSPAR, or Feldspar—A mineral containing potash, which enters in the composition of many rocks, especially of the granite. The adjective felspathic, means containing felspar.

FERRUGINOUS—Containing iron, in any shape or condition.

FLUVIATILE—Proceeding from a river.

FORMATION—A group of layers or mineral mass referred to a common origin in the same period or age.

FOSSILS—Remains of animals and of plants ; or of organized bodies which existed formerly on the surface of our globe, and are now found petrified, or preserved in any other way in the strata of our earth, and dug out of it.

FOSSILIFEROUS—Containing fossils.

FRIABLE—Able or fit to be crumbled to dust or pieces.

FUCOID—Sea plants of former ages, resembling our present sea-weeds.

GLACIER—Accumulations of snow and ice on high mountains, which move continually downwards, in a slow progress, carrying stones and detritus of rocks along.

GLAUCONITE—Green silicate of iron.

GREENSAND—Sand mixed with silicate of iron, from which it derives its green color.

GALLERY—A horizontal excavation or shaft, in a hill or mountain.

GASTROPODOUS—Having the feet or organs of locomotion, on or around the abdominal part of the body.

GRIT—Coarse silicious grains.

HORNBLENDE—A simple mineral, very much of the character of mica. It is of a dark green or black color, and enters into the composition of many rocks, especially syenite.

HORNSTONE—Synonymous with chert.

HYDRATED—Containing a proportion of water.

INDURATE—Grown hard, hardened and not originally hard.

INORGANIC—Without organs, and consequently not capable of having any life, neither vegetable nor animal.

IN SITU—In the original place.

INTERSTRATIFIED—If a certain kind of rocks contains layers or strata of other rocks. Diagram No. 38, page 194; No. 40, page 197; No. 42, page 201, show interstratification.

IRIDESCENCE—The property of exhibiting different colors, varying colors, as for instance, mother of pearl, or of pearl shell.

JUXTAPOSITION—The position of two rocks or formations along side of each other; neither above nor below the other.

KAINOZOIC—Literally, containing recent life, or life in its recent forms. The zoic period of our globe, or that period in which life existed upon the surface of our globe, is, as Table I. exhibits, divided in three ages; the kainozoic is the last.

KLASTIC—Not original, but derived from other material.

LACUSTRINE—Derived from lakes or ponds.

LAMELLIBRANCHIATES—Molluscs or shells, the inhabitants of which are provided with an intestinal bag, having a cutaneous cover with two lobes or appendages, and generally a shell with two valves joined on the back of the animal. Generally they have also two gills.

LAMINATED—Divided in layers as thin as the blade of a knife (lamen), like slate.

LENTICULAR—In the shape of a lens.

LIGNITE—Wood converted into a less perfect coal than the common stone-coal.

LOESS or Lehm—Originally the German expression for loam, or a mixture of sand and clay, but meaning, in this report, a particular kind of loam described on page 251, and the following pages.

LITHOLOGICAL—Concerning the mineral structure or character of a rock or mineral mass.

MAMMOTH—Elephas primigenious, a species of the elephant, extinct since the earliest times of onr present quaternary age, the fossil remains of which are especially found in Siberia, but also in Europe, and on this Continent.

MARINE—Derived from the sea, or made by the sea, as marine deposits.

MARL—For the explanation of the term "marl" see the Appendix.

MATRIX—The surrounding or enveloping rock in which a fossil is found and taken from.

MEZOZOIC—Containing life, or the relics of life, in its intermediate station. The mezozoic age is intermediate between the palaeozoic and kainozoic, as table I. shows.

METAMORPHIC—Changed. metamorphosed by heat. The metamorphic rocks are stratified highly crystalline rocks lying immediately upon the granite, under those rocks which contain fossils, and are, therefore, also called hypogene. They consist principally of gneiss (pronounce nice). mica, slate, or schist, marble, hornblendic schist, quartzit, &c.

MICA—A simple mineral finely laminated and capable of being split in very fine transparent panes of great elasticity. It is frequently divided by disintegration in very brilliant scales. glistening like silver, which are found among sand or clay, which are then called *micaceous*.

MIOCENE—The second division of the tertiary rocks, the fossils of which, although not half referable to living shells. appear more recent than those of the eocene division; whence the name, from two corresponding words of the Greek language.

MILLSTONE-GRIT—A rock of the carboniferous formation overlying the

MOUNTAIN LIMESTONE—An immensely thick stratum of limestone, generally of greenish gray color, and full of fossils. The millstone grit underlies the coal-measures, and is, therefore, the intermediate; the mountain limestone the lower stratum of the carboniferous formation.

MOLASSE, or Molasse Formation—On the northern margin of the Alps extends a very powerful formation in which gray sandstones are predominant, which are called in French Switzerland, on account of their softness, "mollasse." After this name the whole formation has been named. although consisting of several distinct parts of an age commencing from the miocene and extending to the latter part of the pliocene periods, and extending in a lengthy basin along the base of the Alps and the Carpathian mountains.

MOLLUSCA, or Mollusc—Animals destitute of all bones, and with very soft bodies. All shells and muscles belong to this class of animals.

NAGELFLUHE—An expression of geologists of Switzerland, meaning powerful accumulations of conglomerate pebbles, in which fragments of limestone are predominant. The larger conglomerates contain frequently remarkable impressions of smaller ones.

NODULE—A rounded irregular mass.

NUCLEUS—A kernel surrounded by a shell.

OVATE—In the shape of an egg.

OXIDE—A combination of any metallic or mineral body with a certain proportion of oxygen; if the proportion is greater, an acid is formed in many instances.

PALAEONTOLOGY—From three Greek words, meaning, literally, the doctrine of old beings. In modern acceptation it is the science that treats of the remains of beings, animal as well as vegetable, which have lived on our globe in its different conditions, anterior to the existence of man, and left their remains in our rocks.

PALAEOZOIC—A name given to those rocks which contain the remains of animal and vegetable life in its primitive forms. Table I. will explain the position of the palaeozoic rocks.

PEROXIDE—A metallic substance, having combined with more than one proportion of oxygen, as peroxide of manganese, &c.

PHANERO-CRYSTALLINE—The crystallization being perfectly visible.

PHYTOGENE—Derived from vegetables or plants.

PETROGRAPHIC—Synonymous with lithological.

PLASTIC—Perfectly pliable. Plastic clay is such as can be used for pottery and modelling.

PLEIOCENE—Literally more recent. The pleiocene formation overlies the miocene and more of its fossils can be referred to living species than from those of the miocene formation—whence the name.

PLEISTOCENE—Literally most recent. The pleistocene formation overlies the pleiocene, and more of its fossils than from any other tertiary formation can be referred to modern or living species, consequently *most* of all the tertiary rocks; thence the name.

PLUTONIC ROCKS—Such as are believed by geologists to have become solid after having been in an igneous fusion, or in a melted state.

POLYTHALAMIA—Formerly also called rhizopoda, or foraminifera; small microscopic infusoria belonging, according to Ehrenberg, to the bryozoa. They move freely about, and are not fixed. Ehrenberg has discovered that whole geological formations consist of such minute animals; as for instance, nearly the whole cretaceous formation.

PRECIPITATION—Falling down from a more elevated position to a lower one. Precipitations from the clouds are all those aqueous bodies that fall from the clouds, as rain, snow, hail, dew, &c.

PROTOSULPHATE—A combination of sulphuric acid with a body in combination with one proportion of oxygen only. Protosulphate of iron is a combination of sulphuric acid with protoxide of iron, or iron in the first state of oombination with oxygen.

PROTOZOIC FORMATIONS—Those formations in which life appeared first in most curious aud singular forms. Compare note 2, page 263.

PSEUDOMORPHOSED—A second time changed; for instance, if a vegetable or animal body originally petrified by silica or lime is re-petrified by oxide of iron, or *vice versa*.

PUDDING-STONE—A stone consisting of *round, not angular*, pebbles cemented together.

PULMONATES—Provided with lungs to breathe air.

PUMICE-STONE—A spongy, chiefly feldspathic. lava of greyish color, and very low specific gravity, so much so that it swims upon the water.

PYRITES—A combination of sulphur with iron of the color of brass; it is very deceptive, and often mistaken for gold, wherefore it has received the name of "*fool's gold.*"

QUADER—A sandstone found in Germany, and belonging to the cretaceous formation, more particularly to the green sand; it has received its name from the property of splitting in squares and cubes.

QUARTZOSE—Containing the simple mineral of quartz, composed of silex.

QUATERNARY—The geological period following after the tertiary is called the quaternary, being the fourth period in which animal and vegetable life existed. It is the period in which we live, and is, therefore, also called the human period, or reign of man.

RADIATA, or Radiate Animals, are such as show organs radiating from the centre towards the surface. Their mouth is mostly in the middle. They live all in the water, and, with a few exceptions, in the sea. Star fishes are such animals.

REGULUS—The pure metal appearing from under the dross after application of heat.

ROCK—Concerning the use of this term in this report see note 3, page 263.

SCHIST—A rock with a kind of slaty cleavage, but not apt to be split in so even and thin lamina as rocks which have a real slate cleavage. There are mica and hornblendic schists.

SCHISTOSE—Resembling schist, and being laminated like it. Clay is often schistose.

SEAMS—Thin layers separating strata of greater thickness.

SECONDARY AGE—The second age in which organic life appeared. We commence it with the triassic formation; compare Note 7, page 265. For its position and rocks see Table I.

SEDIMENTARY ROCKS—Such as have been formed by deposition of material suspended in water.

SHALE—Indurated clay appearing like slate.

SHELL MARL—See Appendix, p. 321.

SHINGLE—The pebbles found along sea beaches are called shingle.

SILICA—Latin, silex, meaning flint. It contains oxygen, and is also called silicic acid.

SILICIFIED—Transformed into silica, as flint, and many fossils.

SILICIOUS—Containing flint or silicious acid.

SILT—The finely divided material consisting of clay, sand, and vegetable, or, in general, organic matter transported and accumulated by running water. The mouths of rivers contain, generally, considerable layers of it. It is famous for its fertility as an arable soil. Our Mississippi river contains immense deposits of such silt.

SILURIAN—The name of the first formation in which the remains of organic life appear. The name originated from Sir R. Murchison, of England.

STALACTITES—Appendages similar to icicles, formed by water holding carbonate of lime in solution, and hanging down from the ceilings of caverns.

STALAGMITES—When water, holding carbonate of lime in solution, drops down from the ceilings of caverns on the floor, it forms an uneven undulated crust which is called stalagmite, to distinguish it from stalactite.

STRATUM—A layer of mineral matter in our earth. Plural, strata.

STRATIFIED—Consisting of layers whose separation is visible.

STRIKE—The extension, or rather the line of bearing, of terrestrial strata at right angles with the dip.

SULPHATE—A combination of any element or simple substance with sulphuric acid.

SULPHURET—A combination of any metal with sulphur.

SYNCLINAL AXIS—The opposite of "Anticlinal Axis:" when strata dip from opposite directions to an intermediate point or line.

TALUS—The accumulation of matter broken off by the action of the atmosphere from the top or face of a hill, bluff, or mountain, on the base of such hill, bluff, or mountain. Diagram No. 31, page 150, shows a talus at B; diagram No. 32 page 152, at e.

TERTIARY AGE—The third age, containing the fossil remains of organized life. The tertiary strata or rocks formed during this age, overlie the secondary, and are overlaid by the quaternary rocks.

TERRA SIGILLATA—Red clay, used formerly for making sealing-wax.

TETRAHEDRA—Crystals with four facets are called tetrahedra; with eight, octohedra; with twelve, dodecahedra; etc

TILL—A name for the diluvial deposits.

TRANSITION FORMATION—For explanation see Note 2, page 263.

TRILOBITE—A fossil marine animal, similar to an insect, having the body divided into three lobes. The trilobites appear first in the silurian, and extend to the carboniferous formation; there are many genera and species.

TUFA—Porous matter ejected from a volcano.

TUFACEOUS—Resembling tufa, and being of a loose and porous structure.

UPHEAVAL—When the surface of the earth is raised by internal extension, or any other catastrophe. Most mountains originate from such upheavals.

VEIN—Fissures and cracks in rocks, filled by material quite different from the cracked rock. Metallic veins are called lodes—very large veins, and veins consisting of trap-rock "dykes." Veins are sometimes very wide, and miles long, and branch out into many smaller parts.

ZOIC—Filled with life, or the remains of life. The zoic age is that which is characterized by the remains of organic life; its formations are exhibited in Table I.

ZOOGENE—Originating from animal life or bodies. Zoogene fossils are all those which were once bodies, or parts of bodies, of animals of any description.

ERRATA.

Page 12, line 12 from top, read *for* instead of "but."
" 31, line 2 from bottom, read (3. *a*.) instead of "(3.)"
" 34, line 12 from bottom, read *carboniferous* instead of "carbonaceous."
" 41, line 2 from top, read *different formations* instead of "carboniferous formations."
" 49, line 8 from top, read *fucoids* instead of "fucoides."
" 63, line 6 from bottom, read (31) instead of "(30.)"
" 85, line 18 from bottom, read *exogyra turritella* instead of "exogyra tunitella."
" 92, in diagram No. 15, in the middle of the triangular hollow, read *d* instead of "e."
" 92, line 1 from bottom, add c to ferruginous.
" 100, line 13 from bottom, read *radiates* instead of "radiats."
" 100, line 9 from bottom, after *enumerated* insert fossils.
" 114, line 9 from bottom, read *counties* instead of "conntics."
" 121, line 3 from top, read *other* instead of "ether other."
" 136, line 15 from bottom, read *cretaceous lime group* instead of "lime group."
" 145, line 6 from top, read *it is* instead of "and is."
" 161, line 14 from bottom, read *Cassidaria* instead of "Cassædaria."
" 161, line 2 from bottom read *Ceriopora* instead of "Ceriopara."
" 190, line 19 from top, read *equisetum* instead of "equiretum."
" 286, line 14 from bottom, read *a Professor of Modena* instead of "Professor Modena."
" 310, line 17 from bottom, the semicolon should come after *of*.
" 316, line 5 from top, read *soon more light* instead of "more light soon."
" 327, line 7 from top, read *Erlaeuterungen* instead of "Erlaueterungen."
" 335, line 3 from top, read 2.230 instead of "2230."

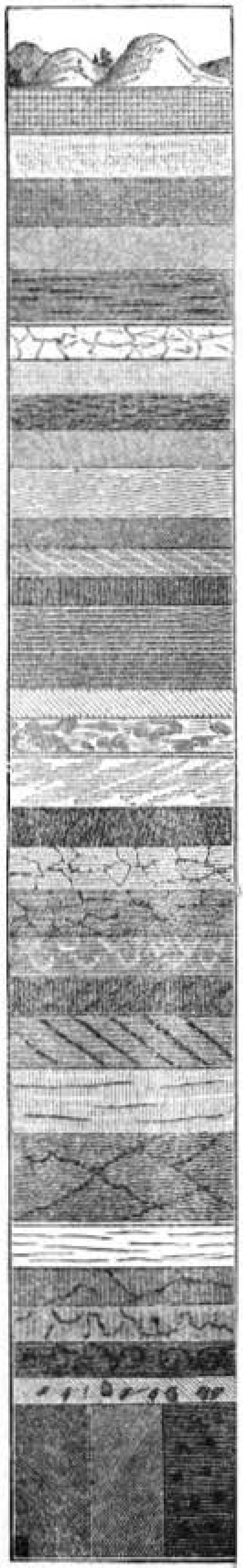
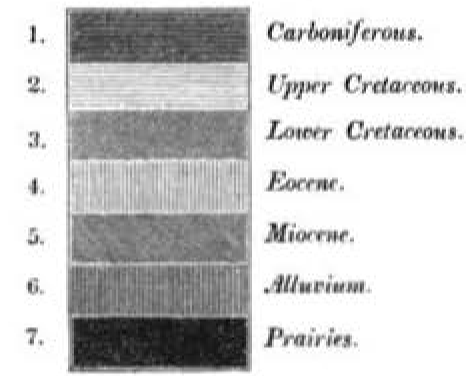
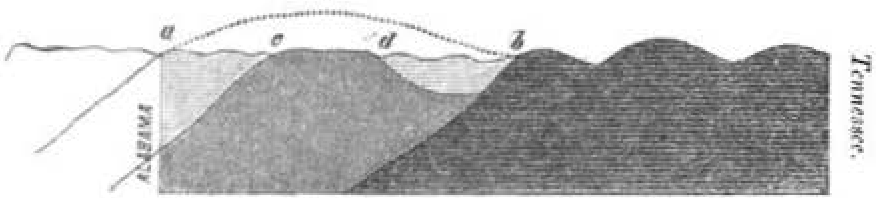
GEOLOGICAL AGES.			NAMES OF THE FORMATIONS.		GEOLOGICAL FORMATIONS
ZOIC PERIOD.	QUATERNARY OR HUMAN AGE		*Alluvium,*		
			Postpleiocene,		
	TERTIARY OR KAINOZOIC AGE		*Pleistocene,*		
			Pleiocene,		
			Miocene,		
			Eocene,		
	SECONDARY OR MESOZOIC AGE		*Cretaceous,*		
			Wealden,		
			Oölitic,	*Jurassic,*	
			Liassic,		
			Triassic,	*Poikilitic,*	
	PRIMARY FOSSILIFEROUS OR PALAEZOIC AGE	TRANSITION FORMATIONS	*Permian,*		
			Carboniferous,		
			Devonian,		
			Silurian,		
AZOIC PERIOD.	PRIMARY ROCKS	STRATIFIED	*Metamorphic System,*		
		UNSTRATIFIED	*Granitic System,*		

TABLE II.

LATITUDINAL SECTIONS OF THE STATE OF MISSISSIPPI FROM N. TO S.

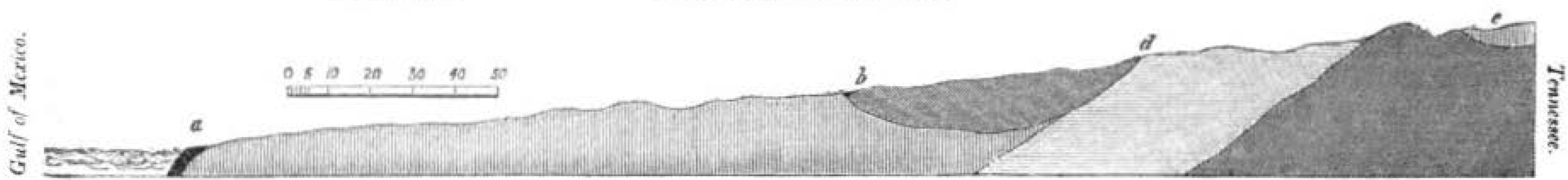


No. 1.—Under the 88th degree, 20 min. of Lon. from Greenwich.



Scale of Miles.

No. 2.—Under the 89th degree.



No. III.—Under the 90th degree, 10 min.

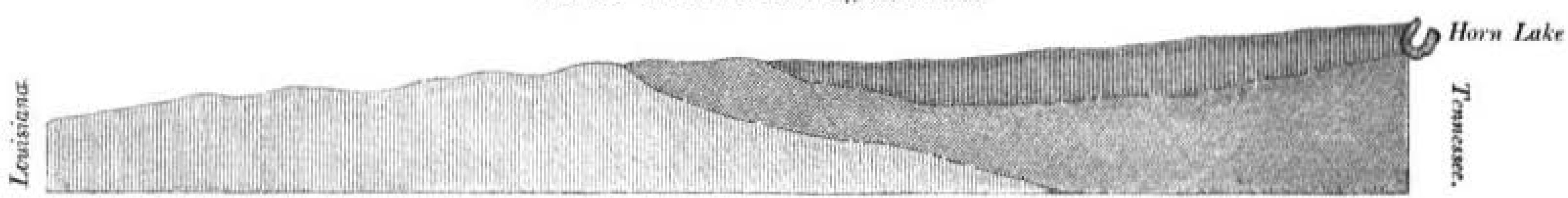
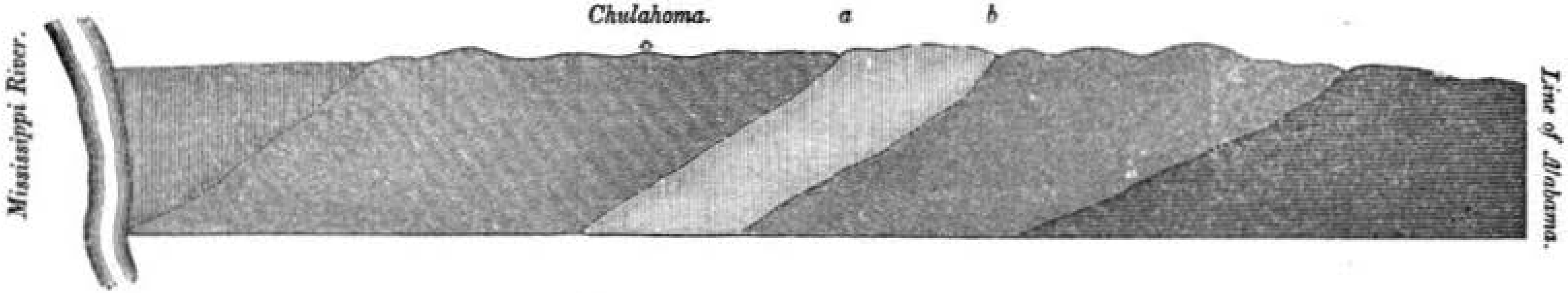


TABLE III.

LONGITUDINAL SECTIONS OF THE STATE OF MISSISSIPPI FROM E. TO W.

No. 1.—Under the 34th degree, 40 min. of North Lat.



No. 2.—Section under the 33d degree, 50½ min. North Lat.

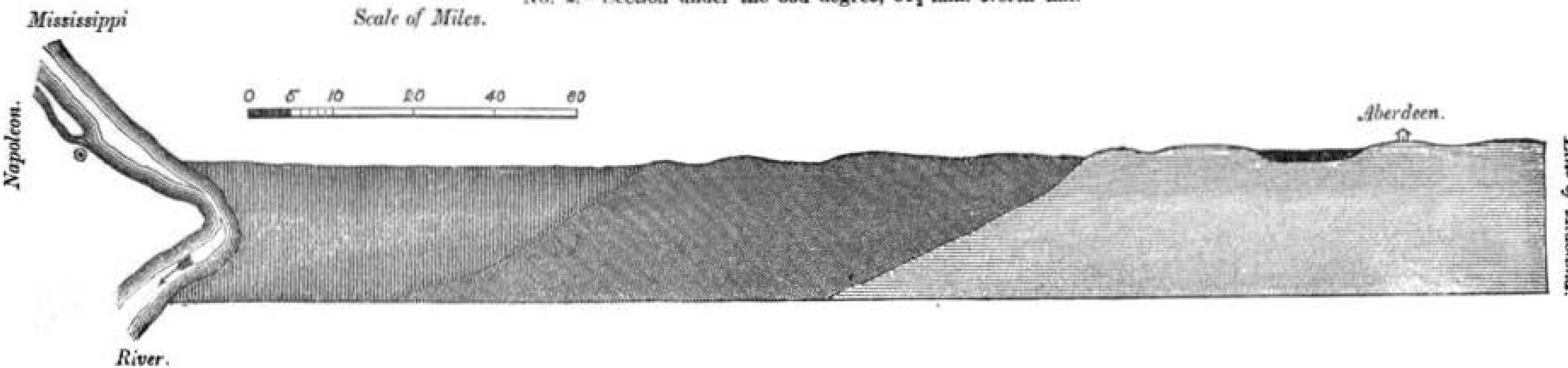
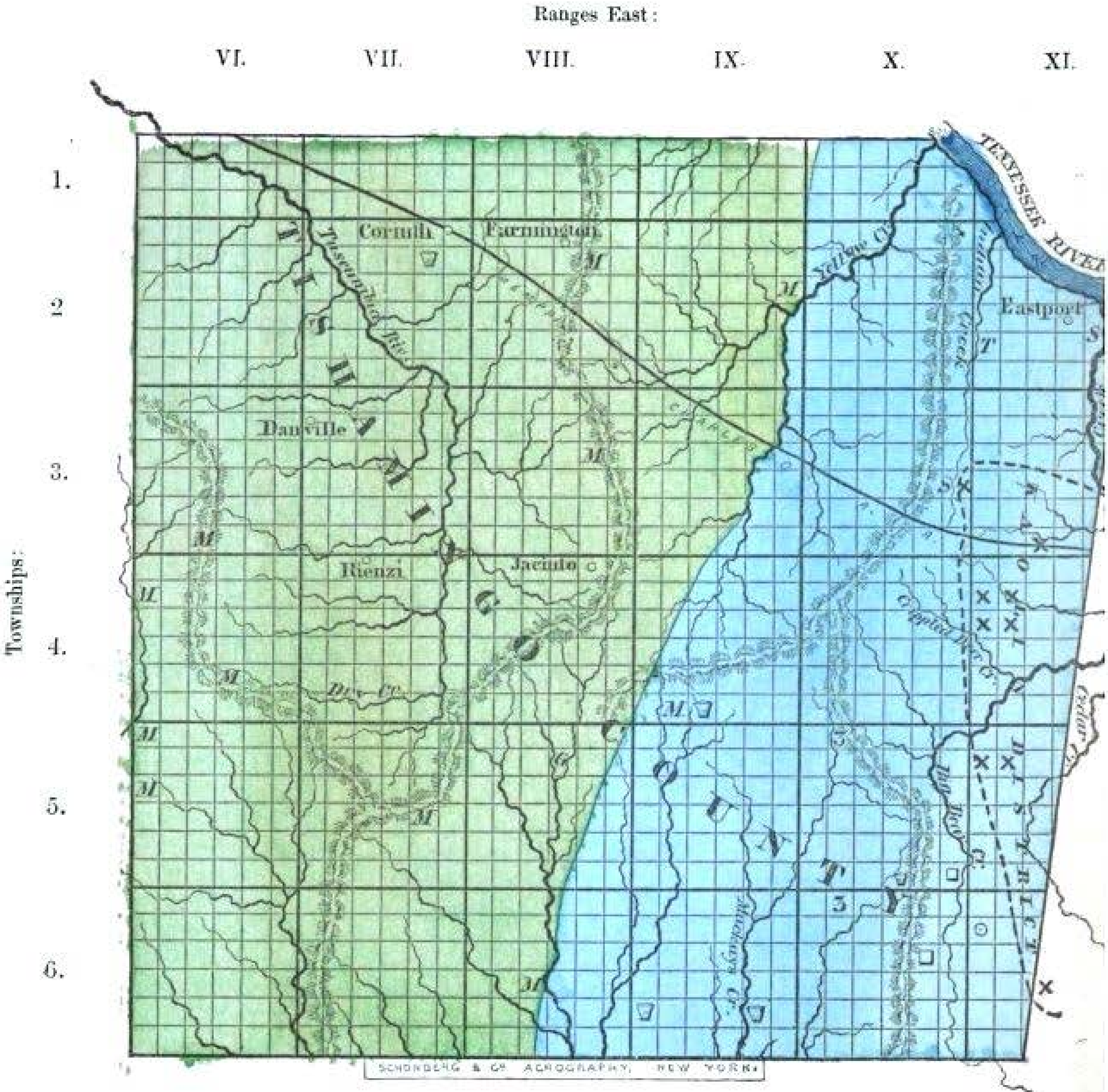


TABLE IV.

TISHAMINGO COUNTY.



Sections of one Square Mile.

6	5	4	3	2	1	
7	8	9	10	11	12	*Lower Cretaceous.*
18	17	16	15	14	13	
19	20	21	22	23	24	
30	29	28	27	26	25	*Carboniferous Formations.*
31	32	33	34	35	36	

S *Outcrop of Silica.*
T " *of Terra Sigillata.*
G *Greensand.*
M *Marl.*
Numbers refer to diagrams.
Mineral Springs.
Quarries of Stone.
Millstone Quarry.
Outcrop of Kaolin.

TABLE V.

THE PRAIRIES ABOVE TIBBY CREEK.

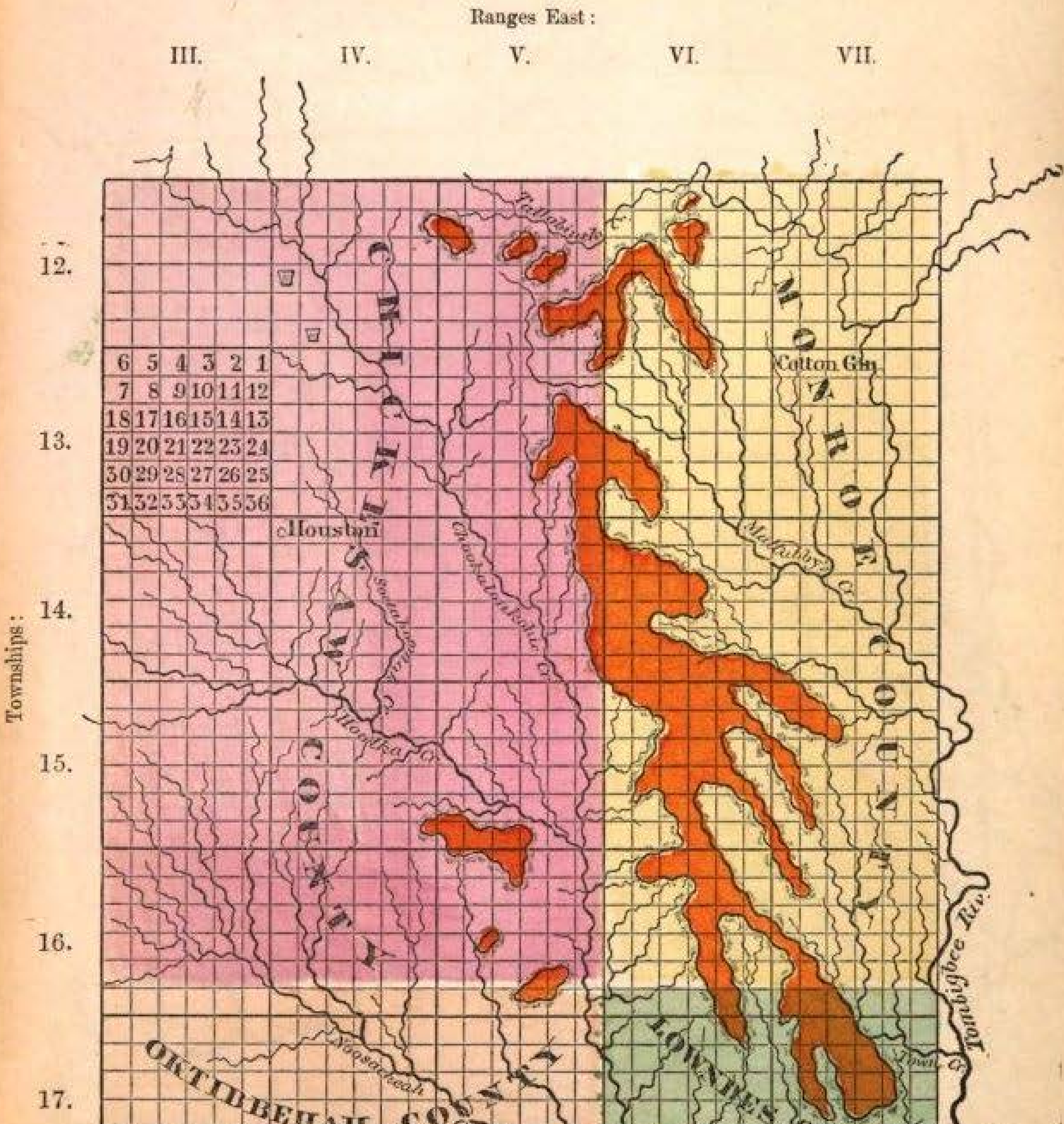


TABLE VI.

PONTOTOC COUNTY.

Ranges East :

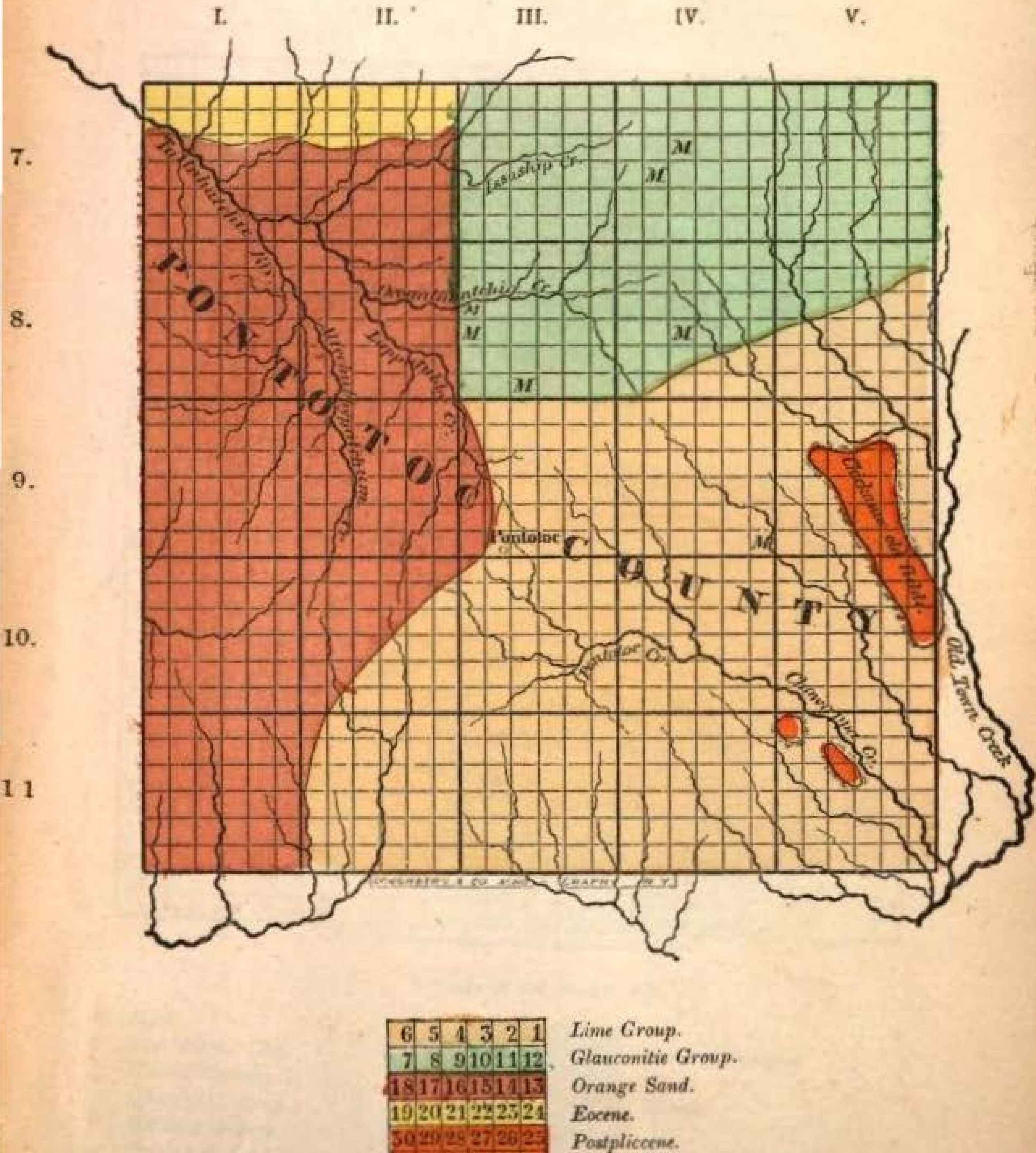
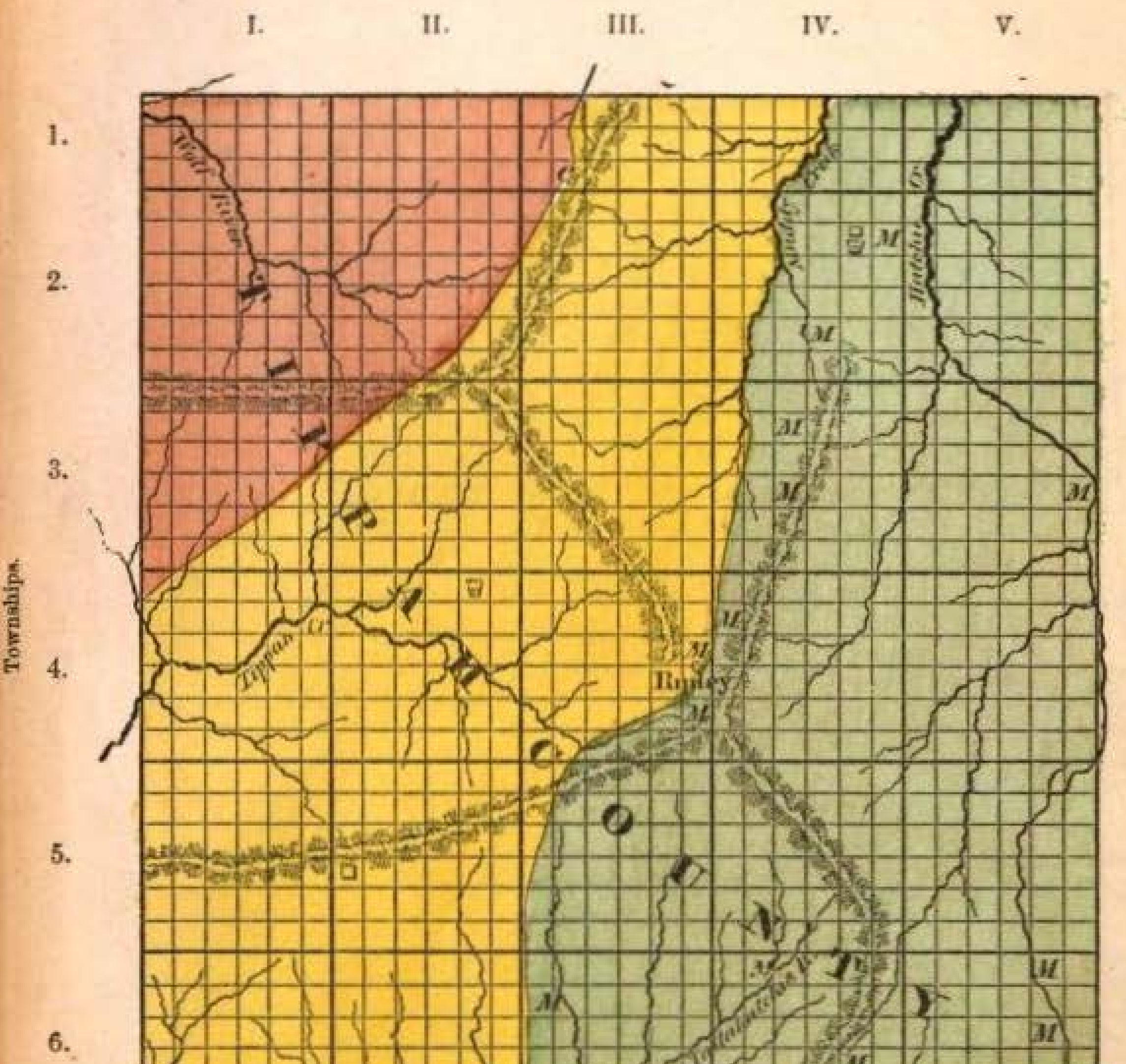


TABLE VII.

TIPPAH COUNTY.



Sections of one Square Mile.

M *Marl.*
C *Fine Plastic Clay.*
Mineral Springs.
Quarries of Stone.
Millstone Quarry.
Outcrop of Kaolin.